# Manchester • Boston Regional Airport
# City of Manchester - Department of Aviation

## AIRFIELD LIGHTING VAULT EXPANSION

## FAA AIP No. 3-33-0011-TBD-2025
## Bid # FY25-804-38

**PROJECT MANUAL**

**March 2025**
**ISSUED FOR BID**

**PREPARED BY:**

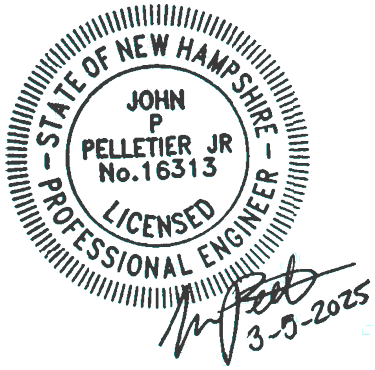
**JACOBS ENGINEERING GROUP INC.**
**2 EXECUTIVE PARK DRIVE, SUITE 205**
**BEDFORD NH 03110**

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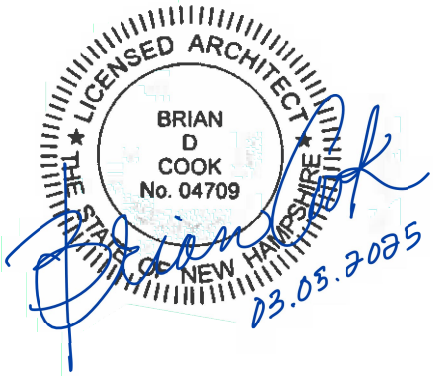
SEALS




CIVIL ENGINEER OF RECORD
JOHN PELLETIER, PE
NEW HAMPSHIRE PE No. 16313
SHEETS G001 - C503
AND ASSOCIATED TECHNICAL
SPECIFICATIONS



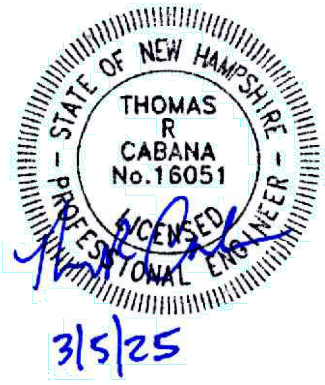

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SPECIFICATIONS




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SPECIFICATIONS




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SHEETS E000 - F101
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**ADVERTISEMENT FOR BIDS**

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**ADVERTISEMENT FOR BIDS**
**CITY OF MANCHESTER - DEPARTMENT OF AVIATION**
**REQUEST FOR BIDS FOR**

***AIRFIELD LIGHTING VAULT EXPANSION***
***at***
**MANCHESTER-BOSTON REGIONAL AIRPORT**

***City Bid # FY25-804-38***
***AIP # 3-33-0011-TBD-2025***

The City of Manchester, New Hampshire, Department of Aviation is seeking bids for the **Airfield Lighting Vault Expansion**. The scope of the work in general includes expansion of the airfield lighting vault (including new regulators), asphalt and concrete pavement removal, asphalt paving, storm drainage replacement, airfield lighting home run duct bank and cabling, perimeter fencing demolition and installation, and airfield markings.

Bids will be accepted only from contractors that meet the Department of Aviation qualification requirements. Refer to the project manual for the qualification requirements.

Bid documents may be obtained by emailing John.Pelletier@jacobs.com after **4:00 PM on March 5, 2025.**

A pre-bid informational meeting will be held in-person at the Airport administrative offices boardroom located on the third floor of the Airport terminal at One Airport Road, Manchester, NH on **March 19, 2025 at 2:00 PM** Prospective bidders shall RSVP not less 24 hours prior to the meeting through Ms. Christina Adams at the Airport Engineering and Planning Office who can be reached at (603) 624-6539 or cadams@flymanchester.com. There is no virtual meeting option.

Bids will be publicly opened and read aloud on **April 2, 2025, at 2:00 pm** at the Airport administrative offices boardroom located on the third floor of the Airport terminal at One Airport Road, Manchester, NH. Each bidder must deposit with his/her bid, security in the amount of 5% of the total bid. A 100% performance and payment bond will be required with the contract. The contract will be awarded to lowest responsive and responsible bidder. The Bidder shall refer to all federal, state, and local bidding requirements within the documents. The Owner reserves the right to waive any informality in the bidding or to reject any or all bids.

In this bid process and the resulting Contract, if executed, all Bidders and Contractors must fully comply with the Required Contact Provisions for Airport Improvement Program and for Obligated Sponsors contained within the Contract Documents. These provisions include, but are not restricted to, Disadvantaged Business Enterprise (DBE) Subcontractor participation, Equal Employment Opportunity requirements, and compliance with Federal Wage and Hour requirements (Davis-Bacon Act). All requirements of the Federal funding and, as well as all administrative regulations shall apply to this project, as if herein written out in full. The attention of prospective bidders is called to the fact that this project is to be bid upon and the contract executed, under the Federal Funding Rules and Regulations for carrying out the provisions of:

- Civil Rights General Provisions (Title 49 United States Code, § 47123)
- Title VI Provisions of the Civil Rights Act of 1964, as amended and supplemented
- Buy American Preferences (Title 49 United States Code, §50101), BABA and other related U.S. statutes, guidance, and policies of the FAA
- Foreign Trade Restriction: Denial of Public Works Contracts on Suppliers of Goods and Services of Countries that Deny Contracts to Suppliers of Goods and Services of Countries that Deny Procurement Market Access to U.S. Contractors (DOT Regulation 49 CFR Part 30)
- Davis-Bacon Act (DOL Regulation 29 CFR Part 5)
- Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246, as amended, and DOL Regulation 41 CFR Part 60)
- Government Debarment and Suspension and Government-wide Requirements for Drug-free Workplace (2 CFR Part 180 (Subpart C), 2 CFR part 1200, DOT Order 4200.5 DOT Suspension & Debarment Procedures & Ineligibility)

The requirements of 49 CFR Part 26, Regulations of the U.S. Department of Transportation, apply to this contract. Award of this contract will be conditioned upon satisfying the requirements of this section. These requirements apply to all bidders/offerors, including those who qualify as a DBE. A DBE contract goal of **8.0%** has been established for this contract. The bidder/offeror shall make good faith efforts, as defined in Appendix A, 49 CFR Part 26, to subcontract **8.0%** of the dollar value of the prime contract to Disadvantaged Business Enterprises (DBE), as defined in 49 CFR Part 26.

The Manchester-Boston Regional Airport in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 USC §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders or offerors that it will affirmatively ensure that for any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit responses to this invitation and no businesses will be discriminated against on the grounds of race, color, national origin (including limited English proficiency), creed, sex (including sexual orientation and gender identity), age, or disability in consideration for an award.

All requests for information should be directed in writing to: John Pelletier, PE, Jacobs Engineering Group, Inc., by email at John.Pelletier@jacobs.com

It is the bidder's responsibility to provide an e-mail address to the Engineer for use in issuance of any addenda.

**END OF SECTION**

# INFORMATION FOR BIDDERS

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# INFORMATION FOR BIDDERS

## 1.01 RECEIPT AND OPENING BIDS

The City of Manchester, Department of Aviation, Manchester, New Hampshire (herein called the Owner), invites bids on the form attached hereto, all blanks of which must be appropriately filled in. Bids will be received by the Manchester-Boston Regional Airport Administration Office at One Airport Road Manchester, NH until **2:00 pm on April 2, 2025** and then at said office publicly opened and read aloud.

The envelopes containing the bid must be sealed, addressed and designated as:

**Airfield Lighting Vault Expansion**

The Owner may consider irregular any bid not prepared and submitted in accordance with the provisions hereof and may waive any informalities or reject any and all bids. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid prior to November 1, 2025.

## 1.02 DESCRIPTION OF WORK

The work under this project generally consists of an expansion of the airfield lighting vault (including new regulators), construction of new home run duct bank, airfield lighting cabling, asphalt and concrete pavement demolition, asphalt paving, storm drainage replacement, perimeter fencing demolition and installation, and airfield markings.

All areas of the airport disturbed by the Contractor's operations not within the construction limits as set forth by the Owner shall be restored at least equal to original condition at no cost to the Owner.

Attention shall be directed to the Contract Documents for specific information of the work to be performed. The Contract Documents consist of the plans and project manual.

## 1.03 PREPARATION OF BID & METHOD OF AWARD

Each bid must be prepared in strict accordance with the requirements of Section 20 of the General Provisions of these specifications.

The Owner reserves the right to reject any or all proposals for any reason the Owner deems advisable. Further, the owner reserves the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts. Award of contract will be made by the Owner upon the recommendation of the Engineer to the lowest, eligible, responsive bidder meeting the requirements of the Owner, the Federal Aviation Administration and the State of New Hampshire.

**The Contract will be awarded to the Contractor with the lowest qualified total bid for the Base Bid.**

**Should all bids exceed the available funding for the project, the Owner may reject all bids or may delete work items altogether, if necessary to bring the Contract awarded within funds available to finance the project. Such reduction or deletion of work shall not constitute a basis for withdrawal of the proposal or for adjustment of the unit or lump sum prices bid – subject to the limitations**

**described in Section 40 of the General Provisions. Award will be based on available funding.**

Notice of the acceptance of this proposal will be given to the successful bidder by the Owner posting a letter to the bidder's address stated in said proposal. If within 15 calendar days after this day when such notice was given, the successful bidder shall fail to deliver his/her bonds properly executed and his/her contract duly signed, in consideration of such failure, this proposal and acceptance, at the option of the Owner, may become null and void, and the bid guaranty accompanying his/her proposal shall become the property of the Owner which may proceed to accept another of the proposals.

## 1.04 SUBCONTRACTS

The bidder is specifically advised that any person, firm, or other party to whom it is proposed to award a subcontract under this Contract must be acceptable to the Owner and the Federal Aviation Administration.

The successful bidder will be required to submit a list of his/her subcontractors within 5 business days of the opening of Bids and before the award of a contract.

## 1.05 BIDDER'S QUALIFICATIONS

All Bidders for projects with an estimated cost in excess of $250,000 must be pre-qualified by the Manchester-Boston Regional Airport. Refer to Section 20-02 for additional information. Complete the qualification requirements provided in the bid proposal.

## 1.06 BID MODIFICATION

Any bidder may modify his/her bid by written communication at any time prior to the schedule closing time for receipt of bids, providing such written communication is received by the Owner prior to the bid closing time. The written communication should not reveal the bid price but should provide the addition or subtraction or any other modification so that the final prices or terms will not be known by the Owner until the sealed bid is opened.

## 1.07 PROPOSAL GUARANTY BID SECURITY

Each bid must be accompanied by cash, certified check of the bidder, or a bid bond prepared on the form of bid bond included in the Contract Documents in the amount of 5% of the bid, duly executed by the bidder as principal and having as surety thereon a surety company approved by the Owner. The bid bond shall be executed or countersigned for the surety by a person who has current power of attorney for the surety.

The bid security will be returned to all except the two lowest bidders within three days after the opening of bids, and the remaining cash, checks, or bid bonds will be returned promptly after the Owner and the accepted bidder have executed the Contract, or, if no award has been made prior to **November 1, 2025,** upon demand of the bidder at any time thereafter, so long as he has not been notified of the acceptance of his bid.

## 1.08 TIME OF COMPLETION/CONSTRUCTION DURATION AND LIQUIDATED DAMAGES

The construction duration is as stated in the Bid Proposal. The Notice to Proceed will be for the construction period. The bidder must agree to commence work on a date to be specified in the following written Notice to Proceed of the Owner and to fully complete the project within the calendar days as specified on in the plans. Bidder must agree to pay to the Owner as liquidated damages the sum of two

thousand five hundred dollars ($2,500.00) for each and every calendar day the work remains incomplete beyond the above specified time.

## 1.09 SECURITY FOR FAITHFUL PERFORMANCE

Simultaneously with his/her delivery of the executed Contract, the successful bidder shall furnish Surety bonds as security for faithful performance of this Contract and for the payment of all persons performing labor on the project under this Contract and furnishing materials in connection with this Contract, as specified in the General Provisions included herein. The bonds shall be of the form provided hereinafter and shall be executed by Surety acceptable to the Owner. The bonds shall be executed by or countersigned by an agent for Surety and said agent to have current power of attorney for the Surety. Each bond shall be in the amount of 100% of Contract awarded. Contractors should also submit with all bonds evidence showing the financial strength of the Surety.

Prior to the final payment for the project, the Contractor shall deliver to the Owner a Warranty Bond in the amount of 5% of the final cost of the construction.

## 1.10 ADDENDA AND INTERPRETATIONS

No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any bidder orally. Every request for such interpretation shall be in writing addressed to Nick Deres, Project Manager with Jacobs Engineering Group Inc., 2 Executive Park Drive, Bedford, NH 03110, by email at John.Pelletier@jacobs.com and to be given consideration, must be received at least three (3) working days prior to the date fixed for the public opening of bids. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications which, if issued, will be mailed by certified mail with return receipt requested, sent Federal Express, or faxed, or emailed to all prospective bidders (at the respective address or fax number furnished for such purposes), not later than one (1) working days prior to the date fixed for the opening of bids. Failure of any bidder to receive any such addendum or interpretation shall not relieve such bidder from any obligation under his/her bid as submitted. All addenda so issued shall become part of the Contract Documents. All requests for interpretation must be received at least 72 hours prior to the bid opening.

## 1.11 POWER OF ATTORNEY

Attorneys-in-fact or others who sign bid bonds or contract bonds must file with each bond a certified and effectively dated copy of their power of attorney.

## 1.12 LAWS AND REGULATIONS

The bidder’s attention is directed to the fact that all applicable Federal and State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the Contract throughout, and they will be deemed to be included in the Contract the same as though therein written out in full. The Contractor shall be responsible for payment of all taxes, fees, and assessments as levied by Federal, State and Local authorities.

## 1.13 EXECUTION OF CONTRACT

The individual, firm, partnership, or corporation to whom or to which the Contract has been awarded shall sign the necessary agreements entering into a Contract with the Owner and return them to the Office of the Owner (with the required contract bonds) within 15 calendar days after the Contract is mailed.

## 1.14 APPROVAL OF CONTRACT

Approval of the Contract shall be in accordance with paragraph 30-07 of the General Provisions. No Contract is binding upon the Owner until it has been executed by the Owner and delivered to the Contractor.

## 1.15 FAILURE TO EXECUTE CONTRACT

Failure of a bidder to comply with any of the requirements of the proposal, failure to execute the Contract within 15 days after mailing, as specified, or failure to furnish contract bonds as required shall be just cause for the annulment of the award. In the event of such annulment of the award, the amount of bid security shall become the property of the Owner, not as a penalty but as fixed and agreed liquidated damages. Award may then be made to the next best qualified bidder, or the work re-bid, or otherwise handled as the Owner may elect.

## 1.16 NOTICE OF SPECIAL CONDITIONS

Attention is particularly called to those parts of the Contract Documents which deal with the following:

a. Inspection of work.
b. Insurance requirements.
c. Scheduling the contract work.
d. Liquidated damages.
e. Airport safety and security.
f. Buy American Act.
g. Wage Rates.

## 1.17 EMPLOYMENT OF WOMEN

Women will be afforded equal opportunity in all areas of employment. However, the employment of women shall not diminish the standards or requirements for the employment of minorities.

## 1.18 EQUAL EMPLOYMENT OPPORTUNITY

a. Each bidder will be required to comply with the affirmative action plan for equal employment opportunity prescribed by the OFCC, United States Department of Labor, Regulations of the Secretary of Labor (41 CFR 60), or by other designated trades used in the performance of the contract and other non-federally involved contracts in the area geographically defined in the plan.

b. The proposed contract is under and subject to Executive Order 11246 of September 26, 1965, as amended, and to the equal opportunity clause; and

c. The successful bidder will be required to submit a Certification of Nonsegregated Facilities prior to award of the contract, and to notify prospective subcontractors of the requirement for such a certification where the subcontract exceeds $10,000. Samples of the certification and the notice to subcontractors appear in the specifications.

d. When a determination has been made to award a contract or subcontract to a specific contractor, such contractor is required, prior to the award or after the award, or both, to furnish such other information as the FAA, the sponsor, or the Director of OFCC requests.

e. A bidder must indicate whether he has previously had a contract subject to the equal opportunity clause, whether he has filed all report forms required in such contract, and if not, compliance report Standard Form (SF) 100 must be submitted with his bid.

f. Equal Employment Opportunity (EEO) and labor provisions, when applicable, are included in the bidding documents of specifications.

g. Contractors and subcontractors may satisfy EEO requirements of paragraph 2 of the EEO contract clause by stating in all solicitations or advertisements for employees that: "All qualified applicants will receive consideration for employment without regard to race, color, sex, or national origin." or by using a single advertisement in which appears in clearly distinguished type, the phrase: "an equal opportunity employer".

h. A contractor having 50 or more employees and his subcontractors having 50 or more employees and who may be awarded a subcontract of $50,000 or more will, within 120 days from contract commencement, be required to develop a written affirmative action compliance program for each of its establishments (state and local governments are exempt).

## 1.19 Electronically Provided Bid Documents

Bid Documents provided electronically are provided as a convenience to the Bidder and are not the controlling data for the contract. The original hard copy (paper) contract plans and specifications and modifications thereto reviewed and signed by the Engineer are the legal construction documents and shall be used for interpretations and determinations for the project, overriding any alterable electronic files. Bidder agrees to accept full responsibility for their use of the electronic files and the completeness, correctness, and/or readability of the electronic media file, and shall indemnify, defend, and hold harmless, Jacobs Engineering Group, Inc. and the Owner from any and all claims (including third party) arising from discrepancies between the electronic media file and the sealed drawings or report.

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**BID PROPOSAL**

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**PROPOSAL**

**for**

***AIRFIELD LIGHTING VAULT EXPANSION***
**at**
**Manchester • Boston Regional Airport**

Proposal of _____ (hereinafter called "Bidder") a

corporation organized under the laws of the State of _____, a partnership, or an

individual** doing business as_____, to the **City of Manchester,**

**New Hampshire, Department of Aviation** (hereinafter called "Owner").

The bidder in compliance with your invitation for bids for the construction of airport improvements having examined the plans and specifications with related documents and the site of the proposed work if required, and being familiar with all of the conditions surrounding the construction of the proposed project including the availability of materials, and labor, hereby proposes to furnish all plant, labor, materials, supplies, equipment, services, and to construct the work in accordance with the Contract Documents, within the time set forth therein, and at the amount in U.S. dollars provided herein. This price is to cover all expenses incurred in performing the work required under the Contract Documents, of which this proposal is a part.

Time of Completion and Liquidated Damages

Bidder hereby agrees to commence work under this Contract on the date to be specified in written "Notice to Proceed" of the Owner, and to fully complete the project within **240 calendar days.**

Bidder further agrees to pay to the Owner, as liquidated damages, the sum of **two thousand five hundred dollars ($2,500.00)** for each and every **calendar day** that the work remains incomplete beyond the time specified for milestone dates and completion as hereinafter provided in the Contract Documents.

Bidder acknowledges receipt of the addenda shown on the attached form entitled, **ACKNOWLEDGMENT OF ADDENDA**.

***** Strike out inapplicable terms.***

Bidder agrees to perform all the work described in the specifications, shown on the plans or directed, for the unit prices provided in the Bid Forms provided herein.

## ACKNOWLEDGMENT OF ADDENDA

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

Addendum No. _____ Date:

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| A-001-1 | 1 LS | Airfield Lighting Vault Expansion<br>_____Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-002-1 | 1 LS | As-Built Plans<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-002-2 | 1 LS | Aerial Photos (All Phases)<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-003-1 | 1 AL | Gate Guard Allowance<br>Fifty Thousand Dollars and Zero Cents<br>Per Allowance | $50,000 | .00 |
| G-004-1 | 1 LS | Maintenance and Protection of Traffic (Phase 1)<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-004-2 | 1 LS | Maintenance and Protection of Traffic (Phase 2)<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-004-3 | 1 LS | Contractor's Safety Plan Compliance Document (All Phases)<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| G-004-4 | 1 AL | Utility Locating Allowance<br>Seven Thousand Five Hundred Dollars and Zero Cents<br>Per Allowance | $7,500 | .00 |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| G-005-1 | 3 MO | Engineer Field Office<br>_____ Dollars and<br>_____ Cents<br>Per Month | | |
| C-102-1 | 805 LF | Installation, Maintenance, and Removal of Silt Fence<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| C-102-2 | 8 EA | Installation, Relocation, and Removal of Inlet Protector<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| C-102-3 | 1 EA | Installation and Removal of Construction Entrance/Exit<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| C-102-4 | 1 LS | Concrete Washout Area<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| C-105-1 | 1 LS | Mobilization (5%) - Included under Building Tab<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| M-001-1 | 11 EA | Bollards<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| M-002-1 | 1 AL | Contaminated Soil Removal and Replacement<br>Twenty Thousand Dollars and Zero Cents<br>Per Allowance | $20,000 | .00 |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| 304.25 | 85 CY | Gravel<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-101-1 | 535 SY | HMA Pavement Removal - 4" Nominal Depth<br>_____ Dollars and<br>_____ Cents<br>Per Square Yard | | |
| P-101-2 | 125 SY | HMA Pavement Removal - 13" Nominal Depth<br>_____ Dollars and<br>_____ Cents<br>Per Square Yard | | |
| P-101-3 | 2,730 SY | PCC Pavement Removal - 9" Nominal Depth<br>_____ Dollars and<br>_____ Cents<br>Per Square Yard | | |
| P-101-5 | 155 LF | Removal of Pipe - 12" CMP<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| P-101-6 | 250 LF | Removal of Perimeter Drain Pipe<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| P-101-7 | 1 EA | Removal of Storm Drain Structures<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| P-101-8 | 7 EA | Removal of Bollards<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| P-152-1 | 1,050 CY | Unclassified Excavation<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-152-2 | 525 CY | Embankment in Place<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-152-3 | 10 CY | Rock Excavation<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-154-1 | 575 CY | Subbase Course<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-209-1 | 580 CY | Crushed Aggregate Base Course<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-403-1 | 925 TON | Asphalt Mix Pavement Base and Surface Course (PG 76-28)<br>_____ Dollars and<br>_____ Cents<br>Per Ton | | |
| P-603-1 | 375 GAL | Emulsified Asphalt Tack Coat<br>_____ Dollars and<br>_____ Cents<br>Per Gallon | | |
| P-605-1 | 1,525 LF | Sawing and Joint Sealing Filler – HMA<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| P-610-1 | 5 CY | Concrete Sidewalks<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-610-2 | 30 CY | Concrete Equipment Pads<br>_____ Dollars and<br>_____ Cents<br>Per Cubic Yard | | |
| P-620-1 | 295 SF | Pavement Marking – Temporary Color<br>_____ Dollars and<br>_____ Cents<br>Per Square Foot | | |
| P-620-2 | 295 SF | Pavement Marking – Permanent Color<br>_____ Dollars and<br>_____ Cents<br>Per Square Foot | | |
| P-620-3 | 460 SF | Pavement Marking – Permanent Black<br>_____ Dollars and<br>_____ Cents<br>Per Square Foot | | |
| P-620-4 | 110 SF | Pavement Marking – Removal<br>_____ Dollars and<br>_____ Cents<br>Per Square Foot | | |
| D-701-1 | 155 LF | 12-Inch Reinforced Concrete Pipe (Class V)<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| D-701-2 | 275 LF | 6-Inch PVC Drain Pipe<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| D-705-1 | 30 LF | Remove & Replace 6" Perforated Underdrain Pipe<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| D-705-2 | 170 LF | Pipe Underdrains for Foundations<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| D-751-1 | 1 EA | 48-Inch Diameter Catch Basin<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| D-751-2 | 1 EA | Tie Into New Perimeter Drain System<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| T-901-1 | 2,740 SY | Seeding<br>_____ Dollars and<br>_____ Cents<br>Per Square Yard | | |
| T-905-1 | 2,740 SY | Topsoil (4" Depth)<br>_____ Dollars and<br>_____ Cents<br>Per Square Yard | | |
| F-162-1 | 115 LF | 8' Tall Chain Link Fence with Barbed Wire<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| F-162-2 | 380 LF | 10' Tall Chain Link Fence with Barbed Wire<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| F-162-3 | 1 EA | 16' Swing Gate, 10' Tall with Barbed Wire<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| F-162-4 | 250 LF | Remove Chain Link Fence and Gates<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-100-1 | 1 LS | Furnish and Install ALCMS by System Manufacturer<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| L-105-1 | 15,000 LF | Cable Removal<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-105-2 | 1 LS | Demolition of Existing ALCMS System<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| L-108-1 | 46,000 LF | No. 8 AWG, 5kV, L-824, Type C Cable, Installed in Duct Bank or Conduit<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-108-2 | 2,000 LF | No. 6 AWG, Solid, Bare Copper Counterpoise Wire, Installed Above the Duct Bank or Conduit, Including Connections/Terminations<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| L-108-3 | 14 EA | 3/4" Dia. X 10' Copper Clad Steel Ground Rod<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| L-109-1 | 1 LS | Constant Current Regulator System<br>_____ Dollars and<br>_____ Cents<br>Per Lump Sum | | |
| L-110-1 | 500 LF | Reinforced, Concrete Encased Schedule 40 PVC Electrical Conduit, 20-Way 4-inch, in Mill and Overlay Full Strength Pavement<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-110-2 | 200 LF | Concrete Encased Schedule 40 PVC Electrical Conduit, 20-Way 4-inch, in Turf<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-110-3 | 70 LF | Concrete Encased Schedule 40 PVC Electrical Ductbank, 8-Way 4-inch, in Turf<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-110-4 | 70 LF | Concrete Encased Schedule 40 PVC Electrical Conduit, 12-Way 4-inch, in Turf<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |

**Manchester • Boston Regional Airport**
AIRFIELD LIGHTING VAULT EXPANSION
**BID FORM**

**BASE BID**

| ITEM NO. | ESTIMATED QUANTITY/ UNIT | DESCRIPTION AND UNIT PRICE (IN WORDS) | FIGURES | |
|---|---|---|---|---|
| | | | UNIT PRICE | |
| | | | Dollars | Cents |
| L-110-5 | 70 LF | Concrete Encased Schedule 40 PVC Drainage Conduit, 1-Way 4-inch, in Mill and Overlay Full Strength Pavement<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-110-6 | 70 LF | Direct Earth Buried Schedule 40 PVC Drainage Conduit, 1-Way 4-inch, in Turf<br>_____ Dollars and<br>_____ Cents<br>Per Linear Foot | | |
| L-110-7 | 2 EA | Cored Hole<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| L-115-1 | 2 EA | Electrical Manhole 8' x 10', Aircraft Rated<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |
| 330000-1 | 1 AL | Electrical Utility Service<br>_____ Dollars and<br>_____ Cents<br>Per Each | | |

## BID SUMMARY

**TOTAL BASE BID:**

_____**dollars**
(amount in words)

($_____).
(amount in figures)

The stated prices shall include-all plant, labor, materials, supplies, equipment, services, incidentals, expenses, overhead, profit, insurance, etc., perform all work required by the Contract Documents.

The bidder agrees that the Owner may base the low bid on either Item A or Item B, as applicable.

The bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding.

The bidder agrees that this bid shall be good and may not be withdrawn prior to **November 1, 2025**.

The bidder agrees that the Owner may select only one work item, may reduce the quantities, or may delete work items altogether if necessary to bring the contract awarded within funds available to finance the project. Such re2
duction or deletion of work shall not constitute a basis for withdrawal of this proposal.

Upon receipt of written notice of acceptance of this bid, bidder will execute the formal contract provided within 15 calendar days and deliver the Surety Bonds as required by the General Provisions. The bid security attached in the sum of _____ _____ is to become the property of the Owner in the event the contract and bonds are not executed within the time above set forth, as liquidated damages for the delay and additional expenses to the Owner caused thereby.

Respectfully submitted:

Name of Bidder: _____

By: _____

Name and Title: _____

Business Address: _____

(Affix corporate seal if bid is by a corporation)

**CERTIFICATE AS TO CORPORATE PRINCIPAL**

**PROPOSAL**

I, _____ certify that I am the _____ of the corporation named as Bidder in the above Proposal; that _____ who signed the said Proposal on behalf of the Bidder was then _____ of said Corporation; that I know his/her signature and his/her signature thereto is genuine; and that said Proposal was duly signed, sealed and attested to for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporate powers.

_____
(Signature)

(Corporate Seal)

**BID BOND**

KNOW ALL MEN BY THESE PRESENTS, THAT WE, THE UNDERSIGNED,

_____

*(Name of Principal)*

as PRINCIPAL, and _____

*(Name of Surety)*

as SURETY, are held and are firmly bound unto **The City of Manchester, New Hampshire, Department of Aviation** hereinafter called the Owner, in the penal sum of

_____

lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

**THE CONDITION OF THIS OBLIGATION IS SUCH**, that whereas the Principal has submitted the accompanying Bid Amount of _____ for

***AIRFIELD LIGHTING VAULT EXPANSION***
**at**
**Manchester • Boston Regional Airport**

NOW, THEREFORE, if the Principal shall not withdraw said bid within **213 calendar days** after the opening thereof, and shall within fifteen (15) calendar days after the prescribed forms are presented to him/her for signature, enter into a written Contract with the Owner in accordance with the bid as accepted, and give bonds with good and sufficient Surety or sureties, as may be required, for the faithful performance and proper fulfillment of such Contract; or in the event of the withdrawal of said bid within the period specified, or the failure to enter into such Contract and give such bonds within the time specified, if the Principal shall pay the Owner the difference between the amount specified in said bid and the amount for which the Owner may procure the required work or supplies or both, if the latter amount be in excess of the former, then the above obligation shall be void and of no effect, otherwise to remain in full force and virtue.

IN WITNESS WHEREOF, the above named Principal and Surety have executed this instrument under their several seals this _____day of _____, name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

In presence of: _____SEAL

*Individual Principal*

_____

_____

*Business Address*

_____SEAL

*Individual Principal*

_____

_____

*Business Address*

Attest:

_____ _____

*Corporate Principal*

_____ _____

*Business Address*

**Affix Corporate Seal**

By: _____

Attest:

_____

_____ _____

*Corporate Surety*

_____

*Business Address*

**Affix Corporate Seal**

By:_____

*Attorney-in-Fact*

** Power of attorney for person(s) signing for surety company must be attached to this bond.*

**CERTIFICATE AS TO CORPORATE PRINCIPAL**

**BID BOND**

I, _____ , certify that I am the

_____ of the Corporation named as principal in the within

bond; that _____ , who signed the said bond on

behalf of the Principal was then _____

of said Corporation; that I know his/her signature, and his/her signature thereto is genuine, and that said bond was duly signed, sealed, and attested to for and in behalf of said Corporation by authority of its governing body.

_____

**Affix Corporate Seal**

# QUALIFICATION STATEMENT
# for
# Airfield Lighting Vault Expansion
# at
# MANCHESTER•BOSTON REGIONAL AIRPORT

All questions must be answered, and the data given must be clear and comprehensive. This statement must be notarized. Where necessary, questions shall be answered on separate attached sheets. The applicant may submit any additional information he/she desires.

INSTRUCTIONS FOR COMPLETING QUALIFICATION STATEMENT

*Item 1* *Completed for the project.*
*Item 2* *Enter full company name*
*Item 2a* *Check the appropriate box.*
*Item 2b* *Insert the company Federal ID No.*
*Item 2c* *Insert the company DUNS No. (will be used to check eligibility to contract for federally funded projects. In place of DUNS No. a "NH ABGP Certification Regarding Debarment or Suspension" form at the NHDOT website shall be provided.*
*Item 3* *Enter company main office address, phone & fax no.*
*Item 4* *Enter date when business was first established.*
*Item 5* *Enter date of incorporation and State.*
*Item 6* *Enter number of years that this corporate entity has been engaged in contracting. Provide applicable lists for either a or b.*
*Item 7* *Enter brief description of type of work performed.*
*Item 7a* *Enter years of experience.*
*Item 8* *Attach schedule of uncompleted work.*
*Item 9* *Attach schedule of completed work for prior 5 years.*
*Item 10a* *Check the appropriate box. If any are Yes, attach documentation.*
*Item 10b* *Check the appropriate box in 1, 2 & 3. If any are Yes, attach documentation.*
*Item 11* *Attach list as indicated.*
*Item 12a* *Attach list of major suppliers & sub-contractors utilized in the past 5 years.*
*Item 12b* *Attach list of major suppliers & sub-contractors who have brought suit or filed liens against the company in the past five years.*
*Item 13* *Provide all required information for bank, bonding company and bonding agent.*
*Item 14* *Attach list of the Company's major equipment.*
*Item 15* *Attach list of 3 professional references as indicated.*
*Item 16* *Attach list of all parties involved in legal action with the company in the past 5 years.*
*Item 17* *Attach list of government entities to be utilized as a company reference.*

***STATEMENT OF TRUTH FORM***
*Applicant is to fill out and sign the Statement of Truth Form*

1. Project: ***Airfield Lighting Vault Expansion***

2. Full Name of Company: _____

   a. Company is: Corporation ☐
   Partnership ☐
   Individual ☐

   b. Federal ID No. (Employer's Identification No.):

   _____

   c. DUNS No.

   _____

3. Permanent main office address:

   _____
   Address City State Zip

   Phone No.:_____ Fax No.: _____

4. Date Established: _____

5. If a corporation, when and where incorporated?

   _____

6. How many years has this organization been engaged in the contracting business under the present firm or trade name?

   _____

   a. If a corporation: Attach list of names and phone numbers of the principal officers.

   b. If a partnership: Attach list type of partnership (general, limited, association, etc.) and names and phone numbers of all partners.

7. Describe the general character of the work performed by the applicant.

   _____

   _____

   _____

   a. How many years of experience, in work similar to the identified projects, has the applicant had?

      (1) As a General Contractor: _____

      (2) As a Sub-Contractor: _____

8. List the construction projects the organization has under contract on the date of this application. Attach a schedule showing: gross contract amount; actual or anticipated start and completion dates; percent complete; percent sublet; name and address of client; name and phone number of person supervising for the client.

9. List the construction projects the organization has completed in the last five (5) years. Attach a schedule showing: gross contract amount; actual start and completion dates; percent sublet; name and address of client; name and phone number of person supervising for the client.

10. a. Of the projects listed in # 8 above, did the applicant's organization, its partners or officers not complete a project by the original contract date?

Yes_____No_____ If yes, attach a list of the project(s) with explanation (s).

b. Of the projects listed in # 8 above.

(1) Did the applicant's organization, its partners', or officers' delay the work by more than 14 days?

Yes ____ No ____

(2) Did the applicant's organization, its partners', or officers' cease work?

Yes ____ No ____

(3) Did the applicant's organization, its partners', or officers' leave the job site during the construction?

Yes ____ No ____

**If yes to any of the above, attach list of project(s) with explanation(s).**

11. List backgrounds and experience of the principal members of the applicant's organization, including the officers and the individuals who will be the field superintendent(s) on the proposed work at the Manchester-Boston Regional Airport. Attach a schedule showing: individuals name; present position; years of construction experience; magnitude and type of work; in what capacity; previous airport work.

12. a. List major material suppliers and/or sub-contractors with whom the organization has done business in the past five (5) years. Attach a schedule showing: name. complete address; phone number; contact person for each.

b. List each material supplier and/or sub-contractor of the applicant who has given notice of lien, filed a mechanics lien, or brought suit for payment on any contract in the last five (5) years. Attach schedule showing name; complete address; phone no.; contact person; explanation and resolution for each.

13. Provide name, complete address, phone no., and contact person for each of the following:

    a. Bank_____

    b. Bonding Company *_____

    c. Bonding Agent_____

    * Bonding Co. must be registered and licensed to do business in the State of New Hampshire.

14. List the major equipment available for the proposed project(s). Attach a schedule showing: quantity; description including size of capacity; condition; age; cost; depreciation; book value.

15. Provide names, complete addresses, and phone numbers for three (3) owners, engineers, or architects, not employed by the applicant, involved in current contracts or contracts completed in the last five (5) years, who can attest to the character, integrity, reputation, judgment, experience, and efficiency of the applicant. Attach the list.

16. Provide names, complete addresses, and phone numbers of all adverse parties in any suit involving the applicant in the last five (5) years. Attach the list.

17. Provide names, complete addresses, and phone numbers for all government entities who have determined the applicant qualified for the type of work requested herein and all who have not determined the applicant qualified, in the last five (5) years. Attach the lists.

18. Submit letter from the Bidder's bonding company stating the maximum bonding limit available to the Bidder. Performance and payment bonds in the amount of 100 percent of the bid price will be required on contracts awarded by the Airport.

## STATEMENT OF TRUTH FORM

I, _____ swear that all the statements herein contained, including the declaration of ownership or organization, and the record of experience have been examined by me, and to the best of my knowledge and belief, are true and correct.

I hereby authorize the Airport Director, his designees, or their agents to make such investigation, inquiry, checks and tests as they, in their sole discretion, deem necessary to attempt to ascertain my qualifications. I hereby waive any and all claims, release and agree to hold harmless any person who provides to the Director or his designees information or opinions held in good faith.

Signed:

_____

Title:_____

SUBSCRIBED AND SWORN TO BEFORE ME, THIS

Day of _____ 20 _____.

Notary-Public or Justice of the Peace

My commission expires:_____

NOTE: Contractor must complete the Release Form and five (5) copies of side one of the attached Qualification Form A which must then be sent to 5 references of your choice.

## RELEASE FORM

As a qualified contractor for Manchester-Boston Regional Airport, I agree to allow the following contact information of our firm (including name, address, phone number and contact name) to be listed on the Airport's website.

Signed:_____

Title: _____ Date: _____

**CONTACT INFORMATION:**

Name of Company: _____

Company Address: _____

_____

Phone Number: _____

Contact Name: _____

Email Address: _____

To: _____

_____

_____

Return to: Manchester-Boston Regional Airport
1 Airport Road, Suite 300
Manchester, NH 03103

RE: APPLICATION FOR MANCHESTER-BOSTON REGIONAL AIRPORT QUALIFICATION FOR:

_____
(Bidder's Company Name)

Dear Sir/Madame:

Your name has been obtained in connection with the application of the above-referenced contractor. The application will be carefully considered by the appropriate City body and your reply, as well as other replies, is an important part of that consideration. Your responsibility in replying to this request is as a responsible citizen rather than as a friend/adversary/acquaintance of the Bidder. The City must rely on replies such as yours to be candid, fair and complete.

Please answer the questions on the second page as accurately and completely as you can from your or your company's experience with the Bidder. When completed, please mail both page one and two of Form A to the Airport at the above address.

Very truly yours,

Manchester-Boston Regional Airport

RELEASE AND HOLD HARMLESS

I, _____, _____, of
(Individual Name of Bidder) (Title)

_____, hereby authorize _____
(Bidder Company Name) (Name of person/company filling out Form A)

to provide to the City of Manchester, Department of Aviation, with all information of any kind which you or the City deem relevant to my qualification as an Bidder. I hereby release, discharge and hold you harmless from any claim arising out of the provision of such information.

Date: _____ By: _____
(Signature of Individual Bidder)

***Form A Page 2 is to be filled out by the firm or client that you are requesting to recommend your company for qualification.***

Do you or your company have business experience with the Bidder?
_____ Yes _____ No

Please state the nature, frequency and time period of your experience with the Bidder.

_____

_____

With respect to that experience, please respond to the following inquiries. Please provide detail on separate paper as to any "no" answer (s).

The Bidder:

| | |
|---|---|
| Had satisfactory work progress | Yes____ No____ |
| Paid all bills for labor and material timely | Yes____ No____ |
| Satisfactorily settled contracts | Yes____ No____ |
| Demonstrated Financial capacity | Yes____ No____ |
| Demonstrated skill, equipment and manpower to perform your contract | Yes____ No____ |
| Is of good character, integrity, reputation, judgment, experience and efficient | Yes____ No____ |
| Performed satisfactorily | Yes____ No____ |
| Complied with all laws and ordinances | Yes____ No____ |
| Provided all warranty, maintenance and service requirements | Yes____ No____ |
| Completed project on time (including punch-list items and project closeout) | Yes____ No____ |

Did you have any problems with Bidder?

If yes, please explain:_____

_____

_____

Any other comments regarding the Bidder's qualifications:_____

_____

_____

Print Name: _____ Date:_____

Signature: _____

**CERTIFICATES OF COMPLIANCE FOR AIP PROJECTS**

**This page intentionally left blank**

## ***CERTIFICATIONS TO ACCOMPANY PROPOSAL BID FORMS***

### 1.01 ALL CONTRACTS

a. The bidder (proposer) must supply all the information required by the proposal forms and specifications.

b. The City of Manchester Department of Aviation, New Hampshire, in accordance with Title VI of the Civil Rights Act of 1964, hereby notifies all bidders that they (bidders) must affirmatively insure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for award.

### 1.02 INSTRUCTIONS TO BIDDERS

a. Section 60-1.7(b) of the Regulations of the Secretary of Labor requires each bidder or prospective prime Contractor and proposed subcontractors, where appropriate, to state in the bid whether it has participated in any previous contract or subcontract subject to the equal opportunity clause; and if so, whether it has filed with the Joint Reporting Committee, the Director, an agency, or the former President's Committee on Equal Employment Opportunity all reports due under the applicable filing requirements. In any case in which a bidder or prospective prime Contractor or proposed subcontractor has participated in a previous contract subject to Executive Orders 10Y25, 11114, or 11246 and has not filed a report due under the applicable filing requirements, no contract nor subcontract shall be awarded unless such Contractor submits a report covering the delinquent period or such other period specified by the FAA or the Director, OFCC.

b. To achieve these requirements, the Bidder shall complete and sign the attached statement.

## AFFIRMATIVE ACTION CERTIFICATION

The Bidder (has / has not)* participated in a previous contract subject to the equal opportunity clause prescribed by Executive Order 10925, or Executive Order 11246, or Executive Order 11114.

The Bidder (has / has not)* submitted all compliance reports in connection with any such contract due under the applicable filing requirements; and that representations indicating submission of required compliance reports signed by proposed subcontractors will be obtained prior to award of subcontracts.

If the Bidder has participated in a previous contract subject to the equal opportunity clause and has not submitted compliance reports due under applicable filing requirements, the Bidder (Proposer) shall submit a compliance report on Standard Form 100, "Employee Information Report EE0-1" prior to the award of contract.

The Bidder (has / has not) been considered for sanction due to violation of Executive Order 11246, as amended.

Dated _____ , 20____ _____

*Legal Name of Person, Firm or Corporation*

By: _____

_____

*Title*

***Strike out inappropriate term.***

## CERTIFICATION OF NONSEGREGATED FACILITIES

1. Notice to Prospective Federal Assisted Construction Contractors.

   a. A Certification of nonsegregated Facilities must be submitted prior to the award of a contract exceeding $10,000 which is not exempt from the provisions of the equal opportunity clause.

   b. Contractors receiving contract awards exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause will be required to provide for the forwarding of the notice to prospective subcontractors for supplies and construction contracts where the subcontracts exceed $10,000 and are not exempt from the provisions of the equal opportunity clause. NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

2. Notice to Prospective Construction Subcontractors.

   a. A Certificate of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the equal opportunity clause.

   b. Contractors receiving subcontract awards exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause will be required to provide for the forwarding of this notice to prospective subcontractors for supplies and construction contracts where the subcontractors exceed $10,000 and are not exempt from the provisions of the equal opportunity clause. NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

3. Notice to Prospective Contractors of Requirement for Certification for Nonsegregated Facilities.

   A Certification of Nonsegregated Facilities must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the equal opportunity clause.

## CERTIFICATION OF NONSEGREGATED FACILITIES (CONTRACTORS/ SUBCONTRACTORS)

The Contractor certifies that he/she does not maintain or provide for his/her employees any segregated facilities at any of his/her establishments, and that he/she does not permit his/her employees to perform their services at any location, under his/her control, where segregated facilities are maintained. The construction contractor certifies further that he will not maintain or provide for his/her employees any segregated facilities at any of his/her establishments, and that he/she will not permit his/her employees to perform their services at any location, under his/her control, where segregated facilities are maintained. The contractor agrees that a breach of this certification is a violation of the equal opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, time clocks, locker rooms and other storage or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex or national origin, because of habit, local custom, or any other reason. The contractor agrees that (except where he/she has obtained identical certifications from proposed subcontractors for specific time periods) he/she will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause, and that he/she will retain such certifications in his/her files.

Certification - The information above is true and complete to the best of my knowledge and belief.

_____

*Name and Title of Signer (Please type)*

_____ _____

*Signature* *Date*

**NOTE:** The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

## Certificate of Buy American Compliance for Manufactured Products

(Equipment/Building Projects)

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with their proposal. The bidder or offeror must indicate how they intend to comply with 49 USC § 50101, and other Made in America Laws, U.S. statutes, guidance, and FAA policies by selecting one on the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (not both) by inserting a checkmark (✓) or the letter "X".

☐ Bidder or offeror hereby certifies that it will comply with 49 USC § 50101, BABA and other related U.S. statutes, guidance, and policies of the FAA by:

a) Only installing steel and manufactured products produced in the United States;
b) Only installing construction materials defined as: an article, material, or supply – other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives that are or consist primarily of non-ferrous metals; plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); lumber or drywall that have been manufactured in the United States.
c) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
d) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

a) To provide to the Airport Sponsor or FAA evidence that documents the source and origin of the steel and manufactured product.
b) To faithfully comply with providing U.S. domestic product.
c) To furnish U.S. domestic product for any waiver request that the FAA rejects.
d) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

☐ The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for a Type 3 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

a) To submit to the Airport Sponsor or FAA within 15 calendar days of being selected as the responsive bidder, a formal waiver request and required documentation that supports the type of waiver being requested.
b) That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination that may result in rejection of the proposal.
c) To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.

d) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

**Required Documentation**

**Type 2 Waiver** (**Nonavailability)** - The iron, steel, manufactured goods or construction materials are not available in sufficient quantity or quality in the United States. The required documentation for the Nonavailability waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire

b) Record of thorough market research, consideration where appropriate of qualifying alternate items, products, or materials including;

c) A description of the market research activities and methods used to identify domestically manufactured items capable of satisfying the requirement, including the timing of the research and conclusions reached on the availability of sources.

**Type 3 Waiver** – The cost of the item components and subcomponents produced in the United States is more that 60 percent of the cost of all components and subcomponents of the "item". The required documentation for a Type 3 waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire including;
b) Listing of all product components and subcomponents that are not comprised of 100 percent U.S. domestic content (Excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108 (products of unknown origin must be considered as non-domestic products in their entirety).
c) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly at place of manufacture.
d) Percentage of non-domestic component and subcomponent cost as compared to total "item" component and subcomponent costs, excluding labor costs associated with final assembly at place of manufacture.

**Type 4 Waiver (Unreasonable Costs)** - Applying this provision for iron, steel, manufactured goods or construction materials, would increase the cost of the overall project by more than 25 percent. The required documentation for this waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire from
b) At minimum two comparable equal bidders and/or offerors;
c) Receipt or record that demonstrates that supplier scouting called for in Executive Order 14005, indicates that no domestic source exists for the project and/or component;
d) Completed waiver applications for each comparable bid and/or offer.

**False Statements**: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

| | |
|---|---|
| Date | Signature |
| Company Name | Title |

## GOALS AND ASSURANCES FOR DISADVANTAGED BUSINESS ENTERPRISES

The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex, in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate.

The requirements of CFR 49 Part 26, Regulations of the U. S. Department of Transportation, apply to this contract. It is the policy of The City of Manchester-Department of Aviation to practice nondiscrimination based on race, color, sex, or national origin in the award or performance of this contract. All firms qualifying under this solicitation are encouraged to submit bids/proposals. Award of this contract will be conditioned upon satisfying the requirements of this bid specification. These requirements apply to all bidders/offerors, including those who qualify as a DBE. A DBE goal of **"8.0"** percent has been established for this contract. The bidder/offeror shall make good faith efforts, as defined in Appendix A, 49 CRF Part 26 (Attachment 1), to meet the contract goal for DBE participation in the performance of this contract.

The bidder/offeror will be required to submit the following information (1) the names and addresses of DBE firms that will participate in this contract; (2) a description of the work that each DBE will perform; (3) the dollar amount of the participation of each DBE Firm participating; (4) written documentation of the bidder/offeror's commitment to use a DBE subcontractor whose participation it submits to meet the contract as provided in the commitment made under (4); and (5) if the contract goal is not met, evidence of good faith efforts.

## DISADVANTAGED BUSINESS ENTERPRISE (DBE) UTILIZATION

The undersigned bidder/offeror has satisfied the requirements of the bid specification in the following manner (please check the appropriate space):

_____ The bidder/offeror is committed to a minimum of **8.0**% DBE utilization on this contract.

_____ The bidder/offeror (if unable to meet the DBE goal of **8.0**%) is committed to a minimum of ____ % DBE utilization on this contract and submits documentation demonstrating good faith efforts.

Name of bidder/offeror's firm:

_____

State Registration No. _____

By _____ _____
(Signature) (Title)

## DBE LETTER OF INTENT

Name of bidder'/offeror's firm:_____

Address:_____

City:_____ State:_____ Zip:_____

Name of DBE firm:_____

Address:_____

City:_____ State:_____ Zip:_____

Telephone:_____

Description of work to be performed by DBE firm:

_____

_____

_____

_____

The bidder/offeror is committed to utilizing the above-named DBE firm for the work described above. The estimated dollar value of this work is $ _____.

**Affirmation**

The above named DBE firm affirms that it will perform the portion of the contract for the estimated dollar value as stated above.

By: _____
(Signature) (Title)

**If the bidder/offeror does not receive award of the prime contract, any and all representations in this letter of Intent and Affirmation shall be null and void.**

(Submit this page for each DBE subcontractor.)

**CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION (For Bids Exceeding $25,000)**

The bidder/offeror certifies, by submission of this proposal or acceptance of this contract, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency. It further agrees by submitting this proposal that it will include this clause without modification in all lower tier transactions, solicitations, proposals, contracts, and subcontracts. Where the bidder/offeror/contractor or any lower tier participant is unable to certify to this statement, it shall attach an explanation to this solicitation/proposal.

Certification - The information above is true and complete to the best of my knowledge and belief.

Name and Title of Signer (Please type)

Signature Date

**NOTE:** The penalty for making false statements in offers is prescribed in 18 U.S.C. 1001.

## CERTIFICATION REGARDING LOBBYING

(31 USC § 1352 – Byrd Anti-Lobbying Amendment, 2 CFR part 200, Appendix II(J), 49 CFR part 20, Appendix A)

The Bidder or Offeror certifies by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

## CERTIFICATION OF OFFERER/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS

The applicant must complete the following two certification statements. The applicant must indicate its current status as it relates to tax delinquency and felony conviction by inserting a checkmark (□) in the space following the applicable response. The applicant agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification in all lower tier subcontracts.

**Certifications**

1) The applicant represents that it is ( □ ) is not ( □ ) a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

2) The applicant represents that it is ( □ ) is not ( □ ) is not a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

**Note**

If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the sponsor has received notification from the agency suspension and debarment official (SDO) that the SDO has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore must provide information to the owner about its tax liability or conviction to the Owner, who will then notify the FAA Airports District Office, which will then notify the agency's SDO to facilitate completion of the required considerations before award decisions are made.

**Term Definitions**

**Felony conviction**: Felony conviction means a conviction within the preceding twenty-four (24) months of a felony criminal violation under any Federal law and includes conviction of an offense defined in a section of the U.S. code that specifically classifies the offense as a felony and conviction of an offense that is classified as a felony under 18 U.S.C. § 3559.

**Tax Delinquency**: A tax delinquency is any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

## TRADE RESTRICTION CERTIFICATION

49 USC § 50104, 49 CFR Part 30

By submission of an offer, the Offeror certifies that with respect to this solicitation and any resultant contract, the Offeror –

1) is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms as published by the Office of the United States Trade Representative (USTR);

2) has not knowingly entered into any contract or subcontract for this project with a person that is a citizen or national of a foreign country included on the list of countries that discriminate against U.S. firms as published by the USTR; and

3) has not entered into any subcontract for any product to be used on the Federal project that is produced in a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR.

This certification concerns a matter within the jurisdiction of an agency of the United States of America and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18 USC Section 1001.

The Offeror/Contractor must provide immediate written notice to the Owner if the Offeror/Contractor learns that its certification or that of a subcontractor was erroneous when submitted or has become erroneous by reason of changed circumstances. The Contractor must require subcontractors provide immediate written notice to the Contractor if at any time it learns that its certification was erroneous by reason of changed circumstances.

Unless the restrictions of this clause are waived by the Secretary of Transportation in accordance with 49 CFR 30.17, no contract shall be awarded to an Offeror or subcontractor:

1) who is owned or controlled by one or more citizens or nationals of a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR or
2) whose subcontractors are owned or controlled by one or more citizens or nationals of a foreign country on such USTR list or
3) who incorporates in the public works project any product of a foreign country on such USTR list.

Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by this provision. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

The Offeror agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification without modification in all lower tier subcontracts. The Contractor may rely on the certification of a prospective subcontractor that it is not a firm from a foreign country included on the list of countries that discriminate against U.S. firms as published by USTR, unless the Offeror has knowledge that the certification is erroneous.

This certification is a material representation of fact upon which reliance was placed when making an award. If it is later determined that the Contractor or subcontractor knowingly rendered an erroneous certification, the Federal Aviation Administration (FAA) may direct through the Owner cancellation of the contract or subcontract for default at no cost to the Owner or the FAA.

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# CONTRACT DOCUMENTS

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**Manchester • Boston Regional Airport**
**Airfield Lighting Vault Expansion**

**CONTRACT**

THIS AGREEMENT, made this _____day of _____, 2025,

(execution date by Owner) by and between **City of Manchester - Department of Aviation,** hereinafter

called "OWNER" and

_____

doing business as a corporation hereinafter called "CONTRACTOR".

WITNESSETH: That for and in consideration of the payments and agreements hereinafter mentioned:

1. The CONTRACTOR will commence and complete the project entitled

**Airfield Lighting Vault Expansion**
**AIRPORT IMPROVEMENT PROGRAM NO. 3-33-0011-TBD-2025**

2. The CONTRACTOR will furnish all of the material, supplies, tools, equipment, labor and other services necessary for the construction and completion of the PROJECT described herein.

3. The CONTRACTOR will commence the work required by the CONTRACT DOCUMENTS on or before a date to be specified in the NOTICE TO PROCEED and will complete the work within the **240 calendar days** from the effective date of the NOTICE TO PROCEED unless the period for completion is extended otherwise by the CONTRACT DOCUMENTS.

The CONTRACTOR shall pay as liquidated damages the sum of two thousand dollars ($2,000.00) for each and every calendar day that the work remains incomplete beyond the above specified time, as provided in the General Provisions

In addition, Bidder must agree to pay the Owner as liquidated damages the sum of **two thousand five hundred dollars ($2,500.00)** for each and every calendar day beyond the specified time on the phasing plans.

4. The CONTRACTOR agrees to perform all of the WORK described in the CONTRACT DOCUMENTS and comply with the terms therein for the sum of_____, or as shown in the BID Schedule.

5. The term "CONTRACT DOCUMENTS" means and includes the following:
   (A) This Agreement
   (B) Addenda as listed herein
   (C) Advertisement for Bids
   (D) Information for Bidders
   (E) Signed Copy of the Bid Proposal
   (F) General Provisions
   (G) Required Contract Provisions for AIP Projects
   (H) Supplemental Provisions
   (I) Contractor Safety Plan Compliance Document (CSPCD)
   (J) Technical Specifications
   (K) Drawings (as listed in Schedule of Drawings)

In the event that any provision in any component part of this Contract conflicts with any provision of any

other component part, the provision of the component part first enumerated in this Paragraph 5 shall govern. The various provisions in Addenda shall be construed in the order of preference of the component part of the Contract which each modified.

**Addenda Issued:**

| Addendum No. | Dated |
|---|---|
| | |
| | |
| | |
| | |

6. The OWNER will pay to the CONTRACTOR in the manner and at such times as set forth in the General Provisions such amounts as required by the CONTRACT DOCUMENTS.

7. This Agreement shall be binding upon all parties hereto and their respective heirs, executors, administrators, successors, and assigns.

8. The Contractor shall indemnify, hold harmless and defend the Owner, the Owner’s agents, employees, contractors, officers, and legal representatives, the United States of America, the Engineer, the Engineer's consultants, and their officers, board members, agents and employees (jointly and severally, the "Indemnitees") from and against all losses, suits, claims, liabilities, penalties, fines, judgments, costs and expenses, including without limitation attorneys' fees, consultants' fees and experts' fees arising out of, or in any manner predicated upon personal injury, death or property damage resulting from, relating to, caused by or arising out of (or which may be claimed to arise out of) the Contractor's performance of its obligations under this Agreement; and is caused in whole or in part by any negligent or willful act or omission of the Contractor, its subcontractors, anyone directly or indirectly employed by either the Contractor or its subcontractors, or anyone for whose acts any of the foregoing may be liable. The agreements contained in the preceding sentence do not extend to claims for damages caused by gross negligence or willful misconduct of the Indemnitees without contributory fault on the part of any person, firm, or corporation.

In any and all claims against an Indemnitee by any employee of the Contractor, its subcontractors, anyone directly or indirectly employed by an employee or subcontractor of the Contractor, or anyone for whose acts of such employees and subcontractors may be liable, the indemnification obligation shall not be limited to in any way by a limitation on the amount of damages, compensation or benefits payable by or for the Contractor or any subcontractor under workers compensation acts, disability benefit acts or other employee benefits acts.

In the event that any action or proceeding is brought against an Indemnitee by reason of any matter for which the Contractor has hereby agreed to indemnify, hold harmless and defend said Indemnitee, the Contractor, upon notice from an Indemnitee, covenants to resist or defend such action or proceeding with counsel acceptable to said Indemnitee.

Notwithstanding the foregoing, nothing herein shall be deemed to constitute a waiver of the sovereign immunity of the **City of Manchester - Department of Aviation** which is hereby reserved to the **City of Manchester - Department of Aviation**.

The provision of this indemnification shall survive the expiration or termination of this Agreement, and the Contractor's obligations hereunder shall apply whenever any one of the Indemnitees incurs costs or liabilities described above.

9. This Contract is executed in a number of counterparts, each of which is an original and constitutes the entire agreement between the parties. This contract shall be construed according to the laws of the **City of Manchester - Department of Aviation**. No portion of this contract shall be understood to waive the sovereign immunity of the **City of Manchester - Department of Aviation**. This contract shall not be amended, except as specified in the General Provisions.

IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials, this Agreement on the date first above written.

**CITY OF MANCHESTER - DEPARTMENT**

**OF AVIATION**

Witnessed:

By: _____

_____
Notary Public
My Commission Expires: _____

Name: _____
(type or print)

(SEAL)

Title: _____

**CONTRACTOR**

Witnessed:

By: _____

_____
Notary Public
My Commission Expires: _____

Name: _____
(type or print)

Title: _____

(SEAL)

## ARTICLE 5. CERTIFICATES OF INSURANCE

The Contractor shall furnish Certificates of Insurance as described in SUPPLEMENTAL PROVISIONS, and shall list the policies as follows:

| Type of Insurance | Limits of Policy Coverage | Number | Insurance Co. | Expiration Date |
|---|---|---|---|---|
| Workman's Compensation | | | | |
| General Liability | | | | |
| Automobile Liability | | | | |
| Builder's Risk | | | | |

These Insurance Certificates as well as Performance and Payment Bonds must be furnished at or before the time of the execution of this document. Such certificates shall, with respect to comprehensive general liability and auto liability insurance, name the City of Manchester, Departments of Aviation and Risk Management, the Program Manager, when designated, and any Architect and Engineering firms designated by the Owner as an additional insured (except worker's compensation).

**IN WITNESS WHEREOF**, the parties to these presents have executed this Contract as of the year and day first above mentioned.

(Seal)
ATTEST:

_____ By: _____

Witness Contractor Date

_____ By: _____

Witness Department of Aviation Date

## CONTRACT BONDS

### FORM OF PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS

That we, _____

an individual*, a partnership*, a corporation organized under the laws of the State of _____

_____* having a usual place of business in the State of _____

_____ as Principal, and _____

_____

a corporation organized under the laws of the State of _____

and having a usual place of business in the State of _____

as Surety, are holden and stand firmly bound and obligated unto the City of Manchester, New Hampshire, Department of Aviation (hereinafter the Owner), its successors and assigns, in the sum of _____

_____---- Dollars

($ _____ ),

lawful money of the United States of America, to and for the true payment whereof, we bind ourselves and each of us, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents. WHEREAS, the said Principal has by means of a written agreement dated_____

_____ , 20____ , entered into a Contract with the Owner for: **Airfield Lighting Vault Expansion at Manchester-Boston Regional Airport.**

a copy of which Contract is attached hereto and by reference made a part hereon.

*Strike out inapplicable terms.

NOW, THEREFORE, THE CONDITION of this obligation is such that if the said Principal and his/her subcontractors shall well and truly keep and perform all the agreements, terms and conditions in said Contract set forth and specified to be by said Principal kept and performed, and shall well and truly indemnify and save harmless the Owner against all counsel fees paid or incurred by the Owner as a result of a breach of any condition of this bond, and against all claims and suits for damage to person or property arising from carelessness or want of due care, or any act or omission on the part of said Principal during the performance of said Contract, then this obligation shall be void; otherwise, it shall remain in full force and virtue.

PROVIDED, FURTHER, that said Surety, for value received, hereby stipulates and agrees that no extension of time, or change in, alteration or addition to the terms of the Contract or to the work to be performed there under or the Contract Documents accompanying the same and no failure or refusal of the Owner to withhold any monies from the Principal shall in any way affect its obligations on this bond, and it does hereby waive notice of any such extension of time, change, alterations or addition to the terms of the Contract or the work or to the Contract Documents.

In the event that the Contract is abandoned by the Principal, or is terminated by the Owner under the provisions of said Contract, said Surety hereby further agrees that said Surety shall, if requested in writing by the Owner, take action as is necessary to complete said Contract.

This bond shall become effective at the same time as the Contract annexed hereto for the work hereinbefore mentioned.

IN WITNESS WHEREOF, we have hereunto set out hands and seals to this bond this _____ day of _____, 2022.

WITNESS:

(SEAL)

Name of Principal

By: _____

WITNESS:

(SEAL)

Name of Surety

Power of Attorney for person signing for the Surety Company must be attached.

## CERTIFICATE AS TO CORPORATE PRINCIPAL

## PERFORMANCE BOND

I, _____, certify that I am the _____of the

Corporation named as Principal in the within bond; that, _____ who

signed the said bond on behalf of the principal was then _____,

of said Corporation; that I know his/her signature and his/her signature thereto is genuine; and that said bond was duly signed, sealed and attested to for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporate powers.

_____ SEAL

(Power of attorney of person(s) signing Bond for Surety Company must be attached.)

NOTE: Date of Bond must not be prior to date of Contract. If Principal is Partnership, all partners must execute bond.

## FORM OF PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS

That we, _____

individual *, a partnership*, a corporation organized under the laws of the State of

_____*

having a usual place of business in the State of_____,

as Principal, and _____ ,

a corporation organized under the laws of the State of _____ , and

having a usual place of business in the State of_____ ,

as Surety, are holden and stand firmly bound and obligated unto the City of Manchester, New Hampshire, Department of Aviation

(hereinafter the Owner), its successors and assigns, in the sum of_____

_____Dollars ($ _____ ), lawful money of the United States of America, to and for the true payment whereof, we bind ourselves and each of us, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the said Principal has by means of a written agreement dated _____ , 20_____ entered into a Contract with the Owner for:

**Airfield Lighting Vault Expansion at Manchester-Boston Regional Airport.**

a copy of which Contract is attached hereto and by reference made a part hereof.

* Strike out inapplicable terms.

NOW, THEREFORE, THE CONDITION Of this obligation is such that is the said Principal and his/her subcontractors shall pay for all labor performed or furnished, for all equipment hired, including trucks, for all material used or employed in such construction, including lumber so employed which is not incorporated in the work, and for fuels, lubricants, power, tools, hardware, and supplies purchased by said principal and used in carrying out said Contract, and for labor and parts furnished upon the order of said contractor for the repair of equipment used in carrying out said Contract, this agreement to make such payments being in compliance with the requirements of Section 16 of Chapter 447, of New Hampshire Revised Statutes, Annotated, 1955, to furnish security there under and being in fact such security, and if said Principal shall well and fully indemnify and save harmless the Owner against all counsel fees paid or incurred by the Owner as a result of a breach of any condition of this bond, and against all claims and suits for damage to person or property arising from carelessness or want of due care, or any act or omission on the part of said Principal during the performance of said Contract, then this obligation shall be void; otherwise, it shall remain in full force and virtue.

PROVIDED, FURTHER, that said Surety, for value received, hereby stipulates and agrees (1) that no extension of time, or change in, alteration or addition to the terms of the Contract or to the work to be performed there under or the Contract Documents accompanying the same and no failure or refusal of the Owner to withhold any monies from the Principal shall in any way affect its obligations on this bond, and it does hereby waive notice of any such extension of time, change, alterations, or addition to the terms of the Contract or the work or to the Contract Documents; (2) that in case of liabilities not covered by said Section 16 of Chapter 447 RSA, as amended, but covered by this bond, then the provisions of this bond shall control.

In addition to the obligations of the undersigned enumerated above, the bond is also made for the use and benefit of all persons, firms and corporations, who may furnish any material or perform any labor on account of said Contract, or rent or hire out any appliances or equipment used or employed in the execution of said Contract and they and each of them are hereby made Obligees hereunder the same as if their own proper respective names were written herein as such, and they and each of them may proceed or sue hereon, and in case of failure of said Principal to carry out the foregoing provisions made for the use and benefit of any said persons, firms and corporations, the Owner as an additional remedy may maintain an action against the undersigned in its own name, but in trust for and for the benefit of said persons, firms and corporations.

This bond shall become effective at the same time as the Contract annexed hereto for the work hereinbefore mentioned.

IN WITNESS WHEREOF, we have set our hands and seals to this bond, this _____ day of _____, 20_____ In presence of:

_____SEAL
*Individual Principal*

_____
*Business Address*

_____SEAL
*Individual Principal*

_____
*Business Address*

Attest:

_____ _____SEAL
*Corporate Principal*

By:_____

Attest:

_____ _____SEAL
*Corporate Surety*

_____
*Business Address*

Countersigned: By: _____

By: _____

## CERTIFICATE AS TO CORPORATE PRINCIPAL

## PAYMENT BOND

I, _____ , certify that I am the

_____ of the Corporation named as Principal in

the within bond; that, _____ who signed the said

bond on behalf of the principal was then _____,

of said Corporation; that I know his/her signature and his/her signature thereto is genuine; and that said bond was duly signed, sealed and attested to for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporate powers.

_____ SEAL

(Power of attorney of person(s) signing Bond for Surety Company must be attached.)

NOTE: Date of Bond must not be prior to date of Contract. If Principal is Partnership, all partners must execute bond.

## SAFETY RESPONSIBILITY COVENANT

It is hereby understood and agreed that the CONTRACTOR is responsible for health and safety on this project including, but not limited to, compliance with all applicable federal, state, and local regulations, codes, rules, orders, laws and ordinances regarding health and safety and shall, at all times, exercise and enforce reasonable precautions for the safety and welfare of all persons and property associated with or affected by this project. The CONTRACTOR's responsibility shall include providing adequate equipment and facilities necessary (including, if required, removal to a hospital) to furnish first aid to any person or person's who may be injured on the project site.

The CONTRACTOR further agrees to defend, indemnify and hold harmless the OWNER and the ENGINEER from any expense, cost or loss including but not limited to fines, demands, suits, legal fees, or penalties, including costs of corrective measures, that the CONTRACTOR, OWNER or ENGINEER may sustain by reason of the CONTRACTOR's failure to provide a safe workplace or to comply with all health and safety laws, rules and regulations in connection with the performance of this Contract.

To achieve the safety goals for this project, the CONTRACTOR shall designate a SAFETY OFFICER whose duty shall be to monitor the project on a daily basis in order to insure that all required safety measures are strictly adhered to and site safety is insured. The SAFETY OFFICER shall act for the CONTRACTOR on safety issues and shall have the right to shut down work on the site until safety deficiencies have been corrected. The project SAFETY OFFICER is designated as:

NAME:_____

TITLE:_____

## CONTRACT BONDS

## WARRANTY BOND

KNOW ALL MEN BY THESE PRESENTS

That we_____, an individual*, a partnership*, a company organized under the laws of the State of_____ , having a usual place of business in the State of_____ , as Principal, and

_____ a company organized under the laws of the State of , and having a usual place of business in the State of , as Surety, are holden and stand firmly bound and obligated unto the City of Manchester, New Hampshire, Department of Aviation (hereinafter the Owner), its successors and assigns, in the sum of _____ Dollars ($ _____ ), lawful money of the United States of America, to and for the true payment whereof, we bind ourselves and each of us, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the said Principal has, by means of a written agreement dated _____,2022, entered into a Contract with the Owner for a copy of which contract is attached hereto and by reference made a part hereof.

* Strike out inapplicable terms.

NOW, THEREFORE, THE CONDITION of this obligation is such that is the said Principal and his/her subcontractors shall remedy any defects due the contractor's failure to conform to the contract requirements or to faulty materials or workmanship, defect of equipment, or design furnished by the contractor, and pay for any damage to other work resulting therefrom, which shall appear **within a period of one year from the date of final acceptance** of the work provided for in the Contract, then this obligation to be void; otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that the Owner shall give Contractor and Surety notice of Observed defects with reasonable promptness.

PROVIDED, FURTHER, that said Surety, for value received, hereby stipulates and agrees that no extension of time, or change in, alteration or addition to the terms of the Contract or to the work to be performed thereunder or the specifications accompanying the same and no failure or refusal of the Owner to withhold any monies from the Principal shall in any way affect its obligations on this bond, and it does hereby waive notice of any such extension of time, change, alterations, or addition to the terms of the Contract or the work or to the specifications.

IN WITNESS WHEREOF, we have set our hands and seals to this bond, this _____ day of _____, 20_____ In presence of:

_____SEAL
*Individual Principal*

_____
*Business Address*

_____SEAL
*Individual Principal*

_____
*Business Address*

Attest:

_____ _____SEAL
*Corporate Principal*

By:_____

Attest:

_____ _____SEAL
*Corporate Surety*

_____
*Business Address*

Countersigned: By: _____

By: _____

## CERTIFICATE AS TO CORPORATE PRINCIPAL

## WARRANTY BOND

I, _____ , certify that I am the

_____ of the Corporation named as Principal in

the within bond; that, _____ who signed the said

bond on behalf of the principal was then _____,

of said Corporation; that I know his/her signature and his/her signature thereto is genuine; and that said bond was duly signed, sealed and attested to for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporate powers.

_____ SEAL

# GENERAL PROVISIONS

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## Section 10 Definition of Terms

When the following terms are used in these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be defined as follows:

| Paragraph Number | Term | Definition |
|---|---|---|
| **10-01** | **AASHTO** | The American Association of State Highway and Transportation Officials. |
| **10-02** | **Access Road** | The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public roadway. |
| **10-03** | **Advertisement** | A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished. |
| **10-04** | **Airport** | Airport means an area of land or water which is used or intended to be used for the landing and takeoff of aircraft; an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way; airport buildings and facilities located in any of these areas, and a heliport. |
| **10-05** | **Airport Improvement Program (AIP)** | A grant-in-aid program, administered by the Federal Aviation Administration (FAA). |
| **10-06** | **Air Operations Area (AOA)** | The term air operations area (AOA) shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron. |
| **10-07** | **Apron** | Area where aircraft are parked, unloaded or loaded, fueled and/or serviced. |
| **10-08** | **ASTM International (ASTM)** | Formerly known as the American Society for Testing and Materials (ASTM). |
| **10-09** | **Award** | The Owner's notice to the successful bidder of the acceptance of the submitted bid. |
| **10-10** | **Bidder** | Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated. |
| **10-11** | **Building Area** | An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon. |
| **10-12** | **Calendar Day** | Every day shown on the calendar. |
| **10-13** | **Certificate of Analysis (COA)** | The COA is the manufacturer's Certificate of Compliance (COC) including all applicable test results required by the specifications. |
| **10-14** | **Certificate of Compliance (COC)** | The manufacturer's certification stating that materials or assemblies furnished fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer's authorized representative. |

| Paragraph Number | Term | Definition |
|---|---|---|
| **10-15** | **Change Order** | A written order to the Contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and contract time adjustment, if any, for work within the scope of the contract and necessary to complete the project. |
| **10-16** | **Contract** | A written agreement between the Owner and the Contractor that establishes the obligations of the parties including but not limited to performance of work, furnishing of labor, equipment and materials and the basis of payment.<br>The awarded contract includes but may not be limited to: Advertisement, Contract form, Proposal, Performance bond, payment bond, General provisions, certifications and representations, Technical Specifications, Plans, Supplemental Provisions, standards incorporated by reference and issued addenda. |
| **10-17** | **Contract Item (Pay Item)** | A specific unit of work for which a price is provided in the contract. |
| **10-18** | **Contract Time** | The number of calendar days or working days, stated in the proposal, allowed for completion of the contract, including authorized time extensions. If a calendar date of completion is stated in the proposal, in lieu of a number of calendar or working days, the contract shall be completed by that date. |
| **10-19** | **Contractor** | The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work. |
| **10-20** | **Contractors Quality Control (QC) Facilities** | The Contractor's QC facilities in accordance with the Contractor Quality Control Program (CQCP). |
| **10-21** | **Contractor Quality Control Program (CQCP)** | Details the methods and procedures that will be taken to assure that all materials and completed construction required by the contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. |
| **10-22** | **Control Strip** | A demonstration by the Contractor that the materials, equipment, and construction processes result in a product meeting the requirements of the specification. |
| **10-23** | **Construction Safety and Phasing Plan (CSPP)** | The overall plan for safety and phasing of a construction project developed by the airport operator or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications. |
| **10-24** | **Drainage System** | The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area. |
| **10-25** | **Engineer** | The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for engineering, inspection, and/or observation of the contract work and acting directly or through an authorized representative. |
| **10-26** | **Equipment** | All machinery, together with the necessary supplies for upkeep and maintenance; and all tools and apparatus necessary for the proper construction and acceptable completion of the work. |

| Paragraph Number | Term | Definition |
|---|---|---|
| **10-27** | **Extra Work** | An item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, but which is found by the Owner's Engineer or Resident Project Representative (RPR) to be necessary to complete the work within the intended scope of the contract as previously modified. |
| **10-28** | **FAA** | The Federal Aviation Administration. When used to designate a person, FAA shall mean the Administrator or their duly authorized representative. |
| **10-29** | **Federal Specifications** | The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration. |
| **10-30** | **Force Account** | **a.** Contract Force Account - A method of payment that addresses extra work performed by the Contractor on a time and material basis.<br>**b.** Owner Force Account - Work performed for the project by the Owner's employees. |
| **10-31** | **Intention of Terms** | Whenever, in these specifications or on the plans, the words "directed," "required," "permitted," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer and/or Resident Project Representative (RPR) is intended; and similarly, the words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer and/or RPR, subject in each case to the final determination of the Owner.<br>Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference. |
| **10-32** | **Lighting** | A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface. |
| **10-33** | **Major and Minor Contract Items** | A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract. All other items shall be considered minor contract items. |
| **10-34** | **Materials** | Any substance specified for use in the construction of the contract work. |
| **10-35** | **Modification of Standards (MOS)** | Any deviation from standard specifications applicable to material and construction methods in accordance with FAA Order 5300.1. |
| **10-36** | **Notice to Proceed (NTP)** | A written notice to the Contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins. |

| Paragraph Number | Term | Definition |
|---|---|---|
| **10-37** | **Owner** | The term "Owner" shall mean the party of the first part or the contracting agency signatory to the contract. Where the term "Owner" is capitalized in this document, it shall mean airport Sponsor only. The Owner for this project is City of Manchester – Department of Aviation. |
| **10-38** | **Passenger Facility Charge (PFC)** | Per 14 Code of Federal Regulations (CFR) Part 158 and 49 United States Code (USC) § 40117, a PFC is a charge imposed by a public agency on passengers enplaned at a commercial service airport it controls. |
| **10-39** | **Pavement Structure** | The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit. |
| **10-40** | **Payment bond** | The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will pay in full all bills and accounts for materials and labor used in the construction of the work. |
| **10-41** | **Performance bond** | The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will complete the work in accordance with the terms of the contract. |
| **10-42** | **Plans** | The official drawings or exact reproductions which show the location, character, dimensions and details of the airport and the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.' |
| **10-43** | **Project** | The agreed scope of work for accomplishing specific airport development with respect to a particular airport. |
| **10-44** | **Proposal** | The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials in accordance with the provisions of the plans and specifications. |
| **10-45** | **Proposal guaranty** | The security furnished with a proposal to guarantee that the bidder will enter into a contract if their own proposal is accepted by the Owner. |
| **10-46** | **Quality Assurance (QA)** | Owner's responsibility to assure that construction work completed complies with specifications for payment. |
| **10-47** | **Quality Control (QC)** | Contractor's responsibility to control material(s) and construction processes to complete construction in accordance with project specifications. |
| **10-48** | **Quality Assurance (QA) Inspector** | An authorized representative of the Engineer and/or Resident Project Representative (RPR) assigned to make all necessary inspections, observations, tests, and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the Contractor. |
| **10-49** | **Quality Assurance (QA) Laboratory** | The official quality assurance testing laboratories of the Owner or such other laboratories as may be designated by the Engineer or RPR. May also be referred to as Engineer's, Owner's, or QA Laboratory. |
| **10-50** | **Resident Project Representative (RPR)** | The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for all necessary inspections, observations, tests, and/or observations of tests of the contract work performed or being performed, or of the materials furnished |

| Paragraph Number | Term | Definition |
|---|---|---|
| | | or being furnished by the Contractor and acting directly or through an authorized representative. |
| **10-51** | **Runway** | The area on the airport prepared for the landing and takeoff of aircraft. |
| **10-52** | **Runway Safety Area (RSA)** | A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to aircraft. See the construction safety and phasing plan (CSPP) for limits of the RSA. |
| **10-53** | **Safety Plan Compliance Document (SPCD)** | Details how the Contractor will comply with the CSPP. |
| **10-54** | **Specifications** | A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing which are cited in the contract specifications by reference shall have the same force and effect as if included in the contract physically. |
| **10-55** | **Sponsor** | A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits to the FAA for an AIP grant; or a private Owner of a public-use airport that submits to the FAA an application for an AIP grant for the airport. |
| **10-56** | **Structures** | Airport facilities such as bridges; culverts; catch basins, inlets, retaining walls, cribbing; storm and sanitary sewer lines; water lines; underdrains; electrical ducts, manholes, handholes, lighting fixtures and bases; transformers; navigational aids; buildings; vaults; and other manmade features of the airport that may be encountered in the work and not otherwise classified herein. |
| **10-57** | **Subgrade** | The soil that forms the pavement foundation. |
| **10-58** | **Superintendent** | The Contractor's executive representative who is present on the work during progress, authorized to receive and fulfill instructions from the RPR, and who shall supervise and direct the construction. |
| **10-59** | **Supplemental Agreement** | A written agreement between the Contractor and the Owner that establishes the basis of payment and contract time adjustment, if any, for the work affected by the supplemental agreement. A supplemental agreement is required if: (1) in scope work would increase or decrease the total amount of the awarded contract by more than 25%: (2) in scope work would increase or decrease the total of any major contract item by more than 25%; (3) work that is not within the scope of the originally awarded contract; or (4) adding or deleting of a major contract item. |
| **10-60** | **Surety** | The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Owner by the Contractor. |
| **10-61** | **Taxilane** | A taxiway designed for low-speed movement of aircraft between aircraft parking areas and terminal areas. |
| **10-62** | **Taxiway** | The portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways, aircraft parking areas, and terminal areas. |
| **10-63** | **Taxiway/Taxilane Safety Area (TSA)** | A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an aircraft. See the construction safety and phasing plan (CSPP) for limits of the TSA. |

| Paragraph Number | Term | Definition |
|---|---|---|
| **10-64** | **Work** | The furnishing of all labor, materials, tools, equipment, and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the contract, plans, and specifications. |
| **10-65** | **Working day** | A working day shall be any day other than a legal holiday, Saturday, or Sunday on which the normal working forces of the Contractor may proceed with regular work for at least six (6) hours toward completion of the contract. When work is suspended for causes beyond the Contractor's control, it will not be counted as a working day. Saturdays, Sundays and holidays on which the Contractor's forces engage in regular work will be considered as working days. |
| **10-66** | **Owner Defined terms** | None |

**END OF SECTION 10**

## Section 20 Proposal Requirements and Conditions

**20-01 Advertisement (Notice to Bidders).** Refer to Advertisement for Bids.

**20-02 Qualification of bidders**. Each bidder shall submit evidence of competency and evidence of financial responsibility to perform the work to the Owner at the time of bid opening.

Evidence of competency, unless otherwise specified, shall consist of statements covering the bidder's past experience on similar work, and a list of equipment and a list of key personnel that would be available for the work.

Each bidder shall furnish the Owner satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, shall consist of a confidential statement or report of the bidder's financial resources and liabilities as of the last calendar year or the bidder's last fiscal year. Such statements or reports shall be certified by a public accountant. At the time of submitting such financial statements or reports, the bidder shall further certify whether their financial responsibility is approximately the same as stated or reported by the public accountant. If the bidder's financial responsibility has changed, the bidder shall qualify the public accountant's statement or report to reflect the bidder's true financial condition at the time such qualified statement or report is submitted to the Owner.

Unless otherwise specified, a bidder may submit evidence that they are prequalified with the State Highway Division and are on the current "bidder's list" of the state in which the proposed work is located. Evidence of State Highway Division prequalification may be submitted as evidence of financial responsibility in lieu of the certified statements or reports specified above.

Each bidder shall submit their qualifications. Refer to the Bid Proposal for the qualification forms.

**20-03 Contents of proposal forms**. The Owner's proposal forms state the location and description of the proposed construction; the place, date, and time of opening of the proposals; and the estimated quantities of the various items of work to be performed and materials to be furnished for which unit bid prices are asked. The proposal form states the time in which the work must be completed, and the amount of the proposal guaranty that must accompany the proposal. The Owner will accept only those Proposals properly executed on physical forms or electronic forms provided by the Owner. Bidder actions that may cause the Owner to deem a proposal irregular are given in paragraph 20-09 *Irregular proposals*.

Mobilization is limited to the percent of the total project cost as defined in Specification C-105 "Mobilization".

A pre-bid conference is required on this project to discuss as a minimum, the following items: material requirements; submittals; Quality Control/Quality Assurance requirements; the construction safety and phasing plan including airport access and staging areas; and unique airfield paving construction requirements. Refer to the Advertisement for Bids for the time, date, and additional information.

**20-04 Issuance of proposal forms**. The Owner reserves the right to refuse to issue a proposal form to a prospective bidder if the bidder is in default for any of the following reasons:

**a.** Failure to comply with any prequalification regulations of the Owner, if such regulations are cited, or otherwise included, in the proposal as a requirement for bidding.

**b.** Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts in force with the Owner at the time the Owner issues the proposal to a prospective bidder.

**c.** Documented record of Contractor default under previous contracts with the Owner.

**d.** Documented record of unsatisfactory work on previous contracts with the Owner.

**20-05 Interpretation of estimated proposal quantities**. An estimate of quantities of work to be done and materials to be furnished under these specifications is given in the proposal. It is the result of careful calculations and is believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. The Owner does not expressly, or by implication, agree that the actual quantities involved will correspond exactly therewith; nor shall the bidder plead misunderstanding or deception because of such estimates of quantities, or of the character, location, or other conditions pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications. It is understood that the quantities may be increased or decreased as provided in the Section 40, paragraph 40-02, Alteration of Work and Quantities, without in any way invalidating the unit bid prices.

**20-06 Examination of plans, specifications, and site**. The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. Bidders shall satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and to the requirements of the proposed contract. The submission of a proposal shall be prima facie evidence that the bidder has made such examination and is satisfied to the conditions to be encountered in performing the work and the requirements of the proposed contract, plans, and specifications.

Records of subsurface investigations and tests are available for inspection of bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the bidder, was obtained, and is intended for the Owner's design and estimating purposes only. Such information has been made available for the convenience of all bidders. It is further understood and agreed that each bidder is solely responsible for all assumptions, deductions, or conclusions which the bidder may make or obtain from their own examination of the boring logs and other records of subsurface investigations and tests that are furnished by the Owner.

**20-07 Preparation of proposal**. The bidder shall submit their proposal on the forms furnished by the Owner. All blank spaces in the proposal forms, unless explicitly stated otherwise, must be correctly filled in where indicated for each and every item for which a quantity is given. The bidder shall state the price (written in ink or typed) both in words and numerals which they propose for each pay item furnished in the proposal. In case of conflict between words and numerals, the words, unless obviously incorrect, shall govern.

The bidder shall correctly sign the proposal in ink. If the proposal is made by an individual, their name and post office address must be shown. If made by a partnership, the name and post office address of each member of the partnership must be shown. If made by a corporation, the person signing the proposal shall give the name of the state where the corporation was chartered and the name, titles, and business address of the president, secretary, and the treasurer. Anyone signing a proposal as an agent shall file evidence of their authority to do so and that the signature is binding upon the firm or corporation.

**20-08 Responsive and responsible bidder.** A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Owner's responsibility to decide if the exceptions taken by a bidder to the solicitation are material or not and the extent of deviation it is willing to accept.

A responsible bidder has the ability to perform successfully under the terms and conditions of a proposed procurement, as defined in 2 CFR § 200.318(h). This includes such matters as Contractor integrity, compliance with public policy, record of past performance, and financial and technical resources.

**20-09 Irregular proposals**. Proposals shall be considered irregular for the following reasons:

**a.** If the proposal is on a form other than that furnished by the Owner, or if the Owner's form is altered, or if any part of the proposal form is detached.

**b.** If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.

**c.** If the proposal does not contain a unit price for each pay item listed in the proposal, except in the case of authorized alternate pay items, for which the bidder is not required to furnish a unit price.

**d.** If the proposal contains unit prices that are obviously unbalanced.

**e.** If the proposal is not accompanied by the proposal guaranty specified by the Owner.

**f.** If the applicable Disadvantaged Business Enterprise information is incomplete.

The Owner reserves the right to reject any irregular proposal and the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts.

**20-10 Bid guarantee**. Each separate proposal shall be accompanied by a bid bond, certified check, or other specified acceptable collateral, in the amount specified in the proposal form. Such bond, check, or collateral, shall be made payable to the Owner.

**20-11 Delivery of proposal.** Each proposal submitted shall be placed in a sealed envelope plainly marked with the project number, location of airport, and name and business address of the bidder on the outside. When sent by mail, preferably registered, the sealed proposal, marked as indicated above, should be enclosed in an additional envelope. No proposal will be considered unless received at the place specified in the advertisement or as modified by Addendum before the time specified for opening all bids. Proposals received after the bid opening time shall be returned to the bidder unopened.

**20-12 Withdrawal or revision of proposals**. A bidder may withdraw or revise (by withdrawal of one proposal and submission of another) a proposal provided that the bidder's request for withdrawal is received by the Owner in writing **or** by email before the time specified for opening bids. Revised proposals must be received at the place specified in the advertisement before the time specified for opening all bids.

**20-13 Public opening of proposals**. Proposals shall be opened, and read, publicly at the time and place specified in the advertisement. Bidders, their authorized agents, and other interested persons are invited to attend. Proposals that have been withdrawn (by written or telegraphic request) or received after the time specified for opening bids shall be returned to the bidder unopened.

**20-14 Disqualification of bidders**. A bidder shall be considered disqualified for any of the following reasons:

**a.** Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.

**b.** Evidence of collusion among bidders. Bidders participating in such collusion shall be disqualified as bidders for any future work of the Owner until any such participating bidder has been reinstated by the Owner as a qualified bidder.

**c.** If the bidder is considered to be in "default" for any reason specified in paragraph 20-04, *Issuance of Proposal Forms*, of this section.

**20-15 Discrepancies and Omissions.** A Bidder who discovers discrepancies or omissions with the project bid documents shall immediately notify the Owner's Engineer of the matter. A bidder that has doubt as to the true meaning of a project requirement may submit to the Owner's Engineer a written request for interpretation no later than three (3) business days prior to bid opening.

Any interpretation of the project bid documents by the Owner's Engineer will be by written addendum issued by the Owner. The Owner will not consider any instructions, clarifications or interpretations of the bidding documents in any manner other than written addendum.

**END OF SECTION 20**

## Section 30 Award and Execution of Contract

**30-01 Consideration of proposals**. After the proposals are publicly opened and read, they will be compared on the basis of the summation of the products obtained by multiplying the estimated quantities shown in the proposal by the unit bid prices. If a bidder's proposal contains a discrepancy between unit bid prices written in words and unit bid prices written in numbers, the unit bid price written in words shall govern.

Until the award of a contract is made, the Owner reserves the right to reject a bidder's proposal for any of the following reasons:

**a.** If the proposal is irregular as specified in Section 20, paragraph 20-09, *Irregular Proposals*.

**b.** If the bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Disqualification of Bidders*.

In addition, until the award of a contract is made, the Owner reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the best interest of the Owner and is in conformance with applicable state and local laws or regulations pertaining to the letting of construction contracts; advertise for new proposals; or proceed with the work otherwise. All such actions shall promote the Owner's best interests.

**30-02 Award of contract**. The award of a contract, if it is to be awarded, shall be made within **213** calendar days of the date specified for publicly opening, unless otherwise specified herein.

If the Owner elects to proceed with an award of contract, the Owner will make award to the responsible bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

**30-03 Cancellation of award**. The Owner reserves the right to cancel the award without liability to the bidder, except return of proposal guaranty, at any time before a contract has been fully executed by all parties and is approved by the Owner in accordance with paragraph 30-07 *Approval of Contract*.

**30-04 Return of proposal guaranty**. All proposal guaranties, except those of the two lowest bidders, will be returned immediately after the Owner has made a comparison of bids as specified in the paragraph 30-01, *Consideration of Proposals.* Proposal guaranties of the two lowest bidders will be retained by the Owner until such time as an award is made, at which time, the unsuccessful bidder's proposal guaranty will be returned. The successful bidder's proposal guaranty will be returned as soon as the Owner receives the contract bonds as specified in paragraph 30-05, *Requirements of Contract Bonds.*

**30-05 Requirements of contract bonds**. At the time of the execution of the contract, the successful bidder shall furnish the Owner a surety bond or bonds that have been fully executed by the bidder and the surety guaranteeing the performance of the work and the payment of all legal debts that may be incurred by reason of the Contractor's performance of the work. The surety and the form of the bond or bonds shall be acceptable to the Owner. Unless otherwise specified in this subsection, the surety bond or bonds shall be in a sum equal to the full amount of the contract.

**30-06 Execution of contract**. The successful bidder shall sign (execute) the necessary agreements for entering into the contract and return the signed contract to the Owner, along with the fully executed surety bond or bonds specified in paragraph 30-05, *Requirements of Contract Bonds,* of this section, within **15** calendar days from the date mailed or otherwise delivered to the successful bidder.

**30-07 Approval of contract**. Upon receipt of the contract and contract bond or bonds that have been executed by the successful bidder, the Owner shall complete the execution of the contract in accordance with local laws or ordinances and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor shall constitute the Owner's approval to be bound by the successful bidder's proposal and the terms of the contract.

**30-08 Failure to execute contract**. Failure of the successful bidder to execute the contract and furnish an acceptable surety bond or bonds within the period specified in paragraph 30-06, *Execution of Contract,* of this section shall be just cause for cancellation of the award and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages to the Owner.

**END OF SECTION 30**

## Section 40 Scope of Work

**40-01 Intent of contract**. The intent of the contract is to provide for construction and completion, in every detail, of the work described. It is further intended that the Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

**40-02 Alteration of work and quantities**. The Owner reserves the right to make such changes in quantities and work as may be necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Owner's Engineer or RPR shall be and is hereby authorized to make, in writing, such in-scope alterations in the work and variation of quantities as may be necessary to complete the work, provided such action does not represent a significant change in the character of the work.

For purpose of this section, a significant change in character of work means: any change that is outside the current contract scope of work; any change (increase or decrease) in the total contract cost by more than 25%; or any change in the total cost of a major contract item by more than 25%.

Work alterations and quantity variances that do not meet the definition of significant change in character of work shall not invalidate the contract nor release the surety. Contractor agrees to accept payment for such work alterations and quantity variances in accordance with Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

Should the value of altered work or quantity variance meet the criteria for significant change in character of work, such altered work and quantity variance shall be covered by a supplemental agreement. Supplemental agreements shall also require consent of the Contractor's surety and separate performance and payment bonds. If the Owner and the Contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

**40-03 Omitted items**. The Owner, the Owner's Engineer or the RPR may provide written notice to the Contractor to omit from the work any contract item that does not meet the definition of major contract item. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be non-performed, the Contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with Section 90, paragraph 90-04, *Payment for Omitted Items*.

**40-04 Extra work**. Should acceptable completion of the contract require the Contractor to perform an item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, Owner may issue a Change Order to cover the necessary extra work. Change orders for extra work shall contain agreed unit prices for performing the change order work in accordance

with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the RPR's opinion, is necessary for completion of the extra work.

When determined by the RPR to be in the Owner's best interest, the RPR may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Extra work that is necessary for acceptable completion of the project, but is not within the general scope of the work covered by the original contract shall be covered by a supplemental agreement as defined in Section 10, paragraph 10-59, *Supplemental Agreement*.

If extra work is essential to maintaining the project critical path, RPR may order the Contractor to commence the extra work under a Time and Material contract method. Once sufficient detail is available to establish the level of effort necessary for the extra work, the Owner shall initiate a change order or supplemental agreement to cover the extra work.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Owner.

**40-05 Maintenance of traffic**. It is the explicit intention of the contract that the safety of aircraft, as well as the Contractor's equipment and personnel, is the most important consideration. The Contractor shall maintain traffic in the manner detailed in the Construction Safety and Phasing Plan (CSPP).

**a.** It is understood and agreed that the Contractor shall provide for the free and unobstructed movement of aircraft in the air operations areas (AOAs) of the airport with respect to their own operations and the operations of all subcontractors as specified in Section 80, paragraph 80-04, *Limitation of Operations*. It is further understood and agreed that the Contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, from, and upon the airport as specified in Section 70, paragraph 70-15, *Contractor's Responsibility for Utility Service and Facilities of Others*.

**b.** With respect to their own operations and the operations of all subcontractors, the Contractor shall provide marking, lighting, and other acceptable means of identifying personnel, equipment, vehicles, storage areas, and any work area or condition that may be hazardous to the operation of aircraft, fire-rescue equipment, or maintenance vehicles at the airport in accordance with the construction safety and phasing plan (CSPP) and the safety plan compliance document (SPCD).

**c.** When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the Contractor shall keep the road, street, or highway open to all traffic and shall provide maintenance as may be required to accommodate traffic. The Contractor, at their expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel. The Contractor shall furnish, erect, and maintain barricades, warning signs, flag person, and other traffic control devices in reasonable conformity with the Manual on Uniform Traffic Control Devices (MUTCD) (http://mutcd.fhwa.dot.gov/), unless otherwise specified. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets or highways. Unless otherwise specified herein, the Contractor will not be required to furnish snow removal for such existing road, street, or highway.

**40-06 Removal of existing structures**. All existing structures encountered within the established lines, grades, or grading sections shall be removed by the Contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall not be measured or paid for directly, but shall be included in the various contract items.

Should the Contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Resident Project Representative (RPR) shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the RPR in accordance with the provisions of the contract.

Except as provided in Section 40, paragraph 40-07, *Rights in and Use of Materials Found in the Work*, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of the work) shall be used in the work as otherwise provided for in the contract and shall remain the property of the Owner when so used in the work.

**40-07 Rights in and use of materials found in the work**. Should the Contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be embankment, the Contractor may at their own option either:

**a.** Use such material in another contract item, providing such use is approved by the RPR and is in conformance with the contract specifications applicable to such use; or,

**b.** Remove such material from the site, upon written approval of the RPR; or

**c.** Use such material for the Contractor's own temporary construction on site; or,

**d.** Use such material as intended by the terms of the contract.

Should the Contractor wish to exercise option a., b., or c., the Contractor shall request the RPR's approval in advance of such use.

Should the RPR approve the Contractor's request to exercise option a., b., or c., the Contractor shall be paid for the excavation or removal of such material at the applicable contract price. The Contractor shall replace, at their expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The Contractor shall not be charged for use of such material used in the work or removed from the site.

Should the RPR approve the Contractor's exercise of option a., the Contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the Contractor shall make no claim for delays by reason of their own exercise of option a., b., or c.

The Contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the lines, grades, or grading sections established for the work, except where such excavation or removal is provided for in the contract, plans, or specifications.

**40-08 Final cleanup**. Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. The Contractor shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the Contractor has obtained the written permission of the property Owner.

**END OF SECTION 40**

## Section 50 Control of Work

**50-01 Authority of the Resident Project Representative (RPR)**. The RPR has final authority regarding the interpretation of project specification requirements. The RPR shall determine acceptability of the quality of materials furnished, method of performance of work performed, and the manner and rate of performance of the work. The RPR does not have the authority to accept work that does not conform to specification requirements.

**50-02 Conformity with plans and specifications**. All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances) in the contract, plans, or specifications.

If the RPR finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications, but that the portion of the work affected will, in their opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable to the Owner, the RPR will advise the Owner of their determination that the affected work be accepted and remain in place. The RPR will document the determination and recommend to the Owner a basis of acceptance that will provide for an adjustment in the contract price for the affected portion of the work. Changes in the contract price must be covered by contract change order or supplemental agreement as applicable.

If the RPR finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor in accordance with the RPR's written orders.

The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the RPR's responsibility to insist on strict compliance with the requirements of the contract, plans, and specifications during the Contractor's execution of the work, when, in the RPR's opinion, such compliance is essential to provide an acceptable finished portion of the work.

The term "reasonably close conformity" is also intended to provide the RPR with the authority, after consultation with the Sponsor and FAA, to use sound engineering judgment in their determinations to accept work that is not in strict conformity but will provide a finished product equal to or better than that required by the requirements of the contract, plans and specifications.

The RPR will not be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions incident thereto.

**50-03 Coordination of contract, plans, and specifications**. The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. If electronic files are provided and used on the project and there is a conflict between the electronic files and hard copy plans, the hard copy plans shall govern. A requirement occurring in one is as binding as though occurring in all. They

are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited advisory circulars (ACs); contract general provisions shall govern over plans, cited standards for materials or testing, and cited ACs; plans shall govern over cited standards for materials or testing and cited ACs. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions shall govern.

From time to time, discrepancies within cited testing standards occur due to the timing of the change, edits, and/or replacement of the standards. If the Contractor discovers any apparent discrepancy within standard test methods, the Contractor shall immediately ask the RPR for an interpretation and decision, and such decision shall be final.

The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers any apparent error or discrepancy, Contractor shall immediately notify the Owner or the designated representative in writing requesting their written interpretation and decision.

**50-04 List of Special Provisions.** Refer to Supplemental Provisions.

**50-05 Cooperation of Contractor**. The Contractor shall be supplied with three hard copies or an electronic PDF of the plans and specifications. The Contractor shall have available on the construction site at all times one hardcopy each of the plans and specifications. Additional hard copies of plans and specifications may be obtained by the Contractor for the cost of reproduction.

The Contractor shall give constant attention to the work to facilitate the progress thereof and shall cooperate with the RPR and their inspectors and with other Contractors in every way possible. The Contractor shall have a competent superintendent on the work at all times who is fully authorized as their agent on the work. The superintendent shall be capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the RPR or their authorized representative.

**50-06 Cooperation between Contractors**. The Owner reserves the right to contract for and perform other or additional work on or near the work covered by this contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct the work not to interfere with or hinder the progress of completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with their own contract and shall protect and hold harmless the Owner from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange their work and shall place and dispose of the materials being used to not interfere with the operations of the other Contractors within the limits of the same project. The Contractor shall join their work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

**50-07 Construction layout and stakes**. The Engineer/RPR shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical controls established by Engineer/RPR. In case of negligence on the part of the Contractor or their employees, resulting in the destruction of any horizontal and vertical control, the resulting costs will be deducted as a liquidated damage against the Contractor.

Prior to the start of construction, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the RPR that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the RPR. The Contractor is responsible to establish all layout required for the construction of the project.

Copies of survey notes will be provided to the RPR for each area of construction and for each placement of material as specified to allow the RPR to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the RPR prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): AutoCAD and/or Microsoft Word.

Laser, GPS, String line, or other automatic control shall be checked with temporary control as necessary. In the case of error, on the part of the Contractor, their surveyor, employees or subcontractors, resulting in established grades, alignment or grade tolerances that do not concur with those specified or shown on the plans, the Contractor is solely responsible for correction, removal, replacement and all associated costs at no additional cost to the Owner.

No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

**50-08 Authority and duties of Quality Assurance (QA) inspectors**. QA inspectors shall be authorized to inspect all work done and all material furnished. Such QA inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. QA inspectors are not authorized to revoke, alter, or waive any provision of the contract. QA inspectors are not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

QA Inspectors are authorized to notify the Contractor or their representatives of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials in question until such issues can be referred to the RPR for a decision.

**50-09 Inspection of the work**. All materials and each part or detail of the work shall be subject to inspection. The RPR shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the RPR requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined

prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Provide advance written notice to the RPR of work the Contractor plans to perform each week and each day. Any work done or materials used without written notice and allowing opportunity for inspection by the RPR may be ordered removed and replaced at the Contractor's expense.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Owner, authorized representatives of the Owners of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

**50-10 Removal of unacceptable and unauthorized work**. All work that does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the RPR as provided in paragraph 50-02, *Conformity with Plans and Specifications*.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of Section 70, paragraph 70-14, *Contractor's Responsibility for Work*.

No removal work made under provision of this paragraph shall be done without lines and grades having been established by the RPR. Work done contrary to the instructions of the RPR, work done beyond the lines shown on the plans or as established by the RPR, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply with any order of the RPR made under the provisions of this subsection, the RPR will have authority to cause unacceptable work to be remedied or removed and replaced; and unauthorized work to be removed and recover the resulting costs as a liquidated damage against the Contractor.

**50-11 Load restrictions**. The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the Contractor of liability for damage that may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The Contractor, at their own expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel.

**50-12 Maintenance during construction**. The Contractor shall maintain the work during construction and until the work is accepted. Maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the Contractor will not be paid an additional amount for such work.

**50-13 Failure to maintain the work**. Should the Contractor at any time fail to maintain the work as provided in paragraph 50-12, *Maintenance during Construction*, the RPR shall immediately notify the Contractor of such noncompliance. Such notification shall specify a reasonable time within which the Contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to the exigency that exists.

Should the Contractor fail to respond to the RPR's notification, the Owner may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition, depending on the exigency that exists. Any maintenance cost incurred by the Owner, shall be recovered as a liquidated damage against the Contractor.

**50-14 Partial acceptance**. If at any time during the execution of the project the Contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Owner, the Contractor may request the RPR to make final inspection of that unit. If the RPR finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the RPR may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

**50-15 Final acceptance.** Upon due notice from the Contractor of presumptive completion of the entire project, the RPR and Owner will make an inspection. If all construction provided for and contemplated by the contract is found to be complete in accordance with the contract, plans, and specifications, such inspection shall constitute the final inspection. The RPR shall notify the Contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the RPR will notify the Contractor and the Contractor shall correct the unsatisfactory work. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the RPR will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

**50-16 Claims for adjustment and disputes.** If for any reason the Contractor deems that additional compensation is due for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, the Contractor shall notify the RPR in writing of their intention to claim such additional compensation before the Contractor begins the work on which the Contractor bases the claim. If such notification is not given or the RPR is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor and the fact that the RPR has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the Contractor shall, within 10 calendar days, submit a written claim to the RPR who will present it to the Owner for consideration in accordance with local laws or ordinances.

Nothing in this subsection shall be construed as a waiver of the Contractor's right to dispute final payment based on differences in measurements or computations.

**50-17 Value Engineering Cost Proposal.** This section not applicable to this project.

**END OF SECTION 50**

## Section 60 Control of Materials

**60-01 Source of supply and quality requirements**. The materials used in the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the Contractor shall furnish documentation to the RPR as to the origin, composition, and manufacture of all materials to be used in the work. Documentation shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the RPR's option, materials may be approved at the source of supply before delivery. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources.

The Contractor shall furnish airport lighting equipment that meets the requirements of the specifications; and is listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program* and *Addendum*, that is in effect on the date of advertisement.

**60-02 Samples, tests, and cited specifications**. All materials used in the work shall be inspected, tested, and approved by the RPR before incorporation in the work unless otherwise designated. Any work in which untested materials are used without approval or written permission of the RPR shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the RPR, shall be removed at the Contractor's expense.

Unless otherwise designated, quality assurance tests will be made by and at the expense of the Owner in accordance with the cited standard methods of ASTM, American Association of State Highway and Transportation Officials (AASHTO), federal specifications, Commercial Item Descriptions, and all other cited methods, which are current on the date of advertisement for bids.

The testing organizations performing on-site quality assurance field tests shall have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, samples for quality assurance will be taken by a qualified representative of the RPR. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at their request after review and approval of the RPR.

A copy of all Contractor QC test data shall be provided to the RPR daily, along with printed reports, in an approved format, on a weekly basis. After completion of the project, and prior to final payment, the Contractor shall submit a final report to the RPR showing all test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests. The Contractor may submit reports electronically in PDF format in lieu of hard copies.

The Contractor shall employ a Quality Control (QC) testing organization to perform all Contractor required QC tests in accordance with Item C-100 Contractor Quality Control Program (CQCP).

**60-03 Certification of compliance/analysis (COC/COA)**. The RPR may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's COC stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified. The COA is the manufacturer's COC and includes all applicable test results.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the RPR.

When a material or assembly is specified by "brand name or equal" and the Contractor elects to furnish the specified "or equal," the Contractor shall be required to furnish the manufacturer's certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

**a.** Conformance to the specified performance, testing, quality or dimensional requirements; and,

**b.** Suitability of the material or assembly for the use intended in the contract work.

The RPR shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

The RPR reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

**60-04 Plant inspection**. The RPR or their authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for acceptance of the material or assembly.

Should the RPR conduct plant inspections, the following conditions shall exist:

**a.** The RPR shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.

**b.** The RPR shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.

**c.** If required by the RPR, the Contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Place office or working space in a convenient location with respect to the plant.

It is understood and agreed that the Owner shall have the right to retest any material that has been tested and approved at the source of supply after it has been delivered to the site. The RPR shall have the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

**60-05 Engineer/ Resident Project Representative (RPR) field office**. Refer to specification section G-005 for RPR field office requirements.

**60-06 Storage of materials**. Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior

to their use in the work. Stored materials shall be located to facilitate their prompt inspection. The Contractor shall coordinate the storage of all materials with the RPR. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans and/or CSPP, the storage of materials and the location of the Contractor's plant and parked equipment or vehicles shall be as directed by the RPR. Private property shall not be used for storage purposes without written permission of the Owner or lessee of such property. The Contractor shall make all arrangements and bear all expenses for the storage of materials on private property. Upon request, the Contractor shall furnish the RPR a copy of the property Owner's permission.

All storage sites on private or airport property shall be restored to their original condition by the Contractor at their expense, except as otherwise agreed to (in writing) by the Owner or lessee of the property.

**60-07 Unacceptable materials**. Any material or assembly that does not conform to the requirements of the contract, plans, or specifications shall be considered unacceptable and shall be rejected. The Contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the RPR.

Rejected material or assembly, the defects of which have been corrected by the Contractor, shall not be returned to the site of the work until such time as the RPR has approved its use in the work.

**60-08 Owner furnished materials**. The Contractor shall furnish all materials required to complete the work, except those specified, if any, to be furnished by the Owner. Owner-furnished materials shall be made available to the Contractor at the location specified.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Owner-furnished materials shall be included in the unit price bid for the contract item in which such Owner-furnished material is used.

After any Owner-furnished material has been delivered to the location specified, the Contractor shall be responsible for any demurrage, damage, loss, or other deficiencies that may occur during the Contractor's handling, storage, or use of such Owner-furnished material. The Owner will deduct from any monies due or to become due the Contractor any cost incurred by the Owner in making good such loss due to the Contractor's handling, storage, or use of Owner-furnished materials.

**END OF SECTION 60**

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## Section 70 Legal Regulations and Responsibility to Public

**70-01 Laws to be observed**. The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Owner and all their officers, agents, or servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor's employees.

**70-02 Permits, licenses, and taxes**. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful execution of the work.

**70-03 Patented devices, materials, and processes**. If the Contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the Patentee or Owner. The Contractor and the surety shall indemnify and hold harmless the Owner, any third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Owner for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the execution or after the completion of the work.

**70-04 Restoration of surfaces disturbed by others**. The Owner reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work. To the extent that such construction, reconstruction, or maintenance has been coordinated with the Owner, such authorized work (by others) must be shown on the plans and is indicated as follows:

No known projects at time of bidding.

Except as listed above, the Contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the RPR.

Should the Owner of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor shall cooperate with such Owners by arranging and performing the work in this contract to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the RPR, the Contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the

Contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

**70-05 Federal Participation**. The United States Government has agreed to reimburse the Owner for some portion of the contract costs. The contract work is subject to the inspection and approval of duly authorized representatives of the FAA Administrator. No requirement of this contract shall be construed as making the United States a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

**70-06 Sanitary, health, and safety provisions**. The Contractor's worksite and facilities shall comply with applicable federal, state, and local requirements for health, safety and sanitary provisions.

**70-07 Public convenience and safety**. The Contractor shall control their operations and those of their subcontractors and all suppliers, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The Contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations and those of their own subcontractors and all suppliers in accordance with Section 40, paragraph 40-05, *Maintenance of Traffic*, and shall limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitation of Operations*.

The Contractor shall remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the order of the RPR. If the RPR determines the existence of Contractor debris in the work site represents a hazard to airport operations and the Contractor is unable to respond in a prompt and reasonable manner, the RPR reserves the right to assign the task of debris removal to a third party and recover the resulting costs as a liquidated damage against the Contractor.

**70-08 Construction Safety and Phasing Plan (CSPP).** The Contractor shall complete the work in accordance with the approved Construction Safety and Phasing Plan (CSPP) developed in accordance with AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP is located in section G-001 of the Technical Specifications.

**70-09 Use of explosives**. The use of explosives is not permitted on this project.

**70-10 Protection and restoration of property and landscape**. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer/RPR has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the execution of the work, resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or at any time due to defective work or materials, and said responsibility shall not be released until the project has been completed and accepted.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work, or in consequence of the non-execution thereof by the Contractor, the Contractor shall restore, at their expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, or otherwise restoring as may be directed, or the Contractor shall make good such damage or injury in an acceptable manner.

**70-11 Responsibility for damage claims**. The Contractor shall indemnify and hold harmless the Engineer/RPR and the Owner and their officers, agents, and employees from all suits, actions, or claims, of any character, brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of their own contract considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is due, their own surety may be held until such suits, actions, or claims for injuries or damages shall have been settled and suitable evidence to that effect furnished to the Owner, except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he or she is adequately protected by public liability and property damage insurance.

**70-12 Third party beneficiary clause**. It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create for the public or any member thereof, a third-party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

**70-13 Opening sections of the work to traffic**. If it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Owner prior to completion of the entire contract, such "phasing" of the work must be specified below and indicated on the approved Construction Safety and Phasing Plan (CSPP) and the project plans. When so specified, the Contractor shall complete such portions of the work on or before the date specified or as otherwise specified.

Refer to the Safety and Phasing Plans and the Construction Safety and Phasing Plan (CSPP).

Upon completion of any portion of work listed above, such portion shall be accepted by the Owner in accordance with Section 50, paragraph 50-14, *Partial Acceptance*.

No portion of the work may be opened by the Contractor until directed by the Owner in writing. Should it become necessary to open a portion of the work to traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the RPR, such portion of the work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provision of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Owner shall be repaired by the Contractor at their expense.

The Contractor shall make their own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

The Contractor must conform to safety standards contained AC 150/5370-2 and the approved CSPP.

Contractor shall refer to the plans, specifications, and the approved CSPP to identify barricade requirements, temporary and/or permanent markings, airfield lighting, guidance signs and other safety requirements prior to opening up sections of work to traffic.

**70-14 Contractor's responsibility for work**. Until the RPR's final written acceptance of the entire completed work, excepting only those portions of the work accepted in accordance with Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part due to the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of government authorities.

If the work is suspended for any cause whatever, the Contractor shall be responsible for the work and shall take such precautions necessary to prevent damage to the work. The Contractor shall provide for normal drainage and shall erect necessary temporary structures, signs, or other facilities at their own expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established planting, seeding, and sodding furnished under the contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

**70-15 Contractor's responsibility for utility service and facilities of others**. As provided in paragraph 70-04, *Restoration of Surfaces Disturbed by Others*, the Contractor shall cooperate with the owner of any public or private utility service, FAA or NOAA, or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct or maintain such utility services or facilities during the progress of the work. In addition, the Contractor shall control their operations to prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have been indicated on the plans and/or in the contract documents.

Refer to the "Underground Utilities and Cables" section of the Supplemental Provisions for a list of known contact information for utilities within or adjacent to the work area(s).

It is understood and agreed that the Owner does not guarantee the accuracy or the completeness of the location information relating to existing utility services, facilities, or structures that may be shown on the plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the Contractor of the responsibility to protect such existing features from damage or unscheduled interruption of service.

It is further understood and agreed that the Contractor shall, upon execution of the contract, notify the Owners of all utility services or other facilities of their plan of operations. Such notification shall be in writing addressed to "The Person to Contact" as provided in this paragraph and paragraph 70-04, *Restoration of Surfaces Disturbed By Others*. A copy of each notification shall be given to the RPR.

In addition to the general written notification provided, it shall be the responsibility of the Contractor to keep such individual Owners advised of changes in their plan of operations that would affect such Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor shall again notify each such Owner of their plan of operation. If, in the Contractor's opinion, the Owner's assistance is needed to locate the utility service or facility or the presence of a representative of the Owner is desirable to observe the work, such advice should be included in the notification. Such notification shall be given by the most expeditious means to reach the utility owner's "Person to Contact" no later than two normal business days prior to the Contractor's commencement of operations in such general vicinity. The Contractor shall furnish a written summary of the notification to the RPR.

The Contractor's failure to give the two days' notice shall be cause for the Owner to suspend the Contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor shall be required to use hand excavation methods within 3 feet (1 m) of such outside limits at such points as may be required to ensure protection from damage due to the Contractor's operations.

Should the Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, the Contractor shall immediately notify the proper authority and the RPR and shall take all reasonable measures to prevent further damage or interruption of service. The Contractor, in such events, shall cooperate with the utility service or facility owner and the RPR continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The Contractor shall bear all costs of damage and restoration of service to any utility service or facility due to their operations whether due to negligence or accident. The Owner reserves the right to deduct such costs from any monies due or which may become due the Contractor, or their own surety.

**70-15.1 FAA facilities and cable runs**. The Contractor is hereby advised that the construction limits of the project include existing facilities and buried cable runs that are owned, operated and maintained by the FAA. The Contractor, during the execution of the project work, shall comply with the following:

**a.** The Contractor shall permit FAA maintenance personnel the right of access to the project work site for purposes of inspecting and maintaining all existing FAA owned facilities.

**b.** The Contractor shall provide notice to the FAA Air Traffic Organization (ATO)/Technical Operations/System Support Center (SSC) Point-of-Contact through the airport director a minimum of seven (7) calendar days prior to commencement of construction activities in order to permit sufficient time to locate and mark existing buried cables and to schedule any required facility outages.

**c.** If execution of the project work requires a facility outage, the Contractor shall contact the FAA Point-of-Contact a minimum of 72 hours prior to the time of the required outage.

**d.** Any damage to FAA cables, access roads, or FAA facilities during construction caused by the Contractor's equipment or personnel whether by negligence or accident will require the Contractor to repair or replace the damaged cables, access road, or FAA facilities to FAA requirements. The Contractor shall not bear the cost to repair damage to underground facilities or utilities improperly located by the FAA.

**e.** If the project work requires the cutting or splicing of FAA owned cables, the FAA Point-of-Contact shall be contacted a minimum of 72 hours prior to the time the cable work commences. The FAA reserves the right to have a FAA representative on site to observe the splicing of the cables as a condition of acceptance. All cable splices are to be accomplished in accordance with FAA specifications and require approval by the FAA Point-of-Contact as a condition of acceptance by the Owner. The Contractor is hereby advised that FAA restricts the location of where splices may be installed. If a cable splice is

required in a location that is not permitted by FAA, the Contractor shall furnish and install a sufficient length of new cable that eliminates the need for any splice.

**70-16 Furnishing rights-of-way**. The Owner will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the Contractor's operations.

**70-17 Personal liability of public officials**. In carrying out any of the contract provisions or in exercising any power or authority granted by this contract, there shall be no liability upon the Engineer, RPR, their authorized representatives, or any officials of the Owner either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

**70-18 No waiver of legal rights**. Upon completion of the work, the Owner will expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, shall not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or stopped from recovering from the Contractor or their surety, or both, such overpayment as may be sustained, or by failure on the part of the Contractor to fulfill their obligations under the contract. A waiver on the part of the Owner of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Owner for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Owner's rights under any warranty or guaranty.

**70-19 Environmental protection**. The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, asphalts, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

**70-20 Archaeological and historical findings**. Unless otherwise specified in this subsection, the Contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the Contractor encounter, during their operations, any building, part of a building, structure, or object that is incongruous with its surroundings, the Contractor shall immediately cease operations in that location and notify the RPR. The RPR will immediately investigate the Contractor's finding and the Owner will direct the Contractor to either resume operations or to suspend operations as directed.

Should the Owner order suspension of the Contractor's operations in order to protect an archaeological or historical finding, or order the Contractor to perform extra work, such shall be covered by an appropriate contract change order or supplemental agreement as provided in Section 40, paragraph 40-04, *Extra Work*, and Section 90, paragraph 90-05, *Payment for Extra Work*. If appropriate, the contract change order or supplemental agreement shall include an extension of contract time in accordance with Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

**70-21 Insurance Requirements.** Refer to Supplemental Provisions for insurance requirements.

**END OF SECTION 70**

## Section 80 Execution and Progress

**80-01 Subletting of contract**. The Owner will not recognize any subcontractor on the work. The Contractor shall at all times when work is in progress be represented either in person, by a qualified superintendent, or by other designated, qualified representative who is duly authorized to receive and execute orders of the Resident Project Representative (RPR).

The Contractor shall perform, with his organization, an amount of work equal to at least **25** percent of the total contract cost.

Should the Contractor elect to assign their contract, said assignment shall be concurred in by the surety, shall be presented for the consideration and approval of the Owner, and shall be consummated only on the written approval of the Owner.

**The Contractor shall provide copies of all subcontracts to the RPR 14 days prior to being utilized on the project. As a minimum, the information shall include the following:**

- Subcontractor's legal company name.
- Subcontractor's legal company address, including County name.
- Principal contact person's name, telephone and fax number.
- Complete narrative description, and dollar value of the work to be performed by the subcontractor.
- Copies of required insurance certificates in accordance with the specifications.
- Minority/ non-minority status.

**80-02 Notice to proceed (NTP)**. The Owners notice to proceed will state the date on which contract time commences. The Contractor is expected to commence project operations within 10 days of the NTP date. The Contractor shall notify the RPR at least 1 week in advance of the time contract operations begins. The Contractor shall not commence any actual operations prior to the date on which the notice to proceed is issued by the Owner.

**80-03 Execution and progress**. Unless otherwise specified, the Contractor shall submit their coordinated construction schedule showing all work activities for the RPR's review and acceptance prior to the preconstruction meeting. The Contractor's progress schedule, once accepted by the RPR, will represent the Contractor's baseline plan to accomplish the project in accordance with the terms and conditions of the Contract. The RPR will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor shall, upon the RPR's request, submit a revised schedule for completion of the work within the contract time and modify their operations to provide such additional materials, equipment, and labor necessary to meet the revised

schedule. Should the execution of the work be discontinued for any reason, the Contractor shall notify the RPR at least 24 hours in advance of resuming operations.

The Contractor shall not commence any actual construction prior to the date on which the NTP is issued by the Owner.

The project schedule shall be prepared as a network diagram in Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), or other format, or as otherwise specified. It shall include information on the sequence of work activities, milestone dates, and activity duration. The schedule shall show all work items identified in the project proposal for each work area and shall include the project start date and end date.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

**80-04 Limitation of operations**. The Contractor shall control their operations and the operations of their subcontractors and all suppliers to provide for the free and unobstructed movement of aircraft in the air operations areas (AOA) of the airport.

When the work requires the Contractor to conduct their operations within an AOA of the airport, the work shall be coordinated with airport operations (through the RPR) at least 1 week prior to commencement of such work, unless more time is specified in the safety and phasing plans/CSPP. The Contractor shall not close an AOA until so authorized by the RPR and until the necessary temporary marking, signage and associated lighting is in place as provided in Section 70, paragraph 70-08, *Construction Safety and Phasing Plan (CSPP).*

When the contract work requires the Contractor to work within an AOA of the airport on an intermittent basis (intermittent opening and closing of the AOA), the Contractor shall maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in such AOA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the Contractor's operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the Construction Safety Phasing Plan (CSPP) and as listed below, cannot be closed to operating aircraft to permit the Contractor's operations on a continuous basis and will therefore be closed to aircraft operations intermittently as follows:

The Contractor shall be required to conform to safety standards contained in AC 150/5370-2, Operational Safety on Airports During Construction and the approved CSPP.

**80-04.1 Operational safety on airport during construction.** All Contractors' operations shall be conducted in accordance with the approved project Construction Safety and Phasing Plan (CSPP) and the Safety Plan Compliance Document (SPCD) and the provisions set forth within the current version of AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP included within the contract documents conveys minimum requirements for operational safety on the airport during construction activities. The Contractor shall prepare and submit a SPCD that details how it proposes to comply with the requirements presented within the CSPP.

The Contractor shall implement all necessary safety plan measures prior to commencement of any work activity. The Contractor shall conduct routine checks to assure compliance with the safety plan measures.

The Contractor is responsible to the Owner for the conduct of all subcontractors it employs on the project. The Contractor shall assure that all subcontractors are made aware of the requirements of the CSPP and SPCD and that they implement and maintain all necessary measures.

No deviation or modifications may be made to the approved CSPP and SPCD unless approved in writing by the Owner. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

**80-05 Character of workers, methods, and equipment**. The Contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the Contractor or by any subcontractor who violates any operational regulations or operational safety requirements and, in the opinion of the RPR, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the RPR, be removed immediately by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without approval of the RPR.

Should the Contractor fail to remove such person or persons, or fail to furnish suitable and sufficient personnel for the proper execution of the work, the RPR may suspend the work by written notice until compliance with such orders.

All equipment that is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall not cause injury to previously completed work, adjacent property, or existing airport facilities due to its use.

When the methods and equipment to be used by the Contractor in accomplishing the work are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the RPR. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request authority from the RPR to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the RPR determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the RPR may direct. No change will be made in basis of payment for the

contract items involved nor in contract time as a result of authorizing a change in methods or equipment under this paragraph.

**80-06 Temporary suspension of the work**. The Owner shall have the authority to suspend the work wholly, or in part, for such period or periods the Owner may deem necessary, due to unsuitable weather, or other conditions considered unfavorable for the execution of the work, or for such time necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the Contractor is ordered by the Owner, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. Claims for such compensation shall be filed with the RPR within the time period stated in the RPR's order to resume work. The Contractor shall submit with their own claim information substantiating the amount shown on the claim. The RPR will forward the Contractor's claim to the Owner for consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the Contractor to compensation for delays due to inclement weather or for any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not become an obstruction nor become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor shall erect temporary structures where necessary to provide for traffic on, to, or from the airport.

**80-07 Determination and extension of contract time**. The number of calendar days shall be stated in the proposal and contract and shall be known as the Contract Time.

If the contract time requires extension for reasons beyond the Contractor's control, it shall be adjusted as follows:

**80-07.1 Contract time based on calendar days.** Contract Time based on calendar days shall consist of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Owner's orders to suspend and resume all work, due to causes not the fault of the Contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either cost of work or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

**80-08 Failure to complete on time**. For each calendar day or working day, as specified in the contract, that any work remains uncompleted after the contract time (including all extensions and adjustments as provided in paragraph 80-07, *Determination and Extension of Contract Time*) the sum specified in the contract and proposal as liquidated damages (LD) will be deducted from any money due or to become due the Contractor or their own surety. Such deducted sums shall not be deducted as a penalty but shall be

considered as liquidation of a reasonable portion of damages including but not limited to additional engineering services that will be incurred by the Owner should the Contractor fail to complete the work in the time provided in their contract.

**Liquidated Damaged can also be found in the Information for Bidders, 1.08 Time of Completion/Construction Duration and Liquidated Damages.**

The maximum construction time allowed for Schedules will be the sum of the time allowed for individual schedules but not more than the time specified in the bid proposal. Permitting the Contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a wavier on the part of the Owner of any of its rights under the contract.

**80-09 Default and termination of contract**. The Contractor shall be considered in default of their contract and such default will be considered as cause for the Owner to terminate the contract for any of the following reasons, if the Contractor:

**a.** Fails to begin the work under the contract within the time specified in the Notice to Proceed, or

**b.** Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to assure completion of work in accordance with the terms of the contract, or

**c.** Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or

**d.** Discontinues the execution of the work, or

**e.** Fails to resume work which has been discontinued within a reasonable time after notice to do so, or

**f.** Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or

**g.** Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or

**h.** Makes an assignment for the benefit of creditors, or

**i.** For any other cause whatsoever, fails to carry on the work in an acceptable manner.

Should the Owner consider the Contractor in default of the contract for any reason above, the Owner shall immediately give written notice to the Contractor and the Contractor's surety as to the reasons for considering the Contractor in default and the Owner's intentions to terminate the contract.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Owner will, upon written notification from the RPR of the facts of such delay, neglect, or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the execution of the work out of the hands of the Contractor. The Owner may appropriate or use any or all materials and equipment that have been mobilized for use in the work and are acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof or use such other methods as in the opinion of the RPR will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Owner, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due the Contractor. If such

expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Owner the amount of such excess.

**80-10 Termination for national emergencies**. The Owner shall terminate the contract or portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the execution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the RPR.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

**80-11 Work area, storage area and sequence of operations**. The Contractor shall obtain approval from the RPR prior to beginning any work in all areas of the airport. No operating runway, taxiway, or air operations area (AOA) shall be crossed, entered, or obstructed while it is operational. The Contractor shall plan and coordinate work in accordance with the approved CSPP and SPCD.

**END OF SECTION 80**

## Section 90 Measurement and Payment

**90-01 Measurement of quantities**. All work completed under the contract will be measured by the RPR, or their authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the RPR.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items shall be measured parallel to the base or foundation upon which such items are placed.

The term “lump sum” when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When requested by the Contractor and approved by the RPR in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed, and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the RPR and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

### Measurement and Payment Terms

| Term | Description |
|---|---|
| **Excavation and Embankment Volume** | In computing volumes of excavation, the average end area method will be used unless otherwise specified. |
| **Measurement and Proportion by Weight** | The term “ton” will mean the short ton consisting of 2,000 pounds (907 km) avoirdupois. All materials that are measured or proportioned by weights shall be weighed on accurate, independently certified scales by competent, qualified personnel at locations designated by the RPR. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the RPR directs, and each truck shall bear a plainly legible identification mark. |
| **Measurement by Volume** | Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be |

| Term | Description |
|---|---|
| | of any size or type acceptable for the materials hauled, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery. |
| **Asphalt Material** | Asphalt materials will be measured by the gallon (liter) or ton (kg). When measured by volume, such volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When asphalt materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, will be used for computing quantities. |
| **Cement** | Cement will be measured by the ton (kg) or hundredweight (km). |
| **Structure** | Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions. |
| **Timber** | Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece. |
| **Plates and Sheets** | The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inch. |
| **Miscellaneous Items** | When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted. |
| **Scales** | Scales must be tested for accuracy and serviced before use. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end.<br>Scales shall be accurate within 0.5% of the correct weight throughout the range of use. The Contractor shall have the scales checked under the observation of the RPR before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed 0.1% of the nominal rated capacity of the scale, but not less than one pound (454 grams). The use of spring balances will not be permitted.<br>In the event inspection reveals the scales have been "overweighing" (indicating more than correct weight) they will be immediately adjusted. All materials received subsequent to the last previous correct weighting-accuracy test will be reduced by the percentage of error in excess of 0.5%.<br>In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), they shall be immediately adjusted. No additional payment to the Contractor will be allowed for materials previously weighed and recorded.<br>Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and the RPR can safely and conveniently view them.<br>Scale installations shall have available ten standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment.<br>All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in |

| Term | Description |
|---|---|
| | this subsection, for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project. |
| **Rental Equipment** | Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered in connection with extra work will be measured as agreed in the change order or supplemental agreement authorizing such work as provided in paragraph 90-05 *Payment for Extra Work*. |
| **Pay Quantities** | When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the RPR. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized changes in the dimensions. |

**90-02 Scope of payment**. The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials, for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the execution thereof, subject to the provisions of Section 70, paragraph 70-18, *No Waiver of Legal Rights*.

When the "basis of payment" subsection of a technical specification requires that the contract price (price bid) include compensation for certain work or material essential to the item, this same work or material will not also be measured for payment under any other contract item which may appear elsewhere in the contract, plans, or specifications.

**90-03 Compensation for altered quantities**. When the accepted quantities of work vary from the quantities in the proposal, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed and accepted. No allowance, except as provided for in Section 40, paragraph 40-02, *Alteration of Work and Quantities,* will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor which results directly from such alterations or indirectly from their own unbalanced allocation of overhead and profit among the contract items, or from any other cause.

**90-04 Payment for omitted items**. As specified in Section 40, paragraph 40-03, *Omitted Items,* the RPR shall have the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner.

Should the RPR omit or order nonperformance of a contract item or portion of such item from the work, the Contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the RPR's order to omit or non-perform such contract item.

Acceptable materials ordered by the Contractor or delivered on the work prior to the date of the RPR's order will be paid for at the actual cost to the Contractor and shall thereupon become the property of the Owner.

In addition to the reimbursement hereinbefore provided, the Contractor shall be reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the date of the RPR's order. Such additional costs incurred by the Contractor must be directly related to the deleted contract

item and shall be supported by certified statements by the Contractor as to the nature the amount of such costs.

**90-05 Payment for extra work**. Extra work, performed in accordance with Section 40, paragraph 40-04, *Extra Work*, will be paid for at the contract prices or agreed prices specified in the change order or supplemental agreement authorizing the extra work.

**90-06 Partial payments**. Partial payments will be made to the Contractor at least once each month as the work progresses. Said payments will be based upon estimates, prepared by the RPR, of the value of the work performed and materials complete and in place, in accordance with the contract, plans, and specifications. Such partial payments may also include the delivered actual cost of those materials stockpiled and stored in accordance with paragraph 90-07, *Payment for Materials on Hand*. No partial payment will be made when the amount due to the Contractor since the last estimate amounts to less than five hundred dollars.

a. From the total of the amount determined to be payable on a partial payment, 10 percent of such total amount will be deducted and retained by the Owner for protection of the Owner's interests. Unless otherwise instructed by the Owner, the amount retained by the Owner will be in effect until the final payment is made except as follows:

(1) Contractor may request release of retainage on work that has been partially accepted by the Owner in accordance with Section 50-14. Contractor must provide a certified invoice to the RPR that supports the value of retainage held by the Owner for partially accepted work.

(2) In lieu of retainage, the Contractor may exercise at its option the establishment of an escrow account per paragraph 90-08.

b. The Contractor is required to pay all subcontractors for satisfactory performance of their contracts no later than 30 days after the Contractor has received a partial payment. Contractor must provide the Owner evidence of prompt and full payment of retainage held by the prime Contractor to the subcontractor within 30 days after the subcontractor's work is satisfactorily completed. A subcontractor's work is satisfactorily completed when all the tasks called for in the subcontract have been accomplished and documented as required by the Owner. When the Owner has made an incremental acceptance of a portion of a prime contract, the work of a subcontractor covered by that acceptance is deemed to be satisfactorily completed.

c. When at least 95% of the work has been completed to the satisfaction of the RPR, the RPR shall, at the Owner's discretion and with the consent of the surety, prepare estimates of both the contract value and the cost of the remaining work to be done. The Owner may retain an amount not less than twice the contract value or estimated cost, whichever is greater, of the work remaining to be done. The remainder, less all previous payments and deductions, will then be certified for payment to the Contractor.

It is understood and agreed that the Contractor shall not be entitled to demand or receive partial payment based on quantities of work in excess of those provided in the proposal or covered by approved change orders or supplemental agreements, except when such excess quantities have been determined by the RPR to be a part of the final quantity for the item of work in question.

No partial payment shall bind the Owner to the acceptance of any materials or work in place as to quality or quantity. All partial payments are subject to correction at the time of final payment as provided in paragraph 90-09, *Acceptance and Final Payment*.

The Contractor shall deliver to the Owner a complete release of all claims for labor and material arising out of this contract before the final payment is made. If any subcontractor or supplier fails to furnish such a release in full, the Contractor may furnish a bond or other collateral satisfactory to the Owner to indemnify the Owner against any potential lien or other such claim. The bond or collateral shall include all costs, expenses, and attorney fees the Owner may be compelled to pay in discharging any such lien or claim.

**90-07 Payment for materials on hand.** Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications and are delivered to acceptable sites on the airport property or at other sites in the vicinity that are acceptable to the Owner. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

**a.** The material has been stored or stockpiled in a manner acceptable to the RPR at or on an approved site.

**b.** The Contractor has furnished the RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.

**c.** The Contractor has furnished the RPR with satisfactory evidence that the material and transportation costs have been paid.

**d.** The Contractor has furnished the Owner legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.

**e.** The Contractor has furnished the Owner evidence that the material stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the work.

It is understood and agreed that the transfer of title and the Owner's payment for such stored or stockpiled materials shall in no way relieve the Contractor of their responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications.

In no case will the amount of partial payments for materials on hand exceed the contract price for such materials or the contract price for the contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this paragraph.

**90-08 Payment of withheld funds**. At the Contractor's option, if an Owner withholds retainage in accordance with the methods described in paragraph 90-06 *Partial Payments*, the Contractor may request that the Owner deposit the retainage into an escrow account. The Owner's deposit of retainage into an escrow account is subject to the following conditions:

**a.** The Contractor shall bear all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Owner.

**b.** The Contractor shall deposit to and maintain in such escrow only those securities or bank certificates of deposit as are acceptable to the Owner and having a value not less than the retainage that would otherwise be withheld from partial payment.

**c.** The Contractor shall enter into an escrow agreement satisfactory to the Owner.

**d.** The Contractor shall obtain the written consent of the surety to such agreement.

**90-09 Acceptance and final payment**. When the contract work has been accepted in accordance with the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR will prepare the final estimate of the items of work actually performed. The Contractor shall approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate which are based on disputes in measurements or computations of the final quantities to be paid under the contract as amended by change order or supplemental agreement. The Contractor and the RPR shall resolve all disputes (if any) in the measurement and computation of final quantities to be paid within 30 calendar days of the Contractor's receipt of the RPR's final estimate. If, after such 30-day period, a dispute still exists, the Contractor may approve the RPR's estimate under protest of the quantities in dispute, and such disputed quantities shall be considered by the Owner as a claim in accordance with Section 50, paragraph 50-16, *Claims for Adjustment and Disputes*.

After the Contractor has approved, or approved under protest, the RPR's final estimate, and after the RPR's receipt of the project closeout documentation required in paragraph 90-11, *Contractor Final Project Documentation,* final payment will be processed based on the entire sum, or the undisputed sum in case of approval under protest, determined to be due the Contractor less all previous payments and all amounts to be deducted under the provisions of the contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

If the Contractor has filed a claim for additional compensation under the provisions of Section 50, paragraph 50-16, *Claims for Adjustments and Disputes,* or under the provisions of this paragraph, such claims will be considered by the Owner in accordance with local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final estimate.

**90-10 Construction warranty.**

**a.** In addition to any other warranties in this contract, the Contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, workmanship, or design furnished, or performed by the Contractor or any subcontractor or supplier at any tier.

**b.** This warranty shall continue for a period of one year from the date of final acceptance of the work, except as noted. If the Owner takes possession of any part of the work before final acceptance, this warranty shall continue for a period of one year from the date the Owner takes possession. However, this will not relieve the Contractor from corrective items required by the final acceptance of the project work. Light Emitting Diode emitting diode (LED) light fixtures with the exception of obstruction lighting, must be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics.

**c.** The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Owner real or personal

property, when that damage is the result of the Contractor's failure to conform to contract requirements; or any defect of equipment, material, workmanship, or design furnished by the Contractor.

**d.** The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for one year from the date of repair or replacement.

**e.** The Owner will notify the Contractor, in writing, within 7 days after the discovery of any failure, defect, or damage.

**f.** If the Contractor fails to remedy any failure, defect, or damage within 14 days after receipt of notice, the Owner shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

**g.** With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall: (1) Obtain all warranties that would be given in normal commercial practice; (2) Require all warranties to be executed, in writing, for the benefit of the Owner, as directed by the Owner, and (3) Enforce all warranties for the benefit of the Owner.

**h.** This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.

**90-11 Contractor Final Project Documentation.** Approval of final payment to the Contractor is contingent upon completion and submittal of the items listed below. The final payment will not be approved until the RPR approves the Contractor's final submittal. The Contractor shall:

**a.** Provide two (2) copies of all manufacturer's warranties specified for materials, equipment, and installations.

**b.** Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.

**c.** Complete final cleanup in accordance with Section 40, paragraph 40-08, *Final Cleanup*.

**d.** Complete all punch list items identified during the Final Inspection.

**e.** Provide complete release of all claims for labor and material arising out of the Contract.

**f.** Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the Disadvantaged Business Enterprise (DBE) subcontractors and/or suppliers associated with the project.

**g.** When applicable per state requirements, return copies of sales tax completion forms.

**h.** Manufacturer's certifications for all items incorporated in the work.

**i.** All required record drawings, as-built drawings or as-constructed drawings.

**j.** Project Operation and Maintenance (O&M) Manual(s).

k. Security for Construction Warranty.

**l.** Equipment commissioning documentation submitted, if required.

**m.** Provide project photographs in accordance with specification G-002 Record Documents

**END OF SECTION 90**

**FAA**
**Airports**

# Contract Provisions for Obligated Sponsors and Airport Improvement Program Projects

(Issued on May 24, 2023)

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# CONTRACT PROVISIONS

## A1 ACCESS TO RECORDS AND REPORTS

**ACCESS TO RECORDS AND REPORTS**

The Contractor must maintain an acceptable cost accounting system. The Contractor agrees to provide the Owner, the Federal Aviation Administration and the Comptroller General of the United States or any of their duly authorized representatives access to any books, documents, papers and records of the Contractor which are directly pertinent to the specific contract for the purpose of making audit, examination, excerpts and transcriptions. The Contractor agrees to maintain all books, records and reports required under this contract for a period of not less than three years after final payment is made and all pending matters are closed.

## A2 AFFIRMATIVE ACTION REQUIREMENT

**NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY**

1. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

**Timetables**

| | |
|---|---|
| Goals for minority participation for each trade: | **4.0%** |
| Goals for female participation in each trade: | 6.9% |

These goals are applicable to all of the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and nonfederally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a) and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs (OFCCP) within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

4. As used in this notice and in the contract resulting from this solicitation, the "covered area" is **[*Sponsor must insert* *state, county, and city*].**

## A3 BREACH OF CONTRACT TERMS

Any violation or breach of terms of this contract on the part of the *Contractor* or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement.

Owner will provide *Contractor* written notice that describes the nature of the breach and corrective actions the *Contractor* must undertake in order to avoid termination of the contract. Owner reserves the right to withhold payments to Contractor until such time the Contractor corrects the breach or the Owner elects to terminate the contract. The Owner's notice will identify a specific date by which the *Contractor* must correct the breach. Owner may proceed with termination of the contract if the *Contractor* fails to correct the breach by the deadline indicated in the Owner's notice.

The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

## A4 BUY AMERICAN PREFERENCE

### A4.1.1 Certification of Compliance with FAA Buy American Preference Statement

**FAA BUY AMERICAN PREFERENCE**

The Contractor certifies that its bid/offer is in compliance with 49 USC § 50101, BABA and other related Made in America Laws,[1] U.S. statutes, guidance, and FAA policies, which provide that Federal funds may not be obligated unless all iron, steel and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list.

The bidder or offeror must complete and submit the certification of compliance with FAA's Buy American Preference, BABA and Made in America laws included herein with their bid or offer. The Airport Sponsor/Owner will reject as nonresponsive any bid or offer that does not include a completed certification of compliance with FAA's Buy American Preference and BABA.

The bidder or offeror certifies that all constructions materials, defined to mean an article, material, or supply other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives that are or consist primarily of: non-ferrous metals; plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); lumber; or drywall used in the project are manufactured in the U.S.

### A4.1.2 Certification of Compliance with FAA Buy American Preference – Equipment/Building Projects

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with their proposal. The bidder or offeror must indicate how they intend to comply with 49 USC § 50101, and other Made in America Laws, U.S. statutes, guidance, and FAA policies by selecting one on the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (not both) by inserting a checkmark (✓) or the letter "X".

☐ Bidder or offeror hereby certifies that it will comply with 49 USC § 50101, BABA and other related U.S. statutes, guidance, and policies of the FAA by:

a) Only installing steel and manufactured products produced in the United States;

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[1] Per Executive Order 14005 "Made in America Laws" means all statutes, regulations, rules, and Executive Orders relating to federal financial assistance awards or federal procurement, including those that refer to "Buy America" or "Buy American," that require, or provide a preference for, the purchase or acquisition of goods, products, or materials produced in the United States, including iron, steel, and manufactured products offered in the United States.

b) Only installing construction materials defined as: an article, material, or supply – other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives that are or consist primarily of non-ferrous metals; plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); lumber or drywall that have been manufactured in the United States.
c) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
d) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

a) To provide to the Airport Sponsor or FAA evidence that documents the source and origin of the steel and manufactured product.
b) To faithfully comply with providing U.S. domestic product.
c) To furnish U.S. domestic product for any waiver request that the FAA rejects.
d) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

☐ The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for a Type 3 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

a) To submit to the Airport Sponsor or FAA within 15 calendar days of being selected as the responsive bidder, a formal waiver request and required documentation that supports the type of waiver being requested.
b) That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination that may result in rejection of the proposal.
c) To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
d) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

**Required Documentation**

**Type 2 Waiver** (**Nonavailability)** - The iron, steel, manufactured goods or construction materials are not available in sufficient quantity or quality in the United States. The required documentation for the Nonavailability waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire
b) Record of thorough market research, consideration where appropriate of qualifying alternate items, products, or materials including;
c) A description of the market research activities and methods used to identify domestically manufactured items capable of satisfying the requirement, including the timing of the research and conclusions reached on the availability of sources.

**Type 3 Waiver** – The cost of the item components and subcomponents produced in the United States is more that 60 percent of the cost of all components and subcomponents of the "item". The required documentation for a Type 3 waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire including;
b) Listing of all product components and subcomponents that are not comprised of 100 percent U.S. domestic content (Excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108 (products of unknown origin must be considered as non-domestic products in their entirety).
c) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly at place of manufacture.
d) Percentage of non-domestic component and subcomponent cost as compared to total "item" component and subcomponent costs, excluding labor costs associated with final assembly at place of manufacture.

**Type 4 Waiver (Unreasonable Costs)** - Applying this provision for iron, steel, manufactured goods or construction materials, would increase the cost of the overall project by more than 25 percent. The required documentation for this waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire from
b) At minimum two comparable equal bidders and/or offerors;
c) Receipt or record that demonstrates that supplier scouting called for in Executive Order 14005, indicates that no domestic source exists for the project and/or component;
d) Completed waiver applications for each comparable bid and/or offer.

**False Statements**: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

| | |
|---|---|
| Date | Signature |
| Company Name | Title |

## A5 CIVIL RIGHTS - GENERAL

### GENERAL CIVIL RIGHTS PROVISIONS

In all its activities within the scope of its airport program, the Contractor agrees to comply with pertinent statutes, Executive Orders, and such rules as identified in Title VI List of Pertinent Nondiscrimination Acts and Authorities to ensure that no person shall, on the grounds of race, color, national origin (including limited English proficiency), creed, sex (including sexual orientation and gender identity), age, or disability be excluded from participating in any activity conducted with or benefiting from Federal assistance.

This provision is in addition to that required by Title VI of the Civil Rights Act of 1964.

### A5.1.1 Specific Clause that is used for General Contract Agreements

The above provision binds the Contractor and subcontractors from the bid solicitation period through the completion of the contract.

### A5.1.2 Specific Clause that is used for Lease Agreements or Transfer Agreements

If the Contractor transfers its obligation to another, the transferee is obligated in the same manner as the Contractor.

The above provision obligates the Contractor for the period during which the property is owned, used or possessed by the Contractor and the airport remains obligated to the Federal Aviation Administration.

## A6 CIVIL RIGHTS – TITLE VI ASSURANCE

**Title VI Solicitation Notice:**

The City of Manchester – Department of Aviation, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 USC §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders or offerors that it will affirmatively ensure that for any contract entered into pursuant to this advertisement, [select businesses, or disadvantaged business enterprises or airport concession disadvantaged business enterprises] will be afforded full and fair opportunity to submit bids in response to this invitation and no businesses will be discriminated against on the grounds of race, color, national origin (including limited English proficiency), creed, sex (including sexual orientation and gender identity), age, or disability in consideration for an award.

### A6.1.1 Title VI List of Pertinent Nondiscrimination Acts and Authorities

Insert this list in every contract or agreement, unless the Sponsor has determined and the FAA concurs, that the contract or agreement is not subject to the Nondiscrimination Acts and Authorities. This list can be omitted if the FAA has determined that the contractor or company is already subject to nondiscrimination requirements, which is a rare occurrence.

**Title VI List of Pertinent Nondiscrimination Acts and Authorities**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor") agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 USC § 2000d *et seq*., 78 stat. 252) (prohibits discrimination on the basis of race, color, national origin);
- 49 CFR part 21 (Non-discrimination in Federally-Assisted programs of the Department of Transportation—Effectuation of Title VI of the Civil Rights Act of 1964);
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 USC § 4601) (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);

- Section 504 of the Rehabilitation Act of 1973 (29 USC § 794 *et seq*.), as amended (prohibits discrimination on the basis of disability); and 49 CFR part 27 (Nondiscrimination on the Basis of Disability in Programs or Activities Receiving Federal Financial Assistance);
- The Age Discrimination Act of 1975, as amended (42 USC § 6101 *et seq*.) (prohibits discrimination on the basis of age);
- Airport and Airway Improvement Act of 1982 (49 USC § 47123), as amended (prohibits discrimination based on race, creed, color, national origin, or sex);
- The Civil Rights Restoration Act of 1987 (PL 100-259) (broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, the Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms "programs or activities" to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- Titles II and III of the Americans with Disabilities Act of 1990 (42 USC § 12101, et seq) (prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities) as implemented by U.S. Department of Transportation regulations at 49 CFR parts 37 and 38;
- The Federal Aviation Administration's Nondiscrimination statute (49 USC § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (ensures nondiscrimination against minority populations by discouraging programs, policies, and activities with disproportionately high and adverse human health or environmental effects on minority and low-income populations);
- Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination includes discrimination because of limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs [70 Fed. Reg. 74087 (2005)];
- Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 USC § 1681, et seq).

### A6.1.2 Nondiscrimination Requirements/Title VI Clauses for Compliance

The Sponsor must include this contract clause in:

1) Every contract or agreement (unless the Sponsor has determined, and the FAA concurs, that the contract or agreement is not subject to the Nondiscrimination Acts and Authorities); and

2) Service contracts with utility companies that are not already subject to substantively identical nondiscrimination requirements.

3) Other types of contracts with utility companies involving property covered by A6.4.2, A6.4.3, or A6.4.4.

**Compliance with Nondiscrimination Requirements:**

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor"), agrees as follows:

1. **Compliance with Regulations:** The Contractor (hereinafter includes consultants) will comply with the Title VI List of Pertinent Nondiscrimination Acts and Authorities, as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.
2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, national origin (including limited English proficiency), creed, sex (including sexual orientation and gender identity), age, or disability in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21.
3. **Solicitations for Subcontracts, including Procurements of Materials and Equipment:** In all solicitations, either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the Contractor of the contractor's obligations under this contract and the Nondiscrimination Acts and Authorities on the grounds of race, color, or national origin.
4. **Information and Reports:** The Contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts and Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the Contractor will so certify to the Sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.
5. **Sanctions for Noncompliance:** In the event of a Contractor's noncompliance with the non-discrimination provisions of this contract, the Sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:
    a. Withholding payments to the Contractor under the contract until the Contractor complies; and/or
    b. Cancelling, terminating, or suspending a contract, in whole or in part.
6. **Incorporation of Provisions:** The Contractor will include the provisions of paragraphs one through six in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations, and directives issued pursuant thereto. The Contractor will take action with respect to any subcontract or procurement as the Sponsor or the Federal Aviation Administration may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the Contractor may request the Sponsor to enter into any litigation to protect the interests of the Sponsor. In addition, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

**(HABENDUM CLAUSE)**

**TO HAVE AND TO HOLD** said lands and interests therein unto (***Title of Sponsor***) and its successors forever, subject, however, to the covenants, conditions, restrictions and reservations herein contained as follows, which will remain in effect for the period during which the real property or structures are used for a purpose for which Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits and will be binding on the (***Title of Sponsor***), its successors and assigns.

The (***Title of Sponsor***), in consideration of the conveyance of said lands and interests in lands, does hereby covenant and agree as a covenant running with the land for itself, its successors and assigns, that (1) no person will on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination with regard to any facility located wholly or in part on, over, or under such lands hereby conveyed [,] [and]* (2) that the (***Title of Sponsor***) will use the lands and interests in lands and interests in lands so conveyed, in compliance with all requirements imposed by or pursuant to Title 49, Code of Federal Regulations, U.S. Department of Transportation, Subtitle A, Office of the Secretary, Part 21, Non-discrimination in Federally-assisted programs of the U.S. Department of Transportation, Effectuation of Title VI of the Civil Rights Act of 1964, and as said Regulations and Acts may be amended[, and (3) that in the event of breach of any of the above-mentioned nondiscrimination conditions, the Department will have a right to enter or re-enter said lands and facilities on said land, and that above described land and facilities will thereon revert to and vest in and become the absolute property of the Federal Aviation Administration and its assigns as such interest existed prior to this instruction].*

(*Reverter clause and related language to be used only when it is determined that such a clause is necessary in order to make clear the purpose of Title VI.)

## A7 CLEAN AIR AND WATER POLLUTION CONTROL

Contractor agrees to comply with all applicable standards, orders, and regulations issued pursuant to the Clean Air Act (42 USC §§ 7401-7671q) and the Federal Water Pollution Control Act as amended (33 USC §§ 1251-1387). The Contractor agrees to report any violation to the Owner immediately upon discovery. The Owner assumes responsibility for notifying the Environmental Protection Agency (EPA) and the Federal Aviation Administration.

Contractor must include this requirement in all subcontracts that exceed $150,000.

## A8 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

1. Overtime Requirements.

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic, including watchmen and guards, in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; Liability for Unpaid Wages; Liquidated Damages.

In the event of any violation of the clause set forth in paragraph (1) of this clause, the Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this clause, in the sum of $29 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this clause.

3. Withholding for Unpaid Wages and Liquidated Damages.

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this clause.

4. Subcontractors.

The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (1) through (4) and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1) through (4) of this clause.

## A9 COPELAND "ANTI-KICKBACK" ACT

Contractor must comply with the requirements of the Copeland "Anti-Kickback" Act (18 USC 874 and 40 USC 3145), as supplemented by Department of Labor regulation 29 CFR part 3. Contractor and subcontractors are prohibited from inducing, by any means, any person employed on the project to give up any part of the compensation to which the employee is entitled. The Contractor and each Subcontractor must submit to the Owner, a weekly statement on the wages paid to each employee performing on covered work during the prior week. Owner must report any violations of the Act to the Federal Aviation Administration.

## A10 DAVIS-BACON REQUIREMENTS

1. Minimum Wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Secretary of Labor under the Copeland

Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalent thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination;

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the Contractor, the laborers, or mechanics to be employed in the classification, or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized

representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii) (B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, *Provided*, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding. The Federal Aviation Administration or the Sponsor shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the Federal Aviation Administration may, after written notice to the Contractor, Sponsor, Applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and Basic Records.

(i) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act); daily and weekly number of hours worked; deductions made; and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records that show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual costs incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship

programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit the payrolls to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR § 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (*e.g.*, the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at *https://www.dol.gov/agencies/whd/government-contracts/construction/payroll-certification* or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker and shall provide them upon request to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit them to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration, the Contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, Sponsor, or Owner).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i), and that such information is correct and complete;

(2) That each laborer and mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR Part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

(iii) The Contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the Sponsor, the Federal Aviation Administration, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, Sponsor, applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR § 5.12.

4. Apprentices and Trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman’s hourly rate) specified in the Contractor’s or subcontractor’s registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice’s level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR § 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal Employment Opportunity. The utilization of apprentices, trainees, and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act Requirements.

The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

6. Subcontracts.

The Contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR §§ 5.5(a)(1) through (10) and such other clauses as the Federal Aviation Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR § 5.5.

7. Contract Termination: Debarment.

A breach of the contract clauses in paragraph 1 through 10 of this section may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR § 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes Concerning Labor Standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

(i) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR § 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR § 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 USC § 1001.

## A11 DEBARMENT AND SUSPENSION

**CERTIFICATION OF OFFEROR/BIDDER REGARDING DEBARMENT**

By submitting a bid/proposal under this solicitation, the bidder or offeror certifies that neither it nor its principals are presently debarred or suspended by any Federal department or agency from participation in this transaction.

### A11.1.1 Lower Tier Contract Certification

**CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT**

The successful bidder, by administering each lower tier subcontract that exceeds $25,000 as a "covered transaction", must confirm each lower tier participant of a "covered transaction" under the project is not presently debarred or otherwise disqualified from participation in this federally-assisted project. The successful bidder will accomplish this by:

1. Checking the System for Award Management at website: http://www.sam.gov.
2. Collecting a certification statement similar to the Certification of Offeror /Bidder Regarding Debarment, above.
3. Inserting a clause or condition in the covered transaction with the lower tier contract.

If the Federal Aviation Administration later determines that a lower tier participant failed to disclose to a higher tier participant that it was excluded or disqualified at the time it entered the covered transaction, the FAA may pursue any available remedies, including suspension and debarment of the non-compliant participant.

# A12 DISADVANTAGED BUSINESS ENTERPRISE

## A12.1.1 Solicitation Language (Solicitations that include a Contract Goal)

Bid Information Submitted as a matter of responsiveness:

The Owner's award of this contract is conditioned upon Bidder or Offeror satisfying the good faith effort requirements of 49 CFR § 26.53.

As a condition of responsiveness, the Bidder or Offeror must submit the following information with its proposal on the forms provided herein:

1) The names and addresses of Disadvantaged Business Enterprise (DBE) firms that will participate in the contract;
2) A description of the work that each DBE firm will perform;
3) The dollar amount of the participation of each DBE firm listed under (1);
4) Written statement from Bidder or Offeror that attests their commitment to use the DBE firm(s) listed under (1) to meet the Owner's project goal
5) Written confirmation from each listed DBE firm that it is participating in the contract in the kind and amount of work provided in the prime contractor's commitment; and
6) If Bidder or Offeror cannot meet the advertised project DBE goal, evidence of good faith efforts undertaken by the Bidder or Offeror as described in appendix A to 49 CFR part 26. The documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract.

Bid Information submitted as a matter of responsibility:

The Owner's award of this contract is conditioned upon Bidder or Offeror satisfying the good faith effort requirements of 49 CFR § 26.53.

As a condition of responsibility, every Bidder or Offeror must submit the following information on the forms provided herein within five days after bid opening.

1) The names and addresses of Disadvantaged Business Enterprise (DBE) firms that will participate in the contract;
2) A description of the work that each DBE firm will perform;
3) The dollar amount of the participation of each DBE firm listed under (1);
4) Written statement from Bidder or Offeror that attests their commitment to use the DBE firm(s) listed under (1) to meet the Owner's project goal;
5) Written confirmation from each listed DBE firm that it is participating in the contract in the kind and amount of work provided in the prime contractor's commitment; and
6) If Bidder or Offeror cannot meet the advertised project DBE goal, evidence of good faith efforts undertaken by the Bidder or Offeror as described in appendix A to 49 CFR part 26. The documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract.

### A12.1.2 Solicitation Language (Race/Gender Neutral Means)

The requirements of 49 CFR part 26 apply to this contract. It is the policy of the City of Manchester – Department of Aviation to practice nondiscrimination based on race, color, sex, or national origin in the award or performance of this contract. The Owner encourages participation by all firms qualifying under this solicitation regardless of business size or ownership.

### A12.1.3 Prime Contracts (Contracts Covered by a DBE Program)

**Contract Assurance (49 CFR § 26.13; mandatory text provided)** –

The Contractor, subrecipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:

1) Withholding monthly progress payments;
2) Assessing sanctions;
3) Liquidated damages; and/or
4) Disqualifying the Contractor from future bidding as non-responsible.

**Prompt Payment (49 CFR § 26.29; acceptable/sample text provided**) –
The prime contractor agrees to pay each subcontractor under this prime contract for satisfactory performance of its contract no later than 30 days from the receipt of each payment the prime contractor receives from City of Manchester – Department of Aviation. The prime contractor agrees further to return retainage payments to each subcontractor within 30 days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written approval of the City of Manchester – Department of Aviation. This clause applies to both DBE and non-DBE subcontractors.

**Termination of DBE Subcontracts (49 CFR § 26.53(f); acceptable/sample text provided)** –
The prime contractor must not terminate a DBE subcontractor listed in response to Airfield Lighting Vault Expansion or an approved substitute DBE firm) without prior written consent of City of Manchester – Department of Aviation. This includes, but is not limited to, instances in which the prime contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm.

The prime contractor shall utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the contractor obtains written consent City of Manchester – Department of Aviation. Unless City of Manchester – Department of Aviation consent is provided, the prime contractor shall not be entitled to any payment for work or material unless it is performed or supplied by the listed DBE.

City of Manchester – Department of Aviation may provide such written consent only if City of Manchester – Department of Aviation agrees, for reasons stated in the concurrence document, that the prime contractor has good cause to terminate the DBE firm. For purposes of this paragraph, good cause includes the circumstances listed in 49 CFR §26.53.

Before transmitting to City of Manchester – Department of Aviation its request to terminate and/or substitute a DBE subcontractor, the prime contractor must give notice in writing to the DBE subcontractor, with a copy to City of Manchester – Department of Aviation, of its intent to request to terminate and/or substitute, and the reason for the request.

The prime contractor must give the DBE five days to respond to the prime contractor's notice and advise [Name of Recipient] and the contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why City of Manchester – Department of Aviation should not approve the prime contractor's action. If required in a particular case as a matter of public necessity (e.g., safety), City of Manchester – Department of Aviation may provide a response period shorter than five days.

In addition to post-award terminations, the provisions of this section apply to preaward deletions of or substitutions for DBE firms put forward by offerors in negotiated procurements.

## A13 DISTRACTED DRIVING

**TEXTING WHEN DRIVING**

In accordance with Executive Order 13513, “Federal Leadership on Reducing Text Messaging While Driving”, (10/1/2009) and DOT Order 3902.10, “Text Messaging While Driving”, (12/30/2009), the Federal Aviation Administration encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or subgrant.

In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding $10,000 that involve driving a motor vehicle in performance of work activities associated with the project.

## A14 PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT

Contractor and Subcontractor agree to comply with mandatory standards and policies relating to use and procurement of certain telecommunications and video surveillance services or equipment in compliance with the National Defense Authorization Act [Public Law 115-232 § 889(f)(1)].

## A15 EQUAL EMPLOYMENT OPPORTUNITY (EEO)

During the performance of this contract, the Contractor agrees as follows:

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identify, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff, or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

(3) The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

(4) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided by the agency contracting officer, advising the labor union or workers' representative of the Contractor's commitments under this section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(5) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(6) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(7) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any such rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(8) The Contractor will include the provisions of paragraphs (1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions, including sanctions for noncompliance*: Provided*, however, that in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

### A15.1.1 EEO Specification

**STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY**
**CONSTRUCTION CONTRACT SPECIFICATIONS**

1. As used in these specifications:

a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

b. "Director" means Director, Office of Federal Contract Compliance Programs (OFCCP), U.S. Department of Labor, or any person to whom the Director delegates authority;

c. "Employer identification number" means the Federal social security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941;

d. "Minority" includes:

(1) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

(2) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race);

(3) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and

(4) American Indian or Alaskan native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the Contractor is participating (pursuant to 41 CFR part 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved plan is individually required to

comply with its obligations under the EEO clause and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a through 7p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in a geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

6. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such

individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.

d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.

f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions including specific review of these items with onsite supervisory personnel such superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.

i. Direct its recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a contractor's work force.

k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.

l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel, for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

m. Ensure that seniority practices, job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

n. Ensure that all facilities and company activities are nonsegregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative action obligations (7a through 7p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the Contractor is a member and participant may be asserted as fulfilling any one or more of its obligations under 7a through 7p of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).

10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, sexual orientation, gender identity, or national origin.

11. The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR part 60-4.8.

14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government, and to keep records. Records shall at least include for each employee, the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g. those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

## A16 FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)

The Sponsor must select *contractor* or *consultant*, as appropriate for the contract.

All contracts and subcontracts that result from this solicitation incorporate by reference the provisions of 29 CFR part 201, et seq, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers.

The *Contractor* has full responsibility to monitor compliance to the referenced statute or regulation. The *Contractor* must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

## A17 LOBBYING AND INFLUENCING FEDERAL EMPLOYEES

**CERTIFICATION REGARDING LOBBYING**

The Bidder or Offeror certifies by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

## A18 PROHIBITION OF SEGREGATED FACILITIES

(a) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Employment Opportunity clause in this contract.

(b) "Segregated facilities," as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin because of written or oral policies or employee custom. The term does not include separate or single-user rest rooms or necessary dressing or sleeping areas provided to assure privacy between the sexes.

(c) The Contractor shall include this clause in every subcontract and purchase order that is subject to the Equal Employment Opportunity clause of this contract.

## A19 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

All contracts and subcontracts that result from this solicitation incorporate by reference the requirements of 29 CFR Part 1910 with the same force and effect as if given in full text. The employer must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The employer retains full responsibility to monitor its compliance and their subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (29 CFR Part 1910). The employer must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

## A20 PROCUREMENT OF RECOVERED MATERIALS

**PROCUREMENT OF RECOVERED MATERIALS**

Contractor and subcontractor agree to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, and the regulatory provisions of 40 CFR Part 247. In the performance of this contract and to the extent practicable, the Contractor and subcontractors are to use products containing the highest percentage of recovered materials for items designated by the Environmental Protection Agency (EPA) under 40 CFR Part 247 whenever:

1) The contract requires procurement of $10,000 or more of a designated item during the fiscal year; or
2) The contractor has procured $10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products.

Section 6002(c) establishes exceptions to the preference for recovery of EPA-designated products if the contractor can demonstrate the item is:

a) Not reasonably available within a timeframe providing for compliance with the contract performance schedule;
b) Fails to meet reasonable contract performance requirements; or
c) Is only available at an unreasonable price.

## A21 RIGHT TO INVENTIONS

**RIGHTS TO INVENTIONS**

Contracts or agreements that include the performance of experimental, developmental, or research work must provide for the rights of the Federal Government and the Owner in any resulting invention as established by 37 CFR part 401, Rights to Inventions Made by Non-profit Organizations and Small Business Firms under Government Grants, Contracts, and Cooperative Agreements. This contract

incorporates by reference the patent and inventions rights as specified within 37 CFR § 401.14. Contractor must include this requirement in all sub-tier contracts involving experimental, developmental, or research work.

## A22 SEISMIC SAFETY

### A22.1.1 Professional Service Agreements for Design

**SEISMIC SAFETY**

In the performance of design services, the Consultant agrees to furnish a building design and associated construction specification that conform to a building code standard that provides a level of seismic safety substantially equivalent to standards as established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their building code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety. At the conclusion of the design services, the Consultant agrees to furnish the Owner a "certification of compliance" that attests conformance of the building design and the construction specifications with the seismic standards of NEHRP or an equivalent building code.

### A22.1.2 Construction Contracts

**SEISMIC SAFETY**

The Contractor agrees to ensure that all work performed under this contract, including work performed by subcontractors, conforms to a building code standard that provides a level of seismic safety substantially equivalent to standards established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety.

## A23 TAX DELINQUENCY AND FELONY CONVICTIONS

**CERTIFICATION OF OFFEROR/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS**

The applicant must complete the following two certification statements. The applicant must indicate its current status as it relates to tax delinquency and felony conviction by inserting a checkmark (✓) in the space following the applicable response. The applicant agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification in all lower tier subcontracts.

**Certifications**

1) The applicant represents that it is ( ) is not ( ) a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

2) The applicant represents that it is ( ) is not ( ) a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

**Note**

If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the Sponsor has received notification from the agency suspension and debarment official (SDO) that the SDO has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore must provide information to the owner about its tax liability or conviction to the Owner, who will then notify the FAA Airports District Office, which will then notify the agency's SDO to facilitate completion of the required considerations before award decisions are made.

**Term Definitions**

**Felony conviction:** Felony conviction means a conviction within the preceding twenty four (24) months of a felony criminal violation under any Federal law and includes conviction of an offense defined in a section of the U.S. Code that specifically classifies the offense as a felony and conviction of an offense that is classified as a felony under 18 USC § 3559.

**Tax Delinquency**: A tax delinquency is any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

## A24 TERMINATION OF CONTRACT

### A24.1.1 Termination for Convenience

**TERMINATION FOR CONVENIENCE (CONSTRUCTION & EQUIPMENT CONTRACTS)**

The Owner may terminate this contract in whole or in part at any time by providing written notice to the Contractor. Such action may be without cause and without prejudice to any other right or remedy of Owner. Upon receipt of a written notice of termination, except as explicitly directed by the Owner, the Contractor shall immediately proceed with the following obligations regardless of any delay in determining or adjusting amounts due under this clause:

1. Contractor must immediately discontinue work as specified in the written notice.
2. Terminate all subcontracts to the extent they relate to the work terminated under the notice.
3. Discontinue orders for materials and services except as directed by the written notice.
4. Deliver to the Owner all fabricated and partially fabricated parts, completed and partially completed work, supplies, equipment and materials acquired prior to termination of the work, and as directed in the written notice.
5. Complete performance of the work not terminated by the notice.
6. Take action as directed by the Owner to protect and preserve property and work related to this contract that Owner will take possession.

Owner agrees to pay Contractor for:

1. Completed and acceptable work executed in accordance with the contract documents prior to the effective date of termination;
2. Documented expenses sustained prior to the effective date of termination in performing work and furnishing labor, materials, or equipment as required by the contract documents in connection with uncompleted work;
3. Reasonable and substantiated claims, costs, and damages incurred in settlement of terminated contracts with Subcontractors and Suppliers; and
4. Reasonable and substantiated expenses to the Contractor directly attributable to Owner's termination action.

Owner will not pay Contractor for loss of anticipated profits or revenue or other economic loss arising out of or resulting from the Owner's termination action.

The rights and remedies this clause provides are in addition to any other rights and remedies provided by law or under this contract.

### A24.1.2 Termination for Default

**TERMINATION FOR CAUSE (CONSTRUCTION)**

Section 80-09 of FAA Advisory Circular 150/5370-10 establishes standard language for conditions, rights, and remedies associated with Owner termination of this contract for cause due to default of the Contractor.

Payment for completed equipment delivered to and accepted by the Owner shall be at the Contract price. The Owner may withhold from amounts otherwise due the Contractor for such completed equipment, such sum as the Owner determines to be necessary to protect the Owner against loss because of Contractor default.

Owner will not terminate the Contractor's right to proceed with the work under this clause if the delay in completing the work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such acceptable causes include: acts of God, acts of the Owner, acts of another Contractor in the performance of a contract with the Owner, and severe weather events that substantially exceed normal conditions for the location.

If, after termination of the Contractor's right to proceed, the Owner determines that the Contractor was not in default, or that the delay was excusable, the rights and obligations of the parties will be the same as if the Owner issued the termination for the convenience the Owner.

The rights and remedies of the Owner in this clause are in addition to any other rights and remedies provided by law or under this contract.

## A25 TRADE RESTRICTION CERTIFICATION

By submission of an offer, the Offeror certifies that with respect to this solicitation and any resultant contract, the Offeror –

1) is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms as published by the Office of the United States Trade Representative (USTR);

2) has not knowingly entered into any contract or subcontract for this project with a person that is a citizen or national of a foreign country included on the list of countries that discriminate against U.S. firms as published by the USTR; and

3) has not entered into any subcontract for any product to be used on the Federal project that is produced in a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR.

This certification concerns a matter within the jurisdiction of an agency of the United States of America and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18 USC § 1001.

The Offeror/Contractor must provide immediate written notice to the Owner if the Offeror/Contractor learns that its certification or that of a subcontractor was erroneous when submitted or has become erroneous by reason of changed circumstances. The Contractor must require subcontractors provide immediate written notice to the Contractor if at any time it learns that its certification was erroneous by reason of changed circumstances.

Unless the restrictions of this clause are waived by the Secretary of Transportation in accordance with 49 CFR § 30.17, no contract shall be awarded to an Offeror or subcontractor:

1) who is owned or controlled by one or more citizens or nationals of a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR; or
2) whose subcontractors are owned or controlled by one or more citizens or nationals of a foreign country on such USTR list; or
3) who incorporates in the public works project any product of a foreign country on such USTR list.

Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by this provision. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

The Offeror agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification without modification in all lower tier subcontracts. The Contractor may rely on the certification of a prospective subcontractor that it is not a firm from a foreign country included on the list of countries that discriminate against U.S. firms as published by USTR, unless the Offeror has knowledge that the certification is erroneous.

This certification is a material representation of fact upon which reliance was placed when making an award. If it is later determined that the Contractor or subcontractor knowingly rendered an erroneous certification, the Federal Aviation Administration (FAA) may direct through the Owner cancellation of the contract or subcontract for default at no cost to the Owner or the FAA.

## A26 VETERAN'S PREFERENCE

In the employment of labor (excluding executive, administrative, and supervisory positions), the Contractor and all sub-tier contractors must give preference to covered veterans as defined within Title 49 United States Code Section 47112. Covered veterans include Vietnam-era veterans, Persian Gulf veterans, Afghanistan-Iraq war veterans, disabled veterans, and small business concerns (as defined by 15 USC § 632) owned and controlled by disabled veterans. This preference only applies when there are covered veterans readily available and qualified to perform the work to which the employment relates.

## A27 DOMESTIC PREFERENCES FOR PROCUREMENTS

**CERTIFICATION REGARDING DOMESTIC PREFERENCES FOR PROCUREMENTS**

The Bidder or Offeror certifies by signing and submitting this bid or proposal that, to the greatest extent practicable, the Bidder or Offeror has provided a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States (including, but not limited to, iron, aluminum, steel, cement, and other manufactured products) in compliance with 2 CFR § 200.322.

**Manchester • Boston Regional Airport**
**Airfield Lighting Vault Expansion**

# DAVIS-BACON WAGE RATES

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"General Decision Number: NH20250025 01/03/2025

Superseded General Decision Number: NH20240025

State: New Hampshire

Construction Type: Heavy

County: Rockingham County in New Hampshire.

HEAVY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

| | |
|---|---|
| If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022: | . Executive Order 14026 generally applies to the contract.<br>. The contractor must pay all covered workers at least $17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025. |
| If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022: | . Executive Order 13658 generally applies to the contract.<br>. The contractor must pay all covered workers at least $13.30 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2025. |

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker

protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

| Modification Number | Publication Date |
|---|---|
| 0 | 01/03/2025 |

ELEC0490-008 06/01/2024

| | Rates | Fringes |
|---|---|---|
| ELECTRICIAN | $ 35.34 | 22.49 |

IRON0007-039 09/16/2024

| | Rates | Fringes |
|---|---|---|
| IRONWORKER (Reinforcing and Structural) | $ 31.95 | 25.00 |

PLUM0131-005 06/01/2024

| | Rates | Fringes |
|---|---|---|
| PIPEFITTER | $ 43.76 | 25.44 |

SUNH2015-011 06/16/2017

| | Rates | Fringes |
|---|---|---|
| CARPENTER, Includes Form Work | $ 28.17 | 8.09 |
| CEMENT MASON/CONCRETE FINISHER | $ 25.49 | 18.11 |
| LABORER: Asphalt, Includes Raker, Shoveler, Spreader and Distributor | $ 23.70 | 1.54 |
| LABORER: Common or General | $ 18.61 | 4.49 |
| LABORER: Pipelayer | $ 30.35 | 17.03 |
| OPERATOR: Backhoe/Excavator/Trackhoe | $ 28.51 | 10.16 |
| OPERATOR: Bulldozer | $ 21.70 | 4.09 |
| OPERATOR: Crane | $ 29.91 | 6.60 |
| OPERATOR: Drill | $ 28.78 | 15.26 |
| OPERATOR: Loader | $ 30.49 | 19.06 |
| OPERATOR: Paver (Asphalt, Aggregate, and Concrete) | $ 27.10 | 5.69 |

OPERATOR: Roller.....$ 23.02 4.52

PAINTER (Brush and Roller).....$ 33.55 19.15

TRAFFIC CONTROL: Flagger.....$ 17.24 ** 1.54

TRUCK DRIVER: Dump Truck.....$ 19.02 5.73

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($17.75) or 13658 ($13.30). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

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The body of each wage determination lists the classifications and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey

rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than ""SU"", ""UAVG"", ?SA?, or ?SC? denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The ""SU"" identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

?SU? wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1).

State Adopted Rate Identifiers

The ""SA"" identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

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WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:

a) a survey underlying a wage determination
b) an existing published wage determination
c) an initial WHD letter setting forth a position on a wage determination matter
d) an initial conformance (additional classification and rate) determination

On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

Branch of Wage Surveys
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

Regarding any other wage determination matter such as conformance decisions, requests for initial decisions should be directed to the WHD Branch of Construction Wage Determinations. Requests can be submitted via email to BCWD-Office@dol.gov or by mail to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"

"General Decision Number: NH20250040 01/03/2025

Superseded General Decision Number: NH20240040

State: New Hampshire

Construction Type: Highway

County: Rockingham County in New Hampshire.

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

| | |
|---|---|
| If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022: | • Executive Order 14026 generally applies to the contract.<br>• The contractor must pay all covered workers at least $17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025. |
| If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022: | • Executive Order 13658 generally applies to the contract.<br>• The contractor must pay all covered workers at least $13.30 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours performing on that contract in 2025. |

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at

http://www.dol.gov/whd/govcontracts.

| Modification Number | Publication Date |
|---|---|
| 0 | 01/03/2025 |

SUNH2019-009 11/22/2022

| | Rates | Fringes |
|---|---|---|
| CARPENTER (Form Work Only) | $ 24.02 | 2.82 |
| CARPENTER, Excludes Form Work | $ 26.09 | 2.51 |
| CEMENT MASON/CONCRETE FINISHER | $ 22.44 | 0.00 |
| ELECTRICIAN | $ 28.08 | 2.78 |
| FENCE ERECTOR (Chain Link Fence) | $ 19.59 | 0.00 |
| HIGHWAY/PARKING LOT STRIPING: Painter | $ 21.63 | 0.00 |
| INSTALLER - GUARDRAIL | $ 31.12 | 9.72 |
| IRONWORKER, REINFORCING | $ 22.71 | 8.19 |
| IRONWORKER, STRUCTURAL | $ 34.45 | 17.20 |
| LABORER: Asphalt, Includes Raker, Shoveler, Spreader and Distributor | $ 18.30 | 2.75 |
| LABORER: Common or General | $ 19.15 | 2.60 |
| LABORER: Landscape | $ 18.06 | 0.00 |
| LABORER: Pipelayer | $ 19.66 | 5.28 |
| OPERATOR: Auger | $ 26.07 | 3.42 |
| OPERATOR: Backhoe/Excavator/Trackhoe | $ 26.98 | 6.50 |
| OPERATOR: Bobcat/Skid Steer/Skid Loader | $ 21.54 | 7.11 |
| OPERATOR: Broom/Sweeper | $ 25.73 | 0.00 |
| OPERATOR: Bucket | $ 30.00 | 0.00 |
| OPERATOR: Bulldozer | $ 25.99 | 6.75 |
| OPERATOR: Crane | $ 29.56 | 3.29 |

| | | |
|---|---|---|
| OPERATOR: Grader/Blade | $ 27.77 | 6.79 |
| OPERATOR: Loader | $ 25.69 | 6.28 |
| OPERATOR: Mechanic | $ 24.53 | 8.36 |
| OPERATOR: Milling Machine | $ 28.55 | 6.88 |
| OPERATOR: Paver (Asphalt, Aggregate, and Concrete) | $ 25.32 | 6.23 |
| OPERATOR: Pounder | $ 36.82 | 10.41 |
| OPERATOR: Roller | $ 23.35 | 5.98 |
| PAINTER: Spray | $ 27.29 | 6.95 |
| TRAFFIC CONTROL: Flagger | $ 13.17 ** | 1.37 |
| TRUCK DRIVER: Dump Truck | $ 19.47 | 3.22 |
| TRUCK DRIVER: Lowboy Truck | $ 22.76 | 5.07 |

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($17.75) or 13658 ($13.30). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

---

The body of each wage determination lists the classifications and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than ""SU"", ""UAVG"", ?SA?, or ?SC? denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The ""SU"" identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

?SU? wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1).

State Adopted Rate Identifiers

The ""SA"" identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

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WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:

a) a survey underlying a wage determination
b) an existing published wage determination
c) an initial WHD letter setting forth a position on a wage determination matter
d) an initial conformance (additional classification and rate) determination

On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

Branch of Wage Surveys
Wage and Hour Division

U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

Regarding any other wage determination matter such as conformance decisions, requests for initial decisions should be directed to the WHD Branch of Construction Wage Determinations. Requests can be submitted via email to BCWD-Office@dol.gov or by mail to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"

"General Decision Number: NH20250022 01/03/2025

Superseded General Decision Number: NH20240022

State: New Hampshire

Construction Type: Building

County: Rockingham County in New Hampshire.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

| | |
|---|---|
| If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022: | . Executive Order 14026 generally applies to the contract.<br>. The contractor must pay all covered workers at least $17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025. |
| If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022: | . Executive Order 13658 generally applies to the contract.<br>. The contractor must pay all covered workers at least $13.30 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2025. |

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

| Modification Number | Publication Date |
|---|---|
| 0 | 01/03/2025 |

ASBE0006-014 09/01/2024

| | Rates | Fringes |
|---|---|---|
| ASBESTOS WORKER/HEAT & FROST INSULATOR | $ 44.36 | 36.63 |

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BOIL0029-004 01/01/2021

| | Rates | Fringes |
|---|---|---|
| BOILERMAKER | $ 38.08 | 25.70 |

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BRNH0003-001 06/01/2020

| | Rates | Fringes |
|---|---|---|
| BRICKLAYER | $ 42.55 | 28.02 |

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ELEC0490-006 06/01/2024

| | Rates | Fringes |
|---|---|---|
| ELECTRICIAN (Includes Low Voltage Wiring and Alarm Installation) | $ 35.34 | 22.49 |

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ELEV0004-007 01/01/2023

| | Rates | Fringes |
|---|---|---|
| ELEVATOR MECHANIC | $ 68.38 | 37.335+a+b |

a. PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, Christmas Day and the Friday after Thanksgiving.

b. VACATION: Employer contributes 8% of basic hourly rate for 5 years or more of service; 6% of basic hourly rate for 6 months to 5 years of service as vacation pay credit.

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IRON0007-037 09/16/2024

| | Rates | Fringes |
|---|---|---|
| IRONWORKER (Reinforcing and Structural) | $ 31.95 | 25.00 |

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LABO0976-008 12/01/2023

| | Rates | Fringes |
|---|---|---|
| LABORER: Common or General | $ 25.40 | 21.43 |

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PLUM0131-004 06/01/2024

| | Rates | Fringes |
|---|---|---|
| PIPEFITTER | $ 43.76 | 25.44 |

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SUNH2015-008 06/16/2017

| | Rates | Fringes |
|---|---|---|
| CARPENTER, Includes Acoustical Ceiling Installation and Form Work (Excludes Drywall Hanging and Drywall Finishing/Taping | $ 24.47 | 8.55 |
| CEMENT MASON/CONCRETE FINISHER | $ 22.04 | 9.70 |
| DRYWALL FINISHER/TAPER | $ 25.00 | 0.00 |
| DRYWALL HANGER, Includes Metal Stud Installation | $ 25.00 | 0.00 |
| GLAZIER | $ 26.75 | 3.48 |
| LABORER: Mason Tender - Brick | $ 16.52 ** | 4.74 |
| OPERATOR: Backhoe/Excavator/Trackhoe | $ 24.02 | 4.25 |
| OPERATOR: Crane | $ 27.42 | 3.83 |
| OPERATOR: Loader | $ 22.25 | 2.13 |
| OPERATOR: Roller | $ 23.56 | 3.28 |
| PAINTER (Brush and Roller) | $ 18.10 | 1.58 |
| PAINTER: Spray | $ 22.99 | 3.28 |
| PLUMBER, Includes HVAC Pipe Installation | $ 26.72 | 5.56 |
| ROOFER | $ 19.22 | 0.00 |
| SHEET METAL WORKER, Includes HVAC Duct Installation | $ 24.88 | 5.46 |
| SPRINKLER FITTER (Fire | | |

Sprinklers).....$ 31.29 9.78

WATERPROOFER.....$ 26.69 0.00

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WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

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WAGE DETERMINATION APPEALS PROCESS

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2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage

and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

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U.S. Department of Labor
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The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

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U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"

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**SUPPLEMENTAL PROVISIONS**

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## I. CONTRACT DOCUMENT DRAWINGS

Attention shall be directed to the General Provisions and to the Supplemental General Provisions for complete definition and enumeration of the Contract Documents. Attention shall be paid to the drawings, specifications, and addenda enumerated in Paragraph I of the Supplemental General Provisions which form a part of this contract.

A. Dimensions

The drawings are made to scale, unless otherwise noted, but all working dimensions shall be taken from the figured dimensions or by actual measurements at the work, and in no case by scaling the prints. The Contractor (and his/her subcontractors) shall study and compare all drawings and verify all figures before laying out or constructing the work and shall be responsible for any and all errors in the Contract work which might have been avoided thereby. Whether or not an error is believed to exist, deviations from the drawings and the dimensions given thereon shall be made only after approval in writing is obtained from the Engineer. The Contractor (and his/her subcontractors) shall take all measurements of existing established conditions not-withstanding the figured dimensions are not in agreement with the Contractor's (or his/her subcontractors) measurements, the Engineer shall be immediately notified and the Engineer will promptly adjust same.

B. Diagrammatic Drawings

1. Work and Materials Included

Plans or drawings where the work is shown diagrammatically indicate approved working systems. Every piece of material, fitting, fixture or small equipment is not shown nor is every difficulty or interference that may be encountered. To carry out the true intent and purpose of the Contract Documents, all necessary parts to make complete, approved working systems, or installations shall be included as if detailed on the drawings.

2. Location of Construction

The location of construction or installations shown on the drawings, unless exactly dimensioned, shall be considered as approximate only. The Contractor (and his/her subcontractors) shall adjust the position of the construction and installation in accordance with good working practices and as directed or approved by the Engineer to meet interferences, provide proper clearance and provide proper access space for operations and maintenance.

C. Typical Details

Where shown on the drawings, typical details shall apply to each and every item of the Contract work where such items are incorporated and the detail is applicable. Unless noted otherwise, such typical details shall be applicable in full.

## II. SPECIAL INSPECTION REQUIREMENTS

A. The project will be financially aided by grants from the Federal Aviation Administration (U. S. Government) and from the New Hampshire Department of Transportation, Bureau of Aeronautics All work done under this Contract will be subject to the rules and regulations and the approval of said Administration and Department. The Contractor shall provide authorized representatives of said Administration and Department with proper access to the work for inspection purposes at any time during the preparation for or progress on the Contract work.

B. The Contractor shall throughout the course of the work give proper notice to the Engineer and all others having jurisdiction of his/her schedule of operations. It shall be the Contractor's

responsibility to have all parts of the work inspected and approved by the proper authorities as required.

C. All applicable inspection and certification requirements of the Standard Specifications referred to herein will be enforced, in addition to any other inspections or certifications deemed necessary by the Engineer.

## III. "OR EQUAL" CLAUSE

Whenever a material, article or piece of equipment is identified on the plans or in the specifications by reference to manufacturer's or vendor's names, trade names, catalogue numbers, etc., it is intended merely to establish a standard; and, any material, article, or equipment of other manufacturers and vendors which will perform adequately the duties imposed by the general design will be considered equally acceptable provided the material, article, or equipment so proposed, is, in the opinion of the Engineer, of equal substance and function. It shall not be purchased or installed by the Contractor without the Engineer's written approval.

## IV. PROTECTION OF LIVES AND HEALTH

To protect the lives and health of his/her employees under the contract, the Contractor shall comply with all pertinent provisions of the "Manual of Accident Prevention in Construction" issued by the Associated General Contractors of America, Inc., and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work, arising out of and in the course of employment on work under the Contract. He/she alone shall be responsible for the safety, efficiency, and adequacy of his/her plant, appliances, and methods, and for any damage which may result from their failure of their improper construction, maintenance, or operation.

## V. INSURANCE

A. General

1. The Contractor, under any circumstances, shall not commence work under this Contract until he/she has obtained all the insurance required by these Specifications. The Owner and the Engineer shall be named as certificate holder on all policies. The types and minimum amounts of the insurance to be provided by the contractor shall be as specified below.

B. Types and Minimum Limits

**1. Workmen's Compensation Insurance**

The Contractor shall procure and shall maintain during the life of this Contract Workmen's Compensation Insurance as required by applicable State of territorial law for all of his/her employees to be engaged in work at the site of the project under this Contract and, in case of any such work sublet, the Contractor shall require the subcontractor similarly to provide Workmen’s Compensation Insurance for all the latter's employees to be engaged in such work unless such employees are covered by the protection afforded by the Contractor's Workmen's Compensation Insurance.

In case any class of employees engaged in hazardous work on this project under this Contract is not protected under the Workmen's Compensation Statute, the Contractor shall provide and shall cause each subcontractor to provide adequate employer's liability insurance for the protection of such of his/her employees as are not otherwise protected.

**2. Contractor's Public Liability and Property, Damage and Vehicle Liability and Property Damage Insurance**

The Contractor shall procure and shall maintain during the life of this Contract, Contractor's Public Liability Insurance, Contractor's Property Damage Insurance, and Vehicle Liability Insurance. The Public Liability and Property Damage policies shall be extended to cover completed operations for a period of one year following acceptance of the contract work. The limits of insurance coverage shall be as follows:

For bodily injury:
$ 500,000.00 Each person
$ 1,000,000.00 Each person

For property damage:

$ 1,000,000.00 Each accident
$ 3,000,000.00 Aggregate

The insurance required under this subparagraph shall provide adequate protection for the contractor against damage claims which may arise from operation under this contract, whether such operations be by the insured or by anyone directly or indirectly employed by him/her and also against any damage or injury to aircraft or persons in aircraft operating on or near the project site. The insurance shall also cover damage or injury resulting from the use, storage, handling or transportation of explosives in connection with the contract work.

**3. Subcontractor's Public Liability and Property Damage Insurance and Vehicle Liability Insurance**

The Contractor shall either (a) require each of his/her subcontractors to procure, and to maintain during the life of his/her subcontract, Subcontractor's Public Liability and Property Damage Insurance and Vehicle Liability and Property Damage Insurance of the types and amount specified in (2) above or (b) insure the activities of all subcontractors under the Contractor's own policies specified in (2) above.

**4. Builder's Risk Insurance and/or All Risk Property Damage Insurance (Fire and Extended Coverage)**

Until the project is completed and accepted by the Owner the Contractor is required to maintain Builder's Risk Insurance and/or All Property Damage Insurance (Fire and Extended Coverage) on a 100 percent completed value basis on all materials and workmanship utilized all portions of the project for the benefit of the Owner, the Contractor and subcontractor as their interests may appear.

***Builder's Risk Insurance is only required for construction of structures or buildings including work on existing structures and/or buildings***.

**5. Owner's, Contractor's Protective Insurance**

The Contractor shall procure and maintain during the life of this Contract at his/her own expense and shall furnish to the Owner a separate Owner's Contractor's Protective Policy providing public liability and property damage with the following minimum limits:

For bodily injury:
$ 500,000.00 Each person
$ 1,000,000.00 Each accident

For property damage:
$ 1,000,000.00 Each accident
$ 3,000,000.00 Aggregate

C. Insurance Certificates

1. The Contractor shall furnish the Owner at the time of executing the Contract, Certificates of Insurance showing clearly the types and amounts of insurance coverage, the operations covered, effective dates, and expiration dates for all of the required insurance coverage. Certificates of Insurance shall be endorsed essentially as follows: "None of the coverage indicated on the Certificate will be modified or cancelled without ten days prior written notice to the Owner." The Certificates of Insurance shall clearly state all of the requirements specified in all these subparagraphs and shall state the month and year of the Contract. Acceptance of the insurance certificates by the Owner shall not relieve or decrease the liability of the Contractor under the Contract.

## VI. SPECIAL HAZARDS

The Contractor's and Subcontractor's Public Liability, Property Damage, Vehicle Liability, and Vehicle Property Damage insurance coverage shall provide adequate protection against the following special hazards:

A. Damage or injury to aircraft or persons in aircraft operating on or near the project site, resulting from any operations under this Contract.

B. Damage or injury resulting from the use, storage, handling or transportation of explosives in connection with the Contract work.

## VII. PRICING OF CONSTRUCTION CONTRACT CHANGE ORDER OR SUPPLEMENTAL AGREEMENT DOCUMENTATION

A. GENERAL

1. The contract language contained in this Section will supplement and take precedence over all other Change Order (CO) or Supplemental Agreement (SA) pricing contract provisions in the Contract Documents provided by the Owner, Design-Builder (Contractor), Construction Manager (Contractor), General Contractor (Contractor) and/or Architect/Owner. It is understood that these contract provisions will govern the pricing and administration of all change order proposals to be submitted by the Construction Manager and/or the General Contractor and/or the Trade Contractors and/or the Subcontractors and/or all other lower tier sub-subcontractors (all referred to as “Contractor” in this Section). In the event of a conflict between the other Contract Documents used for the Project, the change order pricing contract provisions in this Section shall govern.

2. Contractor agrees that it will incorporate the provisions of this Section into all agreements with lower tier Contractors. It is understood that these change order pricing provisions apply to all types of contracts and/or subcontracts specifically including lump sum (or fixed price contracts), and/or, unit price contracts. It is further understood that these change order provisions will apply to all methods of change order pricing specifically including lump sum change order proposals and unit price change order proposals.

3. Whenever change order or Supplemental Agreement proposals to adjust the contract price become necessary, the Owner will have the right to select the method of pricing to be used by the Contractor in accordance with the pricing provisions found in this Section. The options will be (1) lump sum change order proposal, or (2) unit price change order proposal as defined in the following provisions.

4. The word "Change Order" in this section applies to both Change Orders and Supplemental Agreements as defined by Section 10-15 and 10-59 of the General Provisions of these specifications.

B. CHANGE ORDER TYPES

1. Lump Sum Change Orders. Provides a single lump sum amount for extra work that comprises of multiple task and a well-defined amount of effort.

2 Unit Price Change Orders. Provides a per unit amount for a single task that will be measured for payment upon completion of the task.

3. If a CO proposal is not acceptable to the Owner and prompt agreement between the two parties cannot be reached, the Owner at its sole option, may order the Contractor to proceed with the work on a "Time and Material" basis. The resulting CO will be treated as a Lump Sum CO for determining cost. The Time and Material worksheet contained in Technical Specification Section G- 001 will be used to track time and materials on a daily basis and must be signed by the Contractor and the Engineer each day.

C. CHANGE ORDER PROPOSALS

1. The following will apply to all types of Change Orders:

a. For all labor the Contractor shall receive the rate of the personnel reasonably anticipated to perform the work, or in the case of Time and Materials, the wage actually paid as shown by his certified payroll, which shall be at least the minimum rate established by the Contract Documents.

1. The labor rate shall include allowable overhead labor burden defined as employer's net actual cost of payroll taxes (FICA, Medicare, SUTA, FUTA), net actual cost for employer's cost of union benefits (or other usual and customary fringe benefits if the employees are not union employees), and net actual cost to employer for worker's compensation insurance.

2. For all foremen in direct charge of the work the Contractor shall receive the actual wage paid the foremen, as shown on (his certified payroll). No part of the

salary or expense of anyone above the grade of foreman and having general supervision of the work will be included in the labor item.

3. Contractor shall receive the actual cost of such labor and labor burden, to which shall be added a maximum of fifteen percent (15%) of the sum thereof.

b. For all materials used by the Contractor, he shall receive the actual cost of such materials, less any allowable cash discounts, delivered on the work, including delivery charges as shown by original receipted bills, to which shall be added a maximum of five percent (5%) of the sum thereof.

c. For any major power operated machinery, trucks or equipment, which it may be necessary to use, the Owner shall allow the Contractor the rental price as set forth in the standard schedule of equipment rental prices established by the Rental Rate Blue Book for Construction Equipment, current edition as published by Dataquest, or equivalent publication.

1. Should the proper completion of the work require equipment of a type not covered by the above-mentioned schedule, the Owner shall allow the Contractor a reasonable rental price to be agreed upon in writing before the work is begun.

2. No percentage shall be added to the amounts of any of the above stated equipment rental prices, but the price as set forth in the schedule or agreed upon shall be total compensation allowed for the use of such equipment.

3. Major equipment is defined as tools and equipment with an individual purchase cost of more than $750.

d. For all cost of all insurance, bonds, and taxes imposed by law on labor employed on the work, the Contractor shall receive the actual amount paid without being marked up.

1. In the event the Contractor has been required to furnish comprehensive general liability insurance and/or performance and/or payment bonds as part of the base contract price, a final contract change order will be processed to account for the Contractor's net increase or decrease in comprehensive general liability insurance costs and/or bond premium costs associated with change orders to Contractor's base contract price.

e. All extra work performed by a subcontractor will be according to the above requirements as if the work were preformed directly by the Contractor. Extra work performed by a subcontractor may be marked up by the General Contractor by a maximum of five percent (5%). If there are second and third tier subcontractors, subcontractors can markup lower tier subcontractors by a maximum of five percent (5%), the aggregate mark-up of all subcontractors involved shall be a maximum of twenty percent (20%), including the General Contractors markup. The maximum mark-up for all labor, materials and subcontractors is twenty-five percent (25%).

f. In no event will any lump sum or percentage amounts for "contingency" be allowed to be added as a separate line item in change order estimates. Unknowns attributable to labor hours will be accounted for when estimating labor hours anticipated performing the

work. Unknowns attributable to material scrap and waste will be estimated as part of material costs.

g. The Contractor's proposals for changes in the contract amount or time shall be submitted within seven (7) calendar days of the Owner's request, unless the Owner extends such period of time due to the circumstances involved. If such proposals are not received in a timely manner, if the proposals are not acceptable to Owner, or if the changed work should be started immediately to avoid damage to the project or costly delay, the Owner may direct the Contractor to proceed with the changes without waiting for the Contractor's proposal or for the formal change order to be issued. In the case of an unacceptable Contractor proposal, the Owner may direct the Contractor to proceed with the changed work on a time and material basis with an agreed upon "not-to-exceed" price for the work to be performed. Such directions to the Contractor by the Owner shall be confirmed in writing within seven (7) calendar days. The cost or credit, and or time extensions will be determined by negotiations as soon as practical thereafter and incorporated in a Change Order to the Contract.

D. UNAUTHORIZED CHANGES IN THE WORK

Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented.

## VIII. PERMITS

a. The Engineer will provide the awarded Contractor any state and local permits after the bid. The following permits are anticipated.
    1. FAA approval of the Construction Safety and Phasing Plan.

b. The Contract documents have to the greatest extent practical provided the anticipated conditions of the permits.

c. Upon receipt of the listed permits, the Engineer and Contractor will review the permit conditions and if required modify the contract documents accordingly. Should additional and/or a change in the work be required that has a cost impact, the Contractor will be compensated for the additional and/or change in the work per the Change Order process.

d. The Contractor shall be responsible for obtaining any and all applicable building and erosion control permits. All costs of permits and licenses are incidental to the work.

## VIX. LIABILITY & INDEMNITY LANGUAGE

1) *Limitation of City's Liability*

EXCEPT FOR INJURY OR DAMAGE CAUSED BY CITY'S GROSS NEGLIGENCE OR WILLFUL MISCONDUCT, CONTRACTOR SHALL RELEASE CITY AND CITY'S AGENTS, EMPLOYEES, CONTRACTORS, OFFICERS, AND LEGAL REPRESENTATIVES FROM ALL LIABILITY FOR ANY INJURY, DEATH, DAMAGE, LOSS, OR INCONVENIENCE TO PERSONS OR PROPERTY SUSTAINED IN CONNECTION WITH OR INCIDENTAL TO PERFORMANCE UNDER THIS

AGREEMENT, EVEN IF THE INJURY, DEATH, DAMAGE, LOSS, OR INCONVENIENCE IS CAUSED BY CITY'S SOLE OR CONCURRENT NEGLIGENCE. CONTRACTOR HEREBY ACKNOWLEDGES AND AGREES THAT CONTRACTOR AND CONTRACTOR'S AGENTS PROCEED AT THEIR OWN RISK WITH THE ACTIVITIES CONTEMPLATED BY THIS AGREEMENT.

2) *Indemnification*

CONTRACTOR HEREBY AGREES TO AND SHALL, TO THE FULLEST EXTENT PERMITTED BY LAW, DEFEND, INDEMNIFY, AND HOLD CITY AND CITY'S AGENTS, HARMLESS FROM AND AGAINST THE INDEMNIFIED LOSSES, AS DEFINED IN THIS AGREEMENT, INCLUDING, BUT NOT LIMITED TO, THOSE CAUSED BY:

A. CONTRACTOR'S AND/OR CONTRACTOR'S AGENTS' ACTUAL OR ALLEGED NEGLIGENCE OR INTENTIONAL ACTS OR OMISSIONS; AND

B. CITY'S AND CONTRACTOR'S ACTUAL OR ALLEGED CONCURRENT NEGLIGENCE, WHETHER CONTRACTOR IS IMMUNE FROM LIABILITY OR NOT; AND CITY'S, WHETHER CONTRACTOR IS IMMUNE FROM LIABILITY OR NOT.

CONTRACTOR SHALL REQUIRE ALL OF CONTRACTOR'S SUB CONTRACTOR AND THIRD-TIER SUB CONTRACTOR TO RELEASE AND INDEMNIFY CITY TO THE SAME EXTENT AND IN SUBSTANTIALLY THE SAME FORM AS CONTRACTOR'S RELEASE AND INDEMNITY TO CITY.

CONTRACTOR SHALL DEFEND ANY SUCH INDEMNIFIED LOSSES WITH COUNSEL REASONABLY ACCEPTABLE TO CITY. CONTRACTOR SHALL GIVE CITY WRITTEN NOTICE OF ANY INDEMNIFIED LOSSES PROMPTLY AFTER CONTRACTOR RECEIVES NOTICE THEREOF. CONTRACTOR SHALL NOT SETTLE OR COMPROMISE ANY CLAIM RELATED TO ANY INDEMNIFIED LOSSES WITHOUT PRIOR WRITTEN CONSENT OF CITY.

3) *Survival of Indemnity*

THE PROVISIONS UNDER THIS ARTICLE XIV SHALL SURVIVE THE EXPIRATION OR TERMINATION OF THIS AGREEMENT.

# ITEM G-001 Special Work Requirements

## GENERAL

**001-1.1 General.** The purpose of these requirements is to ensure that the contract work does not damage private property or create any hazard to aircraft operations, and to bring to the Contractor's attention special coordination that the Contractor should be aware of that may be unique to airfield construction or unique to the Owner's Facility. It is Contractor's responsibility to conduct all work in strict accordance with the requirements set forth herein and to fully cooperate with the Resident Project Representative (RPR) in every way necessary to fulfill the purposes of these requirements as set forth above.

**001-1.2 Work Limitations.** There are no limitations on work hours. Nightwork is generally 7PM to 7AM. Work on weekends is permitted. Request to work on weekends shall be submitted to the RPR 72 hours in advance. Work may not be allowed on specific days as determined by the RPR and/or the Owner. Such days will notcount towards exhausted contract time.

The following specification sections and regulations further define how work must be executed.

- General Provisions Section 80-04 Limitation of Operations
- General Provisions Section 80-04.1 Operational Safety on Airport During Construction
- FAA Advisory Circular 150/5370-2 (latest revision) "Operational Safety on Airports during Construction"
- The Construction Safety and Phasing Plans
- Airport Security and Compliance Requirements

**001-1.3 Prior Notification.** In accordance with Section 80-03 of the General Provisions, the Contractor shall submit their coordinated construction schedule showing all work activities for the RPR's review and acceptance prior to the pre-construction meeting. This schedule shall be updated during the project as specified.

In addition, the Contractor shall coordinate with the RPR and Owner and submit a detailed written weekly schedule of work that provides the work task by specification number for each day of the following week. The weekly schedule shall be submitted each week for the duration of the project, a minimum of 3-days prior to the week covered by the schedule.

In accordance with Section 80-04 of the General Provisions, the Contractor shall notify the RPR at least one (1) week in advance of the time he/she intends to start work or begin work in a new work area. It should be notedby the Contractor that 48 hours is the minimum time required by the Owner to issue a proper Notice to Airmen (NOTAM) of the pending construction activities. The Contractor's weekly construction scheduleswill also provide advance notice. The RPR and/or Owner may disallow work in areas not included in the weekly schedule and for which the required 1-week advance notice is not provided. Such instance shall not be a valid claim for delays. Prior to the beginning of work each day, the Contractor's Site Superintendentshall meet with the RPR to discuss the day's work schedule. The Contractor must notify the RPR at least 24-hours in advance of any items that will require acceptance testing. 72-hours' notice must be provided for testing on Mondays or testing the day immediately following a Holiday.

**001-1.4 Operational Safety.** Work performed under this contract will require safety and phasing in accordance with FAA regulations defined in Section 80-04.1 *Operational Safety on Airports During Construction* of the General Provisions. The Contractor shall take all precautions necessary to ensure the safety of operating aircraft, as well as his/her own equipment and personnel.

**001-1.5 Coordination.** The Contractor must coordinate all operations with the RPR and/or Owner. The

RPR or Owner will handle coordination with the Federal Aviation Administration, Air Traffic Control Tower, and Tenants.

**001-1.6 Regulations.** All work shall be performed in accordance with FAA Advisory Circular 150/5370-2 (latest revision), "*Operational Safety on Airports during Construction*".

**001-1.7 Construction Safety and Phasing Plans (CSPP).** In addition, all work shall be performed in accordance with the approved Construction Safety and Phasing Plans. The plans have been prepared by the Owner and RPR and approved by the FAA. It outlines the site-specific requirements for safely performing the work in accordance with AC 150/5370-2 (latest revision). The Contractor shall review, in detail, the Construction Safety and Phasing Plans.

Refer to the Construction Safety and Phasing Plans at the end of this specification.

**001-1.8 Contractor's Safety Plan Compliance (SPCD).** Once the Contractor has read and fully understands the CSPP, they shall prepare and submit for approval a Safety Plan Compliance Document (SPCD) as required by FAA AC 150/5370-2 (latest revision).

Similar to a shop drawing the SPCD, including all requirements of this specification, shall be submitted to the RPR for review prior to the Pre-Construction Meeting. The SPCD must be reviewed and approved by the Owner prior to issuance of the notice-to-proceed.

The Contractor shall designate an individual as the Site Safety officer (SSO). The SSO may be the Contractor's Site Superintendent who is responsible for day-to-day operations on the site. The SSO shall be on site daily and work on a daily basis to implement and enforce the CSPP and SPCD. The SSO shall conduct daily inspections. Among other items, the daily inspections shall include inspection of the barricades, lights, closure markers and protection of the taxiway/runway safety and object free areas. When necessary, the SSO will work with the RPR and Owner on safety related items.

At a minimum, the SPCD shall include the items listed in Section 2.4.2 of FAA AC 150/5370-2 (latest revision).

The Contractor shall be required to maintain a copy of the CSPP and SPCD at the project site at all times throughout the project duration.

**001-1.9 Barricades.** The Contractor shall place and maintain construction barricades to clearly define and close work areas to aircraft operations. The barricades are shown in the safety and phasing plans. Barricades shall be placed as shown or as directed by the RPR and/or Owner. Barricades shall meet the minimum requirement of FAA AC 150/5370-2 (latest revision). Refer to details in the contract documents. All temporary lights and barricades shall be weighted against jet blasts (100 mph). The barricades shall be supplied by the Contractor. The Contractor will maintain ownership of the barricades at the completion of the project. There will be no additional compensation for maintenance and repair of barricades.

**001-1.10 Runway and Taxiway Closure Markers.** The Contractor shall transport, place, and maintain runway and taxiway closure markers to clearly define surfaces closed to aircraft operations. The Taxiway Closure Markers shall be supplied by the Contractor. The required markers are shown inthe contract drawings. Markers shall be placed as shown or as directed by the RPR and/or Owner. ClosureMarkers shall meet the minimum requirement of FAA AC 150/5370-2 (latest revision). The method and procedure for securing the markers from dislodging must be approved by the Owner and RPR. Refer to marker details in the contract documents.

**001-1.11 Height Restrictions.** No equipment will be allowed to penetrate the Runway approach surfaces and transitions defined in 49 CFR Part 77 when the runway is active. Tall equipment, such as cranes or boom trucks, will be required to have a flag attached to the highest point. Additionally, during periods of darkness or reduced visibility a red light at the highest point shall also be required.

**001-1.12 Marking of Vehicles and Equipment.** Each motorized vehicle operating on the airport shall be equipped with an amber flashing light. All equipment must have a 3-foot square flag consisting of international orange and white squares not less than one foot square displayed in full view above the vehicle.

Equipment must also have an amber flashing light when operated during periods of limited visibility including darkness, fog, and rain. When not in use, all equipment shall be returned to the designated staging area and lowered to the maximum extent possible. All Contractor and subcontractor vehicles shall have the company identification plainly visible on both sides of the vehicle in order to identify the vehicle.

**001-1.13 Setback Requirements**. No construction operations shall be carried on within 85.5 feet from the centerline of any active taxiway or within 250 feet of the centerline of any active runway unless prior approval has been obtained and such actions are included in the phasing plans. The distances above represent the Taxiway Object Free Area and the Runway Safety Area respectively.

**001-1.14 Protection of Restricted Areas**. The Contractor shall stake and permanently mark on the ground with a readily recognizable marking (football field marking, flagging, cones, or similar material) the restriction lines adjacent to the work area so that workmen can readily recognize the limitations. The restricted areas are defined in the phasing plans and contract drawings.

**001-1.15 Trenches and Excavations**. The Contractor will not be permitted to leave any trenches or other excavations open at night, on weekends or at other times when the Contractor is not on the site, except as approved by the RPR. Open trenches must be clearly defined, confined to the work area(s), and completely surrounded with construction barricades. In addition, no excavations exceeding three inches (3”) in depth shall be left open within the object free areas while the runway, taxiways, or aprons, are in use. All excavations in paved areas must be backfilled and the pavement repaired and properly cured prior to the area being opened to traffic.

**001-1.16 Grading of Temporary Conditions**. The following applies when runways or taxiways must be re-opened. The Contractor shall ensure that the work area within the safety areas of the runways, taxiways and aprons are graded away from the pavements at a maximum slope of 5% for the first 10-feet and then 3% thereafter and shall be left in such condition that it will drain readily and effectively and will not pose a hazard to aircraft. No piles of soil shall be left unspread, no drops or projections in excess of three inches, no sharp changes in grade will be permitted, and the surface shall be thoroughly compacted.

**001-1.17 Radio Control and Communication**. At a minimum, the Contractor shall have two-way communications between the superintendent, escorts, and gate guards to coordinate access to and from the work site. No FAA or airport frequency shall be used for this purpose.

When work areas are adjacent to, within, or require traversing active movement areas (such as taxiways and the runway) the Contractor shall have on site at all times at least two radios capable of monitoring the airport ground frequency (121.9). The radio shall be capable of reliable two-way communications from any location on the airport. The Contractor shall, before the start of construction, test his/her radio(s) with the appropriate agencies to demonstrate the capabilities and to demonstrate the performance of the operator and the equipment. Only MHT Operations will communicate directly with the ATCT. The Contractor shall operate these radios, at his/her expense

**001-1.18 Flag Persons.** The Contractor shall provide flag persons or uniformed officers at locations where

the haul routes enter public streets or highways from airport property in accordance with the applicable local requirements. Additionally, the Contractor shall provide flag persons whenever the service road is restricted to one lane of traffic.

**001-1.19 Owner Provided Escorts.** The Owner will provide escorts throughout the duration of construction as needed. Contractor to coordinate schedule of activities at least one week in advance so that the Ownercan schedule escorts.

**001-1.20 Contractor Provided Escorts.** Not required.

**001-1.21 Haul Routes**. When public highways must be used for haul routes, it will become the Contractors responsibility to obtain the proper permits needed for this function and to obey all rules and regulations pertinent to the public highways.

Haul routes on the airport are shown on the contract drawings and the safety plans. The Contractors vehicles and equipment shall operate within the limits of the indicated haul route.

The Contractor's personnel and vehicles will not have access to the entire airport but shall be limited to the designated work area(s), staging area(s), and haul route(s).

All paved haul roads or access roads shall be kept clean at all times to prevent the accumulation of dirt and mud and the generation of dust by sweeping, washing or other methods as directed by the Airport. Unpaved haul roads, if any, shall be maintained by blading and filling when directed by the Airport and dust shall be controlled at all times.

All paved haul roads disturbed shall be restored to their original condition or better before the contract will be considered complete. All restoration and dust control on haul roads shall be at the Contractors expense.

All non-paved areas on the airport which are disturbed by the Contractors operations shall be scarified or otherwise loosened to a depth not less than five inches (5"). Clods shall be broken and the top three inches (3") of soil shall be worked into a satisfactory seedbed by disking, or by use of cultipackers, rollers, drags, harrows, or other appropriate means. This area shall be seeded, fertilized, and mulched.

**001-1.22 Security and Contractor Provided Gate Guards.** The Contractor shall comply with all airport security requirements as directed by the Owner. The Contractor's personnel, equipment, materials, and deliveries shall be subject to security checks prior to or while on airport property. Any delays incurred due to security inspections shall not be a valid claim for delays.

The Contractor is responsible for maintaining controlled access to the airfield via any and all project access gates. The Contractor must provide an Owner approved security gate guard during all work hours. Gate guards are required to have an Airport issued SIDA badge. Refer to Specification G-003 Gate Guard Allowance. The Contractor shall only allow access to personnel directly working on the project. The access gate will be opened and closed by a MHT Airport Operations Specialist.

Personal Vehicles (POV) are not permitted on the Airfield. The Contractor shall provide safe and adequate transportation to and from the area where POVs are parked and the work area(s).

**001-1.23 Disposal of Surplus and Unsuitable Materials.** All surplus and unsuitable materials not identified to be retained by the Owner, whether suitable or unsuitable, shall be legally disposed of by the Contractor off airport property. No separate measurement or payment will be made for the handling, hauling or disposal, but rather shall be incidental to the item that generated that material.

**001-1.24 Storm Water Management**. The Contractor is responsible for managing all storm water for the duration of the project including all diversion and dewatering of the site. The Contractor is also responsible for repairing all damage caused by storm water. All costs associated with the storm water management shall

be incidental to the overall project. The Contractor shall follow all U. S. Environmental Protection Agency and N.H. Department of Environmental Service regulations.

**001-1.25 U. S. EPA National Pollutant Discharge Elimination System (NPDES) Construction General Permit for Stormwater Discharges during Construction.** Storm Water Pollution Prevention Plan (SWPPP) and SWPPP monitoring are not required for this project.

The Contractor is responsible for all dewatering of excavation and the work areas. The Contractor is advised that work areas down gradient of large impervious areas need to anticipate that dewatering will be required.

**001-1.26 Storage of Materials and Equipment.** The area for storing materials and parking/servicing equipment is shown in the contract drawings. The Contractor will be required to return all equipment to the appropriate Contractor's staging area at the end of work, each day, unless otherwise approved.

Equipment shall be parked in the designated area when not in use.

The Contractor shall provide all necessary temporary fencing and gates to protect materials and equipment from pilferage. The Owner is not responsible for any vandalized equipment or materials stored on the property.

Any area occupied or utilized by the Contractor shall be maintained in a clean and orderly condition satisfactory to the Owner. At the completion of the project, all Contractors' facilities shall be removed promptly and in a workman like manner and the area left clean and free of all debris or surplus material. The Contractor is responsible for restoring to original condition any areas used for the Contractor's operation at no additional cost to the Owner.

**001-1.27 Maintenance of the Construction Site.** The Contractor shall keep the construction site free of paper, boxes, and other debris that could be blown onto the runways, taxiways, and/or aprons.

All airport pavements shall be kept clear and clean at all times. All rocks, mud, and other debris carried on to the airport pavement by the Contractor's equipment must be report to the RPR or Airport Operations. Airport Operations will then close the affected area to air traffic and the Contractor will immediately sweep the area to the satisfaction of Airport Operations.

The Contractor shall have access to the equipment for the application of water to control dust within the construction site and on haul roads. The equipment shall be equipped with a shut-off control valve which can be operated from the cab by the operator. The Contractor shall apply water for dust control as necessary to prevent dust from the construction site and/or haul roads from being a hazard to aircraft and from being a nuisance to the public as direct by the RPR. All water shall be supplied by the Contractor at no additional cost to the Owner.

The Contractor shall maintain at the job site at all times while the construction under this contract is in progress a self-propelled, self-contained vacuum sweeper with rotating brooms and with a 4-cubic yard capacity approved by the RPR. The sweeper shall operate as necessary to keep active aircraft pavements, access roads and the work areas clean. At the close of each day's work, all active aircraft pavements and airport paved roads used or dirtied by the Contractor shall again be swept.

The Contractor shall also be responsible for supplying any other equipment as may be necessary to clean all areas that are contaminated as a result of his/her operations to the complete satisfaction of the RPR and the Owner.

Trucks loaded in the construction area shall have loads trimmed as necessary to ensure that no particles, stones, or debris will fall off and that no legal load limits are exceeded.

The Contractor shall be particularly careful not to track foreign material onto pavements outside of the work area(s) (e.g., tack-coat, rocks, etc.). The Contractor shall be responsible for removing foreign materials from vehicle tires prior to the vehicle leaving its work area.

**001-1.28 Maintenance of the Existing Airfield Lighting.** All existing airfield lighting systems required to safely operate aircraft shall be operational each night and during inclement weather throughout the construction period.

It shall be the responsibility of the Contractor to check the operation of the existing lights each day, to notify the RPR and the Owner of any problems and make any repairs necessary due to his/her operation.

The Contractor shall furnish and install all materials necessary to provide temporary lighting and make any temporary connections to keep the existing airfield lighting operational until the new lighting fixtures, cables, etc. can be installed.

**001-1.29 Smoking**. Absolutely no smoking will be permitted within the AOA. Any Contractor violating this rule shall be asked to leave the premises.

**001-1.30 Employee Identification Badges.** Full-time competent and responsible employees of the Contractor, such as superintendents and foremen, shall obtain an Airport SIDA badge. Additionally, employees who will be onsite for more than two continuous weeks shall obtain an Airport SIDA badge. The SIDA badge requires finger printing screening and a criminal history check. The badge application process may take up to fourteen (14) days, the Contractor shall plan accordingly.

The Contractor shall have a minimum of 1/2 (50%) of on-site workers, including sub-contractors, submit to the badging process, unless otherwise approved by MHT Operations Management. Badged individuals must display their Airport issued badges on their outermost garment at all times while on the airfield.

The costs associated with Airport issued security access badges (approx. $100 each) are the responsibility of the Contractor and shall not be paid for by the Owner.

At all times while on the airfield, non-badged workers must be:
1. Within 100 feet of a badged worker
2. Within visual contact of a badged worker
3. Able to respond to the requests of a badged worker
4. Able to command the attention of a badged worker.

Any non-badged workers will not be allowed on the airfield without valid picture identification acceptable to the TSA (current and valid driver's license, passport, etc.), and shall remain with a badged worker or Airport escort at all times.

The Contractor shall provide the Owner with a list of employees on the job site and their badge number. The list shall include subcontractors and employees. The list shall be updated and submitted weekly.

**Upon completion of the contract the Contractor shall turn all the badges into the Owner for disposal.**

**001-1.31 Record Documents.** The Contractor shall provide all Final Project Documentation as specified throughout the projects specifications and summarized in FAA General Provisions Section 90 *Measurement and Payment,* paragraph 90-11 *Contractor Final Project Documentation,* and Specification G-002 *Record Documents*. The As-built Plans shall also include digital submission in AutoCAD and PDF formats.

## MATERIALS

**001-2.1 Materials.** Prior to ordering, the Contractor shall submit shop drawings to the RPR for all materials

to be used on the project. The submittals and shop drawings shall include a manufacturer's certification that each product meets the specified standard(s), when applicable. Materials not reviewed and approved prior to any installation for the project are subject to having the Contractor remove the unacceptable materials and replaced with approved materials at no additional expense to the Owner.

## METHOD OF MEASUREMENT

**001-3.1 Mobilization**. Mobilization shall be measured in accordance with Specification C-105 *Mobilization* lump sum item.

**001-3.2 Safety and Phasing**. Safety and Phasing items as outlined in Specification G-004 *Maintenance and Protection of Traffic* and the Contract Documents shall include: Contractor provided barricades, channelizer cones, taxiway closure signs, construction signs, covering lights during closures as indicated, disabling circuits during closures as indicated, routing new temporary FAA L-824 cable with temporary connections to keep light circuits active as indicated, lockout/tagout of circuits, maintenance of the construction site, sweeping, application of water for dust control and clean-up of stockpiles on pavements, flaggers, radios, training, badging, badging fees, preparation of required schedules, and all requirements of the project safety and phasing plans. It shall alsoinclude all work associated with the Contractor provided barricades. Assembly, transport, placement, repositioning, maintaining, disassembly and removal of all safety and phasing items shall not be measuredseparately but rather shall be considered incidental to the item. All Safety and Phasing materials and work shall not be measured separately and shall be incidental to the lump sum item for the requirements outlinedin Section G-004 *Maintenance and Protection of Traffic*.

**001-3.3 Contractor's Safety Plan Compliance Document (SPCD)**. The Contactor's preparation and submission of the SPCD will not be measured separately and shall be incidental to the lump sum item for the requirements outlined in Section G-004 *Maintenance and Protection of Traffic*.

**001-3.4 Safety Barricades**. Safety barricades will not be separately measured and shall be incidental to the lump sum item as outlined in Specification G-004 *Maintenance and Protection of Traffic*.

**001-3.5 Gate Guard - Allowance**. Measurement for this allowance will be as outlined in Specification G-003 *GateGuard Allowance Item.*

**001-3.6**. **USEPA NPDES Construction General Permit (CGP) for Stormwater Discharges during Construction/SWPPP.** Not used.

## BASIS OF PAYMENT

**001-4.1 Mobilization.** Mobilization will be paid for in accordance with the Specification C-105 *Mobilization* lumpsum item.

**001-4.2 Safety and Phasing.** Payment for all Safety and Phasing materials and work will not be paid for separately and will be incidental to lump sum items as outlined in Specification G-004 *Maintenance and Protection of Traffic.* Payment thereof shall constitute full compensation for all labor, preparation, materials, equipment, expenses, and incidentals. Payment shall be made after review and upon acceptance of the Contractor's Safety Plan Compliance Document by the Owner and in accordance with the requirements in Specification G-004 *Maintenance and Protection of Traffic* Basis of Payment.

**001-4.3 Safety Plan Compliance Document (SPCD).** Payment for the preparing, furnishing materials andimplementing the SPCD, will not be paid for separately and will be incidental to lump sum item as outlined in Specification G-004 *Maintenance and Protection of Traffic.* Payment thereof shall constitute full compensation for all labor, preparation, materials, equipment, expenses, and incidentals. Payment shall be made after review and upon acceptance of the document by the Owner and in accordance with the requirements in Specification G-004 *Maintenance and Protection of Traffic* Basis of Payment.

**001-4.4 Safety Barricades.** Safety barricades will not be paid for separately and will be incidental to the lump sum item as outlined in Specification G-004 *Maintenance and Protection of Traffic.* Payment thereof shall constitute full compensation for all labor, preparation, materials, equipment, expenses, and incidentals. Payment shall be made after review and upon acceptance of the materials by the Owner and

in accordancewith the requirements in Specification G-004 *Maintenance and Protection of Traffic* Basis of Payment.

**001-4.5 Gate Guard - Allowance.** Payment for this allowance will be paid as outlined in Item G-003 *GateGuard Allowance.*

**Payment shall be made under:**

Refer to the individual item descriptions from this Section for measurement and payment as referencedabove. These referenced items from this section are to be measured and paid under other referenced item sections of the Contract. Any other items, not identified under the Method of Measurement and Basis of Payment as outlined above, shall be considered incidental to the overall project, and will not be measured or paid for separately.

**Construction Safety and Phasing Plan Follows**

# ITEM G-002 Record Documents

## DESCRIPTION

**002-1.1 General.** The Contractor's attention is also directed to Section G-001 *Special Work Requirements* paragraph 001-1.31 *Record Documents* and Section 90 *Measurement and Payment* paragraph 90-11 *Contractor Final Project Documentation* of the General Conditions for additional project closeout documents and requirements.

The work included under this section of these specifications shall consist of preparing and submitting project record documents to the owner as specified in the items outlined below:

**a. Record Documents.** This item includes the following items:

**1. As-Built Plans.**

**2. Project Photographs**

**3. Aerial Photos**

**4. Final DBE Participation Statement.**

**b. Field Data Collection for GIS Survey Conversion.** Not used

## RELATED DOCUMENTS

**002-2.1** Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5300-16B, "General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submissions to the National Geodetic Survey."

**002-2.2** FAA AC 150/5300-17C, "Standards for Using Remote Sensing Technologies in Airport Surveys."

**002-2.3** FAA AC 150/5300-18B, "General Guidance and Specifications for Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards."

## REQUIREMENTS

### 002-3.1 RECORD DOCUMENTS

**a. As-Built Plans.** The Contractor shall maintain at the site a set of drawings on which shall be accurately recorded the actual as-built locations and dimensions of all his/her work. Changes and variations from the Contract Drawings should be clearly noted. The location an elevation of utilities and other items encountered during progress of the work shall be recorded. Notations on mechanical and electrical work shall include nameplate data for all installed equipment. The Contractor shall keep these drawings current as work progresses and available for review by the Engineer at all times. This record of as-built conditions shall include the work of all subcontractors.

Prior to final acceptance of the work, the Contractor shall have a final survey made by a **Land Surveyor licensed in the State of New Hampshire**. The final survey shall consist of taking elevation and state plane coordinate measurements at 50' longitudinal and transverse spacing, at all changes in grade, at the top and toes of slopes, and at the limits of work.

It shall also include the location and elevation of all structures, lights, signs, installed utilities, pavement markings, and joints. For drainage items the survey shall include rim elevations, invert elevations, and sump elevations. All survey shall be referenced to the National Geodetic Survey (NGS) Primary Airport

Control Station (PAC) and/or Secondary Airport Control Stations (SACS). PAC and SAC locations and data may be obtained from http://www.ngs.noaa.gov/cgi-bin/airports.prl?TYPE=PACSAC. A copy of the Survey information shall be delivered to the Engineer in the appropriate vertical datum, in State Plane coordinate system, and in AutoCAD® 2014 format. All elevations shall be to the nearest 0.01 foot with the exception of turf areas which may be to the nearest 0.1 foot.

All "As-Built" information from the final survey shall be shown on the As-Built Drawings and submitted to the Engineer for review. Any errors shall be corrected by the Contractor as required. The As-Built Drawings and final survey shall be completed and accepted by the Engineer before final payment will be made.

**b. Project Photographs.** The Contractor shall furnish photographs of the project, the views shall be as directed or approved by the Engineer. The photographs shall show the project site prior to construction,the work in progress and the project site at the completion of work.

A minimum of 60 color photographs will be taken during each 30-day period of the contract. A digital camera shall be used to take the photographs. At the completion of each 30-day period of the project the Contractor shall deliver to the Engineer one Color print of each view and a CD/USB flash drive with eachphoto. Each view shall be clearly labeled with the date, project and identification of the view.

**c. Aerial Photos.** The Contractor shall furnish four (4) sets of four 11-inch by 14-inch unmounted, oblique aerial color photographs taken from an altitude to completely cover the site of the work, with sufficient detail to shown the work from four different quadrants. These photographs shall be taken after completion of the contract. The Contractor shall inscribe on the reverse side of each photograph all pertinent information such as description, date, compass direction on which the picture was taken, AIP project number, photograph shall include all the airport boundaries.

All sets of photographs shall be delivered to the Engineer. These photographs to be taken with a digital format aerial camera with a photo resolution no less than 2750 x 2200 pixels, minimum photo size shall be 16 MP unless approved by the Engineer.

1. The Contractor shall furnish sixteen (16) color aerial photographs of the entire airport, including all airport boundaries, I-293 on the north, the F.E. Everett Turnpike on the west, Route 28 onthe east, and Delta Drive on the south. This photograph shall be taken with a mapping quality (cartographic) camera.

The Contractor shall submit certification that the camera has been calibrated within the last three (3) yearsin accordance with USGS mapping standards. The photo shall be vertical and shall be enlarged to 1" = 400'. The 1" = 400' enlargements shall be mounted on 48" x 48" Gator Board (or approved equal) and shall be identified on the back of the Gator Board. The Contractor shall also provide a digital image of the aerial photo on CD/USB flash drive.

2. The Contractor shall furnish eleven (11) color aerial photographs of the entire airport, including all airport boundaries, North Perimeter Road on the north, Brown Avenue on the west, Harvey Road on the east, and South Perimeter Road on the south. This photograph shall be taken with a mapping quality (cartographic) camera. The contractor shall submit certification that the camera has been calibrated withinthe last three (3) years in accordance with USGS mapping standards. The photo shall be vertical and shall be enlarged to 1" = 200'. The 1" = 200' enlargements shall be mounted on 48" x 65" Gator Board (or approved equal) and shall be identified on the back of the Gator Board.

3. The Contractor shall furnish one (1) color aerial photographs of the entire airport, including all airport boundaries, I-293 on the north, the F.E. Everett Turnpike on the west, Route 28 on the east, and Delta Drive on the south. This photograph shall be taken with a mapping quality (cartographic) camera. The Contractor shall submit certification that the camera has been calibrated within the last three (3) years in accordance with USGS mapping standards. The photo shall be vertical and shall be enlarged

to approximately 1" = 800' and have the ability to fit on a 24” x 24” mount. This enlargement shall be mounted on 24” x 24” DiBond Mounting Material (or approved equal) and shall be identified on the back of the mount.

Snow cover will not be permitted. Cloud cover shall not obscure photos. The photos shall be taken at the time of day when shadows from the sun will be minimal. Photos shall be clear, in focus, with high resolution and sharpness. Color and tint shall be correct; washed out photos will not be accepted. The Contractor shall submit to the Engineer, contact prints of the photograph for approval prior to making enlargements. Enlargements shall be mounted on Gator Board as indicated above and shall be identified on the back of the Gator Board. Photos shall be suitable for photogrammetric mapping.

**d. Final DBE Participation Statement.** The Contractor shall submit a statement showing the final accounting of all DBE participation actually used in the execution of the work prior to the final acceptance of the project. Should the actual DBE participation be less than the contract goals and/or contractor’s assurance submitted with the bid proposal, than the Contractor shall provide written documentation of their good faith effort to achieve the goal per the requirements of the MHT DBE Plan.

## METHOD OF MEASUREMENT

**002-4.1** Measurement of the As-Built Plans and Aerial Photos (All Phases) will be made for each unit submitted and accepted.

## BASIS OF PAYMENT

**002-5.1** Payment shall be made at the contract unit price, which price and payment thereof shall constitute full compensation for all labor, materials, equipment, utilities, expenses, and incidentals required.

Payment will be made under:

| | | |
|---|---|---|
| Item G-002-1 | As-Built Plans | per Lump Sum |
| Item G-002-2 | Aerial Photos (All Phases) | per Lump Sum |

**END OF ITEM G-002**

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# Item G-003 Gate Guard Allowance

## CONTRACT DOCUMENTS

**003-0.1** This section of these Specifications is a part of the Contract Documents as defined in the General Provisions. All applicable parts of the balance of the Contract Documents are equally as binding for this section as for all other sections.

**a.** All Allowances, if noted on the Bid Form, shall be included in the Base Bid and shall be carried by the Contractor, unless specifically noted to be carried by a subcontractor.

**b.** The Contractor shall cause the work covered by these Allowances to be performed for such amounts and by such persons as the Owner may direct but he will not be required to employ persons against whom he makes a reasonable objection.

**c.** If the cost, when determined, is more than or less than the Allowance, the Contract Sum shall be adjusted accordingly by Change Order, and if allowable herein, will include additional or reducedhandling costs on the site, labor, installation costs, overhead, profit and other expenses resulting to the Contractor from any increase over or decrease from the original Allowance.

**d.** Refer to related Drawings and Specifications for additional information regarding Work to be included as part of Allowances.

## DESCRIPTION

**003-1.1** Under this item, the Contractor shall coordinate with Manchester-Boston Regional Airport and their gate guard security company to provide gate guards for the project under the allowance provided by this specification. The Contractor shall coordinate with the gate guard security company with regard to scheduling the gate guards and when the gate guards will be required to be performing their duties.

## MATERIALS

**003-2.1** Not Used.

## CONSTRUCTION DETAILS

**003-3.1** Not Used.

## METHOD OF MEASUREMENT

**003-4.1** Measurement for the allowance for gate guards will be based on the actual time worked by the gate guard and any allowable associated costs. The exact amount of reimbursement to the gate guard security company will be indicated on the Gate Guard Security Company's invoice and will be the basis of measurement for the allowance without any additional mark-up by the Contractor. There shall be no separate measurement for the Contractor's cost to coordinate and administer the scheduling of the gate guards and it shall be considered incidental to the overall project.

## BASIS OF PAYMENT

**003-5.1** The amount paid to the Contractor shall be the exact amount indicated on the Contractor's invoice from the gate guard security company without mark-up. There shall be no separate payment to the Contractor to coordinate and administer the scheduling of the gate guards and these costs are considered incidental to the overall project.

Payment will be made under:

| | | |
|---|---|---|
| Item G-003-1 | Gate Guard Allowance | per allowance |

**END OF ITEM G-003**

# Item G-004 Maintenance and Protection of Traffic

## CONTRACT DOCUMENTS

**004-0.1** This section of these Specifications is a part of the Contract Documents as defined in the General Provisions. All applicable parts of the balance of the Contract Documents are equally as binding for this section as for all other sections.

## DESCRIPTION

**004-1.1 GENERAL.** This work shall consist of maintaining aircraft and vehicular traffic and protecting the public from damage to person and property within the limits of and for the duration of the Contract.

The Contractor shall comply with all guidelines regarding construction safety set forth in FAA Advisory Circular 150/5370-2 (latest revision), *Operational Safety on Airports During Construction* and Special Provisions.

The following items are specifically included without limiting the generality implied by these Specifications and the Contract Drawings.

- Preparation of the Safety Plan Compliance Document with submission to the Engineer and Airport for review and implementation
- Providing qualified flag persons, as required, at the locations shown on the plans or as directed by the Owner's representative.
- Locating and marking of existing underground lighting or other airfield circuits within the project work areas.
- Staged or phased construction.
- Off-peak construction periods, including both day and night shift work
- Temporary construction lighting for night shift construction periods, if applicable.
- Installation, maintenance and removal of temporary or permanent barricades, warning signs, and hazardmarkings. Furnishing temporary barricades for the project which will remain the property of the Contractor at the completion of the project.
- Temporary alteration or decommissioning of any existing Taxiway lighting and signage and coordination with MHT Ops/FAA Tech Ops for NAVAIDs shutdowns, if required.

- Installation, maintenance, and removal of temporary lights and lighting circuits, including "jumpers" of circuits as required.
- Installation, maintenance, and removal of temporary guidance sign blank panels
- Installation, maintenance, and removal of temporary light coverings
- Installation, maintenance, and removal of temporary lights and lighting
- Testing and maintenance of existing, temporary, and new lighting circuitry.
- Installation, maintenance, and removal of any temporary pavement tapers, transitions or temporaryaccesses to any airport facilities, if applicable.
- Installation, maintenance, and removal of any temporary asphalt pavement tapers and/or transitionsin accordance with FAA Advisory Circular 150/5370-13 - *Off-Peak Construction using Hot Mix Asphalt* (latest revision).
- Installation, maintenance, and removal of any temporary drainage, including, ditches, swales, piping and de-watering of work areas.
- Alteration, adjustment, maintenance of any drainage inlets, structures or systems necessary to maintain airfield operations drainage during construction.
- Cleaning and maintenance of all areas within construction limits and haul routes or areas disturbedby the Contractor's operation via vacuum sweeper trucks.
- Restoration of all surfaces disturbed because of the Contractor's Operations, which are not otherwise paid for under a specific item.
- Placement of temporary markings, including a black primer coat, prior to placing the temporary marking as shown on the plans, in accordance with FAA AC 150/5340-1 *Standards for Airport Markings* (latest revision), and meeting the requirements of Specification Section P-620, if required.
- Removal of temporary markings by approved techniques in accordance with FAA Advisory Circular 150/5340-1 *Standards for Airport Markings* (latest revision) and meeting the requirements of Specification Section P-620., if required.

## METHOD OF MEASUREMENT

**004-2.1** Maintenance and Protection of Traffic for each phase will be measured as a lump sum item for the Phase(s) indicated in the pay item. The lump sum shall include all items required in the plans and specifications.

**004-2.2** Contractor's Safety Plan Compliance Document (All Phases) will be measured as a lump sum item. One document shall cover all phases of the project regardless of the project's award of the Additive Alternates.

**004-2.3** Utility Locating Allowance will be measured based on actual costs of labor, equipment and materials submitted and approved by the RPR. No contractor markup is allowed.

## BASIS OF PAYMENT

**004-3.1** The lump sum price bid for Maintenance and Protection of Traffic [phase(s) vary] shall include all equipment, materials, and labor necessary to adequately and safely maintain and protect traffic.

Progress payments willbe made for this item in proportion to the total amount of contract work completed, less any deductions forunsatisfactory maintenance and protection of traffic.

In the event the contract completion date is extended, no additional payment will be made for maintenance and protection of traffic.

No payment will be made under maintenance and protection of traffic for each calendar day during which there are substantial deficiencies in compliance with the Specification requirements of any subsection of thisSection as determined by the Engineer. The amount of such calendar day non-payment will be determinedby dividing the lump sum amount bid for maintenance and protection of traffic by the number of calendar days between the date the Contractor commences work and the date of completion as designated in this proposal, without regard to any extension of time.

If the Contractor fails to maintain and protect traffic adequately and safely for a period of four (4) hours, theOwner shall correct the adverse conditions by any means it deems appropriate and shall deduct the cost ofthe corrective work from any monies due the Contractor. The cost of this work shall be in addition to the liquidated damages and non-payment for maintenance and protection of traffic listed above.

However, where major non-conformance with the requirement of this Specification is noted by the Engineerand prompt Contractor compliance is deemed not to be obtainable, all contract work may be stopped by direct order of the Engineer regardless of whether corrections are made by the Owner as stated in the paragraph above.

**004-3.2** The lump sum price bid for the Contractor's Safety Plan Compliance Document (All Phases) shall include all equipment, materials, and labor necessary.

**004-3.3** Utility Locating Allowance will be paid based on documented costs approved by the RPR.

Payment will be made under:

| | | |
|---|---|---|
| Item G-004-1 | Maintenance and Protection of Traffic (Phase 1) | per Lump Sum |
| Item G-004-2 | Maintenance and Protection of Traffic (Phase 2) | per Lump Sum |
| Item G-004-3 | Contractor's Safety Plan Compliance Document (All Phases) | per Lump Sum |
| Item G-004-4 | Utility Locating Allowance | per Allowance |

**END OF SECTION G-004**

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# Item G-005 Engineer/RPR Field Office

## CONTRACT DOCUMENTS

**005-0.1** This section of these Specifications is a part of the Contract Documents as defined in the General Provisions. All applicable parts of the balance of the Contract Documents are equally as binding for this section as for all other sections.

## DESCRIPTION

**005-1.1 Description**. The work included under this section of these specifications shall consist of furnishing and maintaining the Engineer/RPR's Field Office and associated equipment in accordance with Section C-105 Mobilization and Section 60-05 of the General Provisions.

## EQUIPMENT AND MATERIALS

**005-2.1 General.** Equipment used in the performance of the work required by this section of the specifications shall be subject to the approval of the Resident Project Representative (RPR) and maintained in a satisfactory working condition at all times.

**005-2.2 Engineer Field Office.** The Contractor shall furnish and maintain during construction of the improvements contained in this Contract, a suitable field office for the RPR at the site of the work. The field office, including all requirements of this specification, shall be available for use by the RPR on the first day of work on the project. The field office shall remain on the site, for the RPR's use, until the project has been approved and accepted during the project's final inspection. This shall include the duration of all awarded work under the contract to include base bid and multiple project areas if applicable. The office shall be equipped with electric lights, heating, and air conditioning, with sanitary facilities in the direct vicinity. Drinking water shall be provided. The field office shall contain not less than 300 square feet of floor area and shall be equipped with locks for doors, and window shades for all windows. Note: if the field office has more than one egress, both shall be in working order and have unobstructed access each with steps as needed. The office shall be equipped with the following furniture and equipment:

1. 1 - standard-size, flat top desk
2. 2 - desk chairs
3. 1 - 6-foot folding table
4. 4 - folding chairs
5. 1 - four-drawer steel file cabinet
6. 1 - OSHA compliant first aid kit
7. 1 – UL listed dry chemical fire extinguisher with minimum rating for Type 2A:10B:C
8. 1 - internet connection for computer (4G USB Modem or equivalent) capable of establishing an internet connection from any location on the job site.
9. 1 - small, office-type refrigerator
10. 1 - multifunction printer/scanner/copier with ink and supplies provided for the duration of the project
11. 1 - 30-gallon and 1 – 15-gallon waste baskets with liner supplies and disposal
12. 1 - laser auto-level, graduated level rod and receiver with recent calibration certificate by a certified technician

The location of the field office shall be approved by the Owner and the RPR. The Contractor shall maintain the office during construction and remove it upon completion of the work.

The Contractor shall pay all internet/data service, sanitary facility, heating, and electric bills applicable to the Contract.

The Contractor shall furnish assistance to the RPR, as requested, to check the layout, obtain quantities or otherwise control the work. Such assistance shall be understood to include the provision of suitable manpower to assist the RPR in taping measurements, holding a survey rod, checking grades and the like. The Contractor's obligations for furnishing assistance to the RPR shall be deemed incidental to the completion of the various work items and no separate payment shall be made for such assistance.

## METHOD OF MEASUREMENT

**005-3.1 Engineer Field Office**. All work and costs involved in furnishing and maintaining the Engineer/RPR field office shall be measured per month. The engineer field office shall be on site for the duration of Phase 2.

## BASIS OF PAYMENT

**005-4.1 Engineer Field Office**. Payment shall be made at the contract unit price, which price and payment thereof shall constitute full compensation for all labor, materials, equipment, utilities, expenses, setup, removal, and incidentals required.

The field office will not be paid for during the winter shutdown (if applicable).

Payment will be made under:

| | | |
|---|---|---|
| Item G-005-1 | Engineer Field Office | per Month |

**END OF SECTION G-005**

# Item C-100 Contractor Quality Control Program (CQCP)

**100-1 General.** Quality is more than test results. Quality is the combination of proper materials, testing, workmanship, equipment, inspection, and documentation of the project. Establishing and maintaining a culture of quality is key to achieving a quality project. The Contractor shall establish, provide, and maintain an effective Contractor Quality Control Program (CQCP) that details the methods and procedures that will be taken to assure that all materials and completed construction required by this contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified here and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The Contractor shall establish a CQCP that will:

**a.** Provide qualified personnel to develop and implement the CQCP.

**b.** Provide for the production of acceptable quality materials.

**c.** Provide sufficient information to assure that the specification requirements can be met.

**d.** Document the CQCP process.

The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the CQCP has been reviewed and approved by the Resident Project Representative (RPR). No partial payment will be made for materials subject to specific quality control (QC) requirements until the CQCP has been reviewed and approved.

The QC requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the quality assurance (QA) testing requirements. QA testing requirements are the responsibility of the RPR or Contractor as specified in the specifications.

A Quality Control (QC)/Quality Assurance (QA) workshop with the Engineer, Resident Project Representative (RPR), Contractor, subcontractors, testing laboratories, and Owner's representative must be held prior to start of construction. The QC/QA workshop will be facilitated by the Contractor. The Contractor shall coordinate with the Airport and the RPR on time and location of the QC/QA workshop. Items to be addressed, at a minimum, will include:

**a.** Review of the CQCP including submittals, QC Testing, Action & Suspension Limits for Production, Corrective Action Plans, Distribution of QC reports, and Control Charts.

**b.** Discussion of the QA program.

**c.** Discussion of the QC and QA Organization and authority including coordination and information exchange between QC and QA.

**d.** Establish regular meetings to discuss control of materials, methods and testing.

**e.** Establishment of the overall QC culture.

**100-2 Description of program.**

**a. General description.** The Contractor shall establish a CQCP to perform QC inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. The CQCP shall ensure conformance to applicable specifications and plans with respect to materials, off-

site fabrication, workmanship, construction, finish, and functional performance. The CQCP shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of QC.

**b. Contractor Quality Control Program (CQCP).** The Contractor shall describe the CQCP in a written document that shall be reviewed and approved by the RPR prior to the start of any production, construction, or off-site fabrication. The written CQCP shall be submitted to the RPR for review and approval at least 10 calendar days before the CQCP Workshop. The Contractor's CQCP and QC testing laboratory must be approved in writing by the RPR prior to the Notice to Proceed (NTP).

The CQCP shall be organized to address, as a minimum, the following:

1. QC organization and resumes of key staff
2. Project progress schedule
3. Submittals schedule
4. Inspection requirements
5. QC testing plan
6. Documentation of QC activities and distribution of QC reports
7. Requirements for corrective action when QC and/or QA acceptance criteria are not met
8. Material quality and construction means and methods. Address all elements applicable to the project that affect the quality of the pavement structure including subgrade, subbase, base, and surface course. Some elements that must be addressed include, but is not limited to mix design, aggregate grading, stockpile management, mixing and transporting, placing and finishing, quality control testing and inspection, smoothness, laydown plan, equipment, and temperature management plan.

The Contractor must add any additional elements to the CQCP that is necessary to adequately control all production and/or construction processes required by this contract.

**100-3 CQCP organization.** The CQCP shall be implemented by the establishment of a QC organization. An organizational chart shall be developed to show all QC personnel, their authority, and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all QC staff by name and function, and shall indicate the total staff required to implement all elements of the CQCP, including inspection and testing for each item of work. If necessary, different technicians can be used for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the CQCP, the personnel assigned shall be subject to the qualification requirements of paragraphs 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The QC organization shall, as a minimum, consist of the following personnel:

**a. Program Administrator.** The Contractor Quality Control Program Administrator (CQCPA) must be a full-time employee of the Contractor, or a consultant engaged by the Contractor. The CQCPA must have a minimum of five (5) years of experience in QC pavement construction with prior QC experience on a project of comparable size and scope as the contract.

Included in the five (5) years of paving/QC experience, the CQCPA must meet at least one of the following requirements:

**(1)** Professional Engineer with one (1) year of airport paving experience.

**(2)** Engineer-in-training with two (2) years of airport paving experience.

**(3)** National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three (3) years of airport paving experience.

**(4)** An individual with four (4) years of airport paving experience, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

The CQCPA must have full authority to institute any and all actions necessary for the successful implementation of the CQCP to ensure compliance with the contract plans and technical specifications. The CQCPA authority must include the ability to immediately stop production until materials and/or processes are in compliance with contract specifications. The CQCPA must report directly to a principal officer of the construction firm. The CQCPA may supervise the Quality Control Program on more than one project provided that person can be at the job site within two (2) hours after being notified of a problem.

**b. QC technicians.** A sufficient number of QC technicians necessary to adequately implement the CQCP must be provided. These personnel must be either Engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent to NICET Level II in Civil Engineering Technology or higher, and shall have a minimum of two (2) years of experience in their area of expertise.

The QC technicians must report directly to the CQCPA and shall perform the following functions:

**(1)** Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.

**(2)** Performance of all QC tests as required by the technical specifications and paragraph100-8.

**(3)** Performance of tests for the RPR when required by the technical specifications.

Certification at an equivalent level of qualification and experience by a state or nationally recognized organization will be acceptable in lieu of NICET certification.

**c. Staffing levels.** The Contractor shall provide sufficient qualified QC personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The CQCP shall state where different technicians will be required for different work elements.

**100-4 Project progress schedule.** Critical QC activities must be shown on the project schedule as required by Section 80, paragraph 80-03, *Execution and Progress*.

**100-5 Submittals schedule.** The Contractor shall submit a detailed listing of all submittals (for example, mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include as a minimum:

**a.** Specification item number

**b.** Item description

**c.** Description of submittal

**d.** Specification paragraph requiring submittal

**e.** Scheduled date of submittal

**100-6 Inspection requirements.** QC inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by paragraph 100-9.

Inspections shall be performed as needed to ensure continuing compliance with contract requirements until completion of the particular feature of work. Inspections shall include the following minimum requirements:

**a.** During plant operation for material production, QC test results and periodic inspections shall be used to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment used in proportioning and mixing shall be inspected to ensure its proper operating condition. The CQCP shall detail how these and other QC functions will be accomplished and used.

**b.** During field operations, QC test results and periodic inspections shall be used to ensure the quality of all materials and workmanship. All equipment used in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The CQCP shall document how these and other QC functions will be accomplished and used.

**100-7 Contractor QC testing facility.**

**a.** For projects that include Item P-401, Item P-403, and Item P-404, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM D3666, *Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials*:

- 8.1.3 Equipment Calibration and Checks;
- 8.1.9 Equipment Calibration, Standardization, and Check Records;
- 8.1.12 Test Methods and Procedures

**b.** For projects that include P-501, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation:

- 7 Test Methods and Procedures
- 8 Facilities, Equipment, and Supplemental Procedures

**100-8 QC testing plan.** As a part of the overall CQCP, the Contractor shall implement a QC testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional QC tests that the Contractor deems necessary to adequately control production and/or construction processes.

The QC testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

**a.** Specification item number (e.g., P-401)

**b.** Item description (e.g., Hot Mix Asphalt Pavements)

**c.** Test type (e.g., gradation, grade, asphalt content)

**d.** Test standard (e.g., ASTM or American Association of State Highway and Transportation Officials (AASHTO) test number, as applicable)

**e.** Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated)

**f.** Responsibility (e.g., plant technician)

**g.** Control requirements (e.g., target, permissible deviations)

The QC testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D3665. The RPR shall be provided the opportunity to witness QC sampling and testing.
All QC test results shall be documented by the Contractor as required by paragraph 100-9.

**100-9 Documentation.** The Contractor shall maintain current QC records of all inspections and tests performed. These records shall include factual evidence that the required QC inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the RPR daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the CQCPA.

Contractor QC records required for the contract shall include, but are not necessarily limited to, the following records:

**a. Daily inspection reports.** Each Contractor QC technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations. These technician's daily reports shall provide factual evidence that continuous QC inspections have been performed and shall, as a minimum, include the following:

**(1)** Technical specification item number and description

**(2)** Compliance with approved submittals

**(3)** Proper storage of materials and equipment

**(4)** Proper operation of all equipment

**(5)** Adherence to plans and technical specifications

**(6)** Summary of any necessary corrective actions

**(7)** Safety inspection.

**(8)** Photographs and/or video

The daily inspection reports shall identify all QC inspections and QC tests conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible QC technician and the CQCPA. The RPR shall be provided at least one copy of each daily inspection report on the work day following the day of record. When QC inspection and test results are recorded and transmitted electronically, the results must be archived.

**b. Daily test reports.** The Contractor shall be responsible for establishing a system that will record all QC test results. Daily test reports shall document the following information:

(1) Technical specification item number and description

(2) Test designation

(3) Location

(4) Date of test

(5) Control requirements

(6) Test results
(7) Causes for rejection
(8) Recommended remedial actions
(9) Retests

Test results from each day's work period shall be submitted to the RPR prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical QC charts. When QC daily test results are recorded and transmitted electronically, the results must be archived.

**100-10 Corrective action requirements.** The CQCP shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action shall include both general requirements for operation of the CQCP as a whole, and for individual items of work contained in the technical specifications.

The CQCP shall detail how the results of QC inspections and tests will be used for determining the need for corrective action and shall contain clear rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and use statistical QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.

**100-11 Inspection and/or observations by the RPR.** All items of material and equipment are subject to inspection and/or observation by the RPR at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate QC system in conformance with the requirements detailed here and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to inspection and/or observation by the RPR at the site for the same purpose.

Inspection and/or observations by the RPR does not relieve the Contractor of performing QC inspections of either on-site or off-site Contractor's or subcontractor's work.

**100-12 Noncompliance.**

**a.** The Resident Project Representative (RPR) will provide written notice to the Contractor of any noncompliance with their CQCP. After receipt of such notice, the Contractor must take corrective action.

**b.** When QC activities do not comply with either the CQCP or the contract provisions or when the Contractor fails to properly operate and maintain an effective CQCP, and no effective corrective actions have been taken after notification of non-compliance, the RPR will recommend the Owner take the following actions:

**(1)** Order the Contractor to replace ineffective or unqualified QC personnel or subcontractors and/or

**(2)** Order the Contractor to stop operations until appropriate corrective actions are taken.

## METHOD OF MEASUREMENT

**100-13** Contractor Quality Control Program (CQCP) will not be measured for payment rather it will be considered incidental to the project.

## BASIS OF PAYMENT

**100-14** Contractor Quality Control Program (CQCP) is incidental to the project and no separate payment will be made.

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

National Institute for Certification in Engineering Technologies (NICET)

ASTM International (ASTM)

| | |
|---|---|
| ASTM C1077 | Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM D3665 | Standard Practice for Random Sampling of Construction Materials |
| ASTM D3666 | Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials |

## END OF ITEM C-100

# Item C-102 Temporary Air and Water Pollution, Soil Erosion, and Siltation Control

## DESCRIPTION

**102-1.** This item shall consist of temporary control measures as shown on the plans or as ordered by the Resident Project Representative (RPR) during the life of a contract to control pollution of air and water, soil erosion, and siltation through the use of silt fences, berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

Temporary erosion control shall be in accordance with the approved erosion control plan; the approved Construction Safety and Phasing Plan (CSPP) and AC 150/5370-2, *Operational Safety on Airports During Construction*. The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

Temporary control measures shall be designed, installed and maintained to minimize the creation of wildlife attractants that have the potential to attract hazardous wildlife on or near public-use airports.

## MATERIALS

**102-2.1 Grass.** Grass that will not compete with the grasses sown later for permanent cover per Item T-901 shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

**102-2.2 Mulches.** Mulches may be hay, straw, fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials per Item T-908. Mulches shall not create a wildlife attractant.

**102-2.3 Fertilizer.** Fertilizer shall be a standard commercial grade and shall conform to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

**102-2.4 Slope drains.** Slope drains may be constructed of pipe, fiber mats, rubble, concrete, asphalt, or other materials that will adequately control erosion.

**102-2.5 Silt fence.** Silt fence shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life. Silt fence shall meet the requirements of ASTM D6461.

**102-2.6 Drain Inlet Protection.** Drain inlet protection shall consist of a permeable geotextile that allows water to pass but prevents silt and sediment from entering the drainage system. The geotextile shall be installed under and integral to the catch basin grate. The geotextile shall have lifting devices that allow the removal of the geotextile without allowing sediment to enter the drainage network. The Contractor shall confirm drain grate sizes prior to ordering.

Table 1 Physical Requirements

| | | |
|---|---|---|
| Grab Strength (lbs.) | ASTM D 4632 | 375 |
| Max. Elongation (%) | ASTM D 4632 | 30% |

| | | |
|---|---|---|
| Puncture Strength (lbs.) | ASTM D 4833 | 140 |
| Burst Strength (psi) | ASTM D 3768 | 600 |
| Trapezoid Tear (lbs.) | ASTM D 4533 | 120 |
| Apparent Opening Size (mm) | ASTM D 4751 | 0.212 |
| Permittivity ($Sec^{-1}$) | ASTM D 4491 | 1.5 |
| Water Flow Rate (gal/min/sf) | ASTM D 4491 | 140 |
| Ultraviolet Degradation (% Retained Strength) | ASTM D 4355 | 90 |

**102-2.7 Other.** All other materials shall meet commercial grade standards and shall be approved by the RPR before being incorporated into the project. Erosion control methods can be found at https://www.nh.gov/dot/org/projectdevelopment/construction/documents/erosioncontrolmanual.pdf

## CONSTRUCTION REQUIREMENTS

**102-3.1 General.** In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

The RPR shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved.

**102-3.2 Schedule.** Prior to the start of construction, the Contractor shall submit schedules in accordance with the approved Construction Safety and Phasing Plan (CSPP) and the plans for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the RPR.

**102-3.3 Construction details.** The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the plans and approved CSPP. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices but are not associated with permanent control features on the project.

Where erosion may be a problem, schedule and perform clearing and grubbing operations so that grading operations and permanent erosion control features can follow immediately if project conditions permit. Temporary erosion control measures are required if permanent measures cannot immediately follow grading operations. The RPR shall limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the RPR.

The Contractor shall provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment as directed by the RPR. If temporary erosion and pollution control measures are required due to the Contractor's

negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or directed by the RPR, the work shall be performed by the Contractor and the cost shall be incidental to this item.

The RPR may increase or decrease the area of erodible earth material that can be exposed at any time based on an analysis of project conditions.

The erosion control features installed by the Contractor shall be maintained by the Contractor during the construction period.

Provide temporary structures whenever construction equipment must cross watercourses at frequent intervals. Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into any waterways, impoundments or into natural or manmade channels.

**102-3.4 Installation, maintenance and removal of silt fence.** Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled, and the soil compacted over the silt fence fabric. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence shall be removed upon approval of the RPR.

## METHOD OF MEASUREMENT

**102-4.1** Temporary erosion and pollution control work required which is not attributed to the Contractor's negligence, carelessness, or failure to install permanent controls will be performed as scheduled or ordered by the RPR. Completed and accepted work will be measured as follows:

- **a.** Sediment Barrier. Sediment Barrier will be measured by the linear foot to the nearest foot. Measurement will be along the top of the fence/filter sock for each continuous run in place.
- **b.** Inlet Protection. Inlet protection shall be measured by the number of each type of inlet protection installed.
- **c.** Temporary seed will not be measured and paid for directly rather it shall be considered subsidiary to the permanent seeding.
- **d.** Construction Entrance/Exit. Construction exit shall be measured per each. Measurement includes excavation, installation of stone, haybales, silt fence, etc., maintenance of the exit, removal of stone, haybales, silt fence, etc., and restoration of the area.
- **e.** Concrete Washout Area. Concrete washout area shall be measured by the lump sum, including construction, cleaning, and removal.

**102-4.2** Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

## BASIS OF PAYMENT

**102-5.1** Accepted quantities of temporary water pollution, soil erosion, and siltation control work ordered by the Engineer and measured as provided in paragraph 102-4.1 will be paid for as follows:

**Payment will be made under**:

| | | |
|---|---|---|
| Item C-102-1 | Installation, Maintenance, and Removal of Silt Fence | per linear foot |
| Item C-102-2 | Installation, Relocation, and Removal of Inlet Protector | per each |
| Item C-102-3 | Installation and Removal of Construction Entrance/Exit | per each |
| Item C-102-4 | Concrete Washout Area | per lump sum |

Where other directed work falls within the specifications for a work item that has a contract price, the units of work shall be measured and paid for at the contract unit price bid for the various items.
Temporary control features not covered by contract items that are ordered by the RPR will be paid for in accordance with Section 90, paragraph 90-05 *Payment for Extra Work*.

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5200-33 *Hazardous Wildlife Attractants on or Near Airports*

AC 150/5370-2 *Operational Safety on Airports During Construction*

ASTM International (ASTM)

ASTM D6461 *Standard Specification for Silt Fence Materials*

United States Department of Agriculture (USDA)

FAA/USDA Wildlife Hazard Management at Airports, A Manual for Airport Personnel

## END OF ITEM C-102

# ITEM C-105 Mobilization

**105-1 Description.** This item of work shall consist of, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items.

**105-2 Mobilization limit.** Mobilization shall be limited to **5** percent of the total project cost.

**105-3 Posted notices.** Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster "Equal Employment Opportunity is the Law" in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL "Notice to All Employees" Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

**105-4 Engineer/RPR field office.** The Contractor shall provide dedicated space for the use of the field RPR and inspectors, as a field office for the duration of the project. This space shall be located conveniently near the construction and shall be separate from any space used by the Contractor. The Contractor shall furnish water, sanitary facilities, heat, air conditioning, and electricity in accordance with local building codes. Refer to Item G-005 for requirements of the Engineer Field Office.

## METHOD OF MEASUREMENT

**105-5.1 Basis of measurement and payment Mobilization.** Based upon the contract lump sum price for "Mobilization" partial payments will be allowed as follows:

**a.** With first pay request, 25%.

**b.** When 25% or more of the original contract is earned, an additional 25%.

**c.** When 50% or more of the original contract is earned, an additional 40%.

**d.** After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the final 10%.

**105-5.2 Basis of measurement and payment Engineer/RPR Field Office.** The Engineer/RPR Field Office shall be measured and paid for under Item G-005 Engineer/RPR Field Office.

## BASIS OF PAYMENT

**105-6 Payment will be made under:**

| | | |
|---|---|---|
| Item C-105-1 | Mobilization | per Lump Sum |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

EEOC-P/E-1 – Equal Employment Opportunity is the Law Poster

United States Department of Labor, Wage and Hour Division (WHD)

WH 1321 – Employee Rights under the Davis-Bacon Act Poster

**END OF ITEM C-105**

# ITEM M-001 Bollards

## DESCRIPTION

**001-1.1 Description.** This item consists of providing new bollards.

## MATERIALS

**001-2.1 Concrete.** Concrete shall conform to section P-610 of the project specifications.

**001-2.2 Pipe.** Standard-weight galvanized steel pipe complying with ASTM A53, or electric-resistance-welded pipe complying with ASTM A 135. NPS Designator is 6. Wall thickness 0.188 inch minimum.

**001-2.3 Bollard Covers.** Covers shall be commercially available sleeves constructed of HDPE with a minimum of 2 reflective bands per bollard. Color as indicated on the contract drawings.

## CONSTRUCTION METHODS

**001-3.1 New Bollards.** Bollards shall be installed as detailed on the contract drawings.

## METHOD OF MEASUREMENT

**001-4.1 New Bollards.** Bollards shall be measured per each installed and accepted.

## BASIS OF PAYMENT

**001-5.1** Payment shall be made at the contract unit price per each new bollard installed. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item M-001-1 | Bollards | per Each |

**END OF ITEM M-001**

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# Item M-002 Contaminated Soil Removal and Replacement

## DESCRIPTION

**002-1.1 Description.** The work involved under this section of these specifications includes removing contaminated soil, if found within the project limits. The exact limits and quantity of contaminated soils will be determined during construction if contaminated soils are encountered. Close coordination and notification to the New Hampshire Department of Environmental Services (NHDES) will be required for the work involved. This work shall only be performed by qualified personnel.

## CONSTRUCTION METHODS

**002-2.1 General.** The Contractor may use any method of excavation at his/her disposal, provided the requirements of these specifications and NHDES regulations are satisfied.

**002-2.2 Contaminated Soil Remediation.** If, during the excavation operations, it is determined that contaminated soils are present, the RPR shall be notified immediately. The Contractor shall provide results of any field and/or laboratory analysis that determines the type and concentration of contamination to the RPR. The RPR shall notify the Owner and NHDES.

Three (3) laboratory soil tests and one (1) laboratory groundwater test for contamination shall be considered in the Contractor's bid proposal. All costs to collect, package, ship and manifest the soil/water samples shall be considered incidental to the work.

Contaminated soil removal will be limited to soil within the excavation limits of the project, unless otherwise directed by the Owner or NHDES. If contaminated soil extends below the groundwater table, personnel from the NHDES shall direct the Contractor as to the proper removal procedures to follow.

The Contractor will remove the contaminated material from Airport property and legally dispose of it in conformance with NHDES and all other applicable regulations.

The Contractor shall replace this material with suitable backfill material, free of organics and other objectionable materials such as vegetation, muck, peat, silt, sod, stumps or roots.

**002-2.3 Suitable Backfill Material.** The Contractor will be required to fill in the excavation created by the contaminated soil remediation operations. The material shall be clean granular readily compactable backfill material, placed and spread in 8-inch lifts. Compaction shall be in accordance with Technical Specification P-152 *Excavation, Subgrade, and Embankment* of these specifications. The finished surface shall be to the elevation determined in the field by the RPR.

**002-2.4 Site Restoration.** Areas disturbed by the soil remediation work not within the limits of the work, shall be restored to their original or better condition. Work shall proceed as directed by the RPR. The area shall have a neat, smooth and pleasing appearance when completed.

## METHOD OF MEASUREMENT

**002-3.1 Contaminated Soil Removal and Replacement.** The contaminated soil removal and replacement to be paid for by allowance.

## BASIS OF PAYMENT

**002-4.1 Contaminated Soil Removal and Replacement.** Payment will be made at the contract allowance price for contaminated soil removal and replacement. This price shall be full compensation for furnishing all materials; for all excavation, preparation, hauling, and placing of these materials; for all coordination, testing, stockpiling, legal disposal off site; and for all labor, equipment, tools, and incidentals necessary to complete the item.

**Payment shall be made under:**

| | | |
|---|---|---|
| Item M-002-1 | Contaminated Soil Removal and Replacement | per Allowance |

**END OF ITEM M-002**

# ITEM P-101 Preparation/Removal of Existing Pavements

## DESCRIPTION

**101-1** This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

## EQUIPMENT AND MATERIALS

**101-2** All equipment and materials shall be specified here and in the following paragraphs or approved by the Resident Project Representative (RPR). The equipment shall not cause damage to the pavement to remain in place.

## CONSTRUCTION

### 101-3.1 Removal of existing pavement.

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

**a. Concrete pavement removal.** Full depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. The pavement inside the saw cut shall be removed by methods which will not cause distress in the pavement which is to remain in place. The Contractor shall legally dispose all material legally off Airport property at a suitable facility. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as directed by the RPR.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans. Any underlaying material that is to remain in place, shall be recompacted and/or replaced as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

**b. Asphalt pavement removal.** Asphalt pavement to be removed shall be cut to the full depth of the asphalt pavement around the perimeter of the area to be removed. The Contractor shall legally dispose all material off Airport property at a suitable facility.

**c. Repair or removal of Base, Subbase, and/or Subgrade.** All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans or as directed by the RPR. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

**101-3.2 Preparation of joints and cracks prior to overlay/surface treatment.** Not Used.

**101-3.3 Removal of Foreign Substances/contaminates prior to remarking.** Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the RPR in the field during construction.

Chemicals and rotary grinding may be used. If chemicals are used, they shall comply with the state's environmental protection regulations. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the RPR that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the RPR.

Removal of foreign substances shall not proceed until approved by the RPR. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

**101-3.4 Concrete spall or failed asphaltic concrete pavement repair.**

**a. Repair of concrete spalls in areas to be overlaid with asphalt.** Not Used.

**b. Asphalt pavement repair.** Not Used.

**101-3.5 Cold milling.** Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The milling machine or grinder shall operate without tearing or gouging the underlaying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed off Airport property. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

**a. Patching.** The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of controlling the depth of cut. The RPR shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.

**b. Profiling, grade correction, or surface correction.** The milling machine shall have a minimum width of 7 feet (2 m) and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of off the airport.

**c. Clean-up.** The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed off Airport property.

**101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment.** Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

**a.** Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.

**b.** Repair joints and cracks in accordance with paragraph 101-3.2.

**c.** Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.

**d.** Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

**101-3.7 Maintenance**. The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the RPR. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

**101-3.8 Preparation of Joints in Rigid Pavement prior to resealing.** Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the joint and does not damage the joint.

**101-3.8.1 Removal of Existing Joint Sealant**. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.

**101-3.8.2 Cleaning prior to sealing**. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.

**101-3.8.3 Joint sealant.** Joint material and installation will be in accordance with Item P-605.

**101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing.** Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the cracks and does not damage the pavement.

**101-3.9.1 Preparation of Crack**. Widen crack with router by removing a minimum of 1/16 inch (2 mm) from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.

**101-3.9.2 Removal of Existing Crack Sealant**. Existing sealants will be removed by routing. Following routing any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

**101-3.9.3 Crack Sealant.** Crack sealant material and installation will be in accordance with Item P-605.

**101-3.9.4 Removal of Pipe and other Buried Structures.**

**a. Removal of Existing Pipe Material.** Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 100% of ASTM D1557, when outside of paved areas must be compacted to 95% of ASTM D1557.

**b. Removal of Inlets/Manholes.** Where indicated on the plans or as directed by the RPR, inlets and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal.

Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas must be compacted to 100% of ASTM D1557, when outside of paved areas must be compacted to 95% of ASTM D1557.

**c. Removal of Aircraft Tie-downs.** Where indicated on the plans or as directed by the RPR, aircraft tie-downs shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. Backfill must be compacted to 100% of ASTM D1557.

## METHOD OF MEASUREMENT

**101-4.1 Pavement removal**. The unit of measurement for pavement removal shall be the number of square yards (square meters) removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar installation shall be incidental to pavement removal.

**101-4.2 Removal of Foreign Substances/contaminates**. Foreign Substances/contaminates removal shall not be measured separately but shall be considered incidental to joint sealant or pavement marking installation.

**101-4.3 Removal of Pipe.** The unit of measurement for removal of pipe will be made at the contract unit price per linear foot. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.4 Removal of Buried Structures.** The unit of measurement for removal of buried structures will be made at the contract unit price for each completed and accepted item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

**101-4.5 Removal of Concrete Pads.** The unit of measurement for pavement removal shall be the number of square yards (square meters) removed by the Contractor. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to concrete pad removal.

**101-4.6 Removal of Bollards.** The unit of measurement for bollards shall be per each removed by the Contractor.

**101-4.7 Removal of Aircraft Tiedowns.** Removal of aircraft tie downs shall not be measured separately but shall be considered incidental to pavement removal.

## BASIS OF PAYMENT

**101-5.1 Payment.** Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

| | | |
|---|---|---|
| Item P-101-1 | HMA Pavement Removal - 4" Nominal Depth | per square yard |
| Item P-101-2 | HMA Pavement Removal - 13" Nominal Depth | per square yard |
| Item P-101-3 | PCC Pavement Removal – 9” Nominal Depth | per square yard |
| Item P-101-4 | PCC Pad Demolition | per square yard |
| Item P-101-5 | Removal of Pipe - 12" CMP | per linear foot |
| Item P-101-6 | Removal of Perimeter Drain Pipe | per linear foot |
| Item P-101-7 | Removal of Storm Drain Structures | per each |
| Item P-101-8 | Removal of Bollards | per each |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

**END OF ITEM P-101**

# ITEM P-152 Excavation, Subgrade, and Embankment

## DESCRIPTION

**152-1.1** This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.
**152-1.2 Classification.** All material excavated shall be classified as defined below:

**a. Unclassified excavation.** Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature which is not otherwise classified and paid for under one of the following items.

**b. Rock excavation**. Rock excavation shall include all solid rock in ledges, in bedded deposits, in unstratified masses, and conglomerate deposits which are so firmly cemented they cannot be removed without blasting or using rippers. All boulders containing a volume of more than 1/2 cubic yard (0.4 $m^3$) will be classified as "rock excavation."

**c. Pavement Removal.** Removal of all pavement types shall be paid for under Item P-101 Preparation/Removal of Existing Pavements

**152-1.3 Unsuitable excavation.** Unsuitable material shall be disposed in designated waste areas as shown on the plans. Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material suitable for topsoil may be used on the embankment slope when approved by the RPR.

## CONSTRUCTION METHODS

**152-2.1 General.** Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with Item P-151.
The suitability of material to be placed in embankments shall be subject to approval by the RPR. All unsuitable material shall be disposed of in waste areas as shown on the plans. All waste areas shall be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the RPR.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the RPR notified per Section 70, paragraph 70-20. At the direction of the RPR, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the

Contractor shall notify the RPR, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

**a. Blasting.** Blasting shall not be allowed.

**152-2.2 Excavation.** No excavation shall be started until the work has been staked out by the Contractor and the RPR has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. The Contractor and RPR shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the RPR. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes **as** shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

The grade shall be maintained so that the surface is well drained at all times.

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the RPR. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas.

**a. Selective grading.** When selective grading is indicated on the plans, the more suitable material designated by the RPR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

**b. Undercutting.** Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard (per cubic meter) for unclassified excavation. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as unclassified excavation.

**c. Over-break.** Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the RPR. All over-break shall be graded or removed by the Contractor and disposed of as directed by the RPR. The RPR shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the RPR determines as avoidable. Unavoidable over-break will be classified as "Unclassified Excavation."

**d. Removal of utilities.** The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by someone other than the Contractor or by the Contractor as indicated on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the RPR. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

**152-2.3 Borrow excavation.** Borrow areas are not required.

**152-2.4 Drainage excavation.** Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the RPR. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

**152-2.5 Preparation of cut areas or areas where existing pavement has been removed.** In those areas on which a subbase or base course is to be placed, the top 12 inches (300 mm) of subgrade shall be compacted to not less than 100 % of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

**152-2.6 Preparation of embankment area.** All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted per paragraph 152-2.10.
Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

**152-2.7 Control Strip.** The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor’s demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor’s expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

**152-2.8 Formation of embankments.** The material shall be constructed in lifts as established in the control strip, but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.
When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the RPR. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within ±2% of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The RPR and contractor will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with D 1557. A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the contractor for every 1,500 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than 100% percent of the maximum density as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm) which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The RPR shall perform all density tests for acceptance. If the specified density is not attained, the area represented by the test or as designated by the RPR shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.
Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 12 inches (300 mm) of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the RPR and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, cement concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the RPR.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2 feet (60 cm) in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

Payment for compacted embankment will be made under embankment in-place and no payment will be made for excavation, borrow, or other items.

**152-2.9 Proof rolling.** Not Used**.**

**152-2.10 Compaction requirements.** The subgrade under areas to be paved shall be compacted to a depth of 12 inches (300 mm) and to a density of not less than 100 percent of the maximum dry density as determined by ASTM D1557. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12 inches (300 mm)and to a density of not less than 95 percent of the maximum density as determined by ASTM D1557.

The material to be compacted shall be within ±2% of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, follow the methods in ASTM D1557. Tests for moisture content and compaction will be taken at a minimum of 2,500 S.Y. of subgrade. All quality assurance testing shall be done by the RPR.

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.
If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the RPR and the finished subgrade shall be maintained.

**152-2.11 Finishing and protection of subgrade.** Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the RPR.

**152-2.12 Haul.** All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

**152-2.13 Surface Tolerances.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

**152-2.14 Topsoil.** When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans and the approved CSPP, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the RPR, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

## METHOD OF MEASUREMENT

**152-3.1** Measurement for payment specified by the cubic yard (cubic meter) shall be computed by the comparison of digital terrain model (DTM) surfaces for computation of neat line design quantities. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by cross-sections shown on the plans, subject to verification by the RPR.

**152-3.1** The quantity of unclassified or rock excavation to be paid for shall be the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

**152-3.2** The quantity of embankment in place shall be the number of cubic yards (cubic meters) measured in its final position.

## BASIS OF PAYMENT

**152-4.1** Unclassified excavation and Rock Excavation payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

**152-4.2** For embankment in place, payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-152-1 | Unclassified Excavation | per cubic yard |
| Item P-152-2 | Embankment in Place | per cubic yard |
| Item P-152-3 | Rock Excavation | per cubic yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO T-180 | Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

ASTM International (ASTM)

| | |
|---|---|
| ASTM D698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)) |
| ASTM D1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2700 kN-m/m$^3$)) |
| ASTM D6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5370-2 | Operational Safety on Airports During Construction Software |

Software

FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design

U.S. Department of Transportation

| | |
|---|---|
| FAA RD-76-66 | Design and Construction of Airport Pavements on Expansive Soils |

**END OF ITEM P-152**

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# Item P-154 Subbase Course

## DESCRIPTION

**154-1.1** This item shall consist of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course in accordance with these specifications, and in conformity with the dimensions and typical cross-section shown on the plans.

## MATERIALS

**154-2.1 Materials.** The subbase material shall consist of hard durable particles or fragments of granular aggregates. The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. The material shall be free from vegetative matter, excessive amounts of clay, and other objectionable substances; uniformly blended; and be capable of being compacted into a dense, stable subbase.

The subbase material shall exhibit a California Bearing Ratio (CBR) value of at least 20 when tested in accordance with ASTM D1883. The subbase material shall meet the gradation specified in the table below.

**Subbase Gradation Requirements**

| Sieve designation | Percentage by weight passing sieves | Contractor's Final Gradation | Job Control Grading Band Tolerances[1] (Percent) |
|---|---|---|---|
| | Subbase Aggregate | | |
| 3 inch (75 mm) | 100 | | 0 |
| 1 1/2 inch (37.5 mm) | | | 0 |
| 3/4 inch (19.0 mm) | 70-100 | | ±10 |
| No. 10 (2.00 mm) | 20-100 | | ±10 |
| No. 40 (425 µm) | 5-60 | | ±5 |
| No. 200 (75 µm) | 0-10 | | ±5 |

[1]The "Job Control Grading Band Tolerances" shall be applied to "Contractor's Final Gradation" to establish the job control grading band.

The portion of the material passing the No. 40 (425 µm) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than six (6) when tested in accordance with ASTM D4318.

**154-2.2 Sampling and testing.**

**a. Aggregate base materials.** Samples shall be taken by the Contractor per ASTM D75 for initial aggregate subbase requirements and gradation. Material shall meet the requirements in paragraphs 154-2.1. The Contractor shall submit to the Resident Project Representative (RPR) certified test results showing that the aggregate meets the Material requirements of this section. Tests shall be representative of the material to be used for the project.

**b. Gradation requirements.** The Contractor shall take at least one aggregate subbase sample per day in the presence of the RPR to check the final gradation. Samples shall be taken from the in-place, un-compacted material at sampling locations determined by the RPR on a random basis per ASTM D3665. Sampling shall be per ASTM D75 and tested per ASTM C136 and ASTM C117. Results shall be furnished to the RPR by the Contractor each day during construction. Material shall meet the requirements in paragraph 154-2.1.

**154-2.3 Separation Geotextile.** Not used.

**154-2.4 Geogrid.** Not used.

## CONSTRUCTION METHODS

**154-3.1 General.** The subbase course shall be placed where designated on the plans or as directed by the RPR. The material shall be shaped and thoroughly compacted within the tolerances specified. Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support the construction equipment without movement, shall be mechanically modified to the depth necessary to provide stability as directed by the RPR. The mechanical modification shall include the addition of a fine-grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so the course will not deform under construction equipment traffic.

**154-3.2 Preparing underlying course.** Prior to constructing the subbase course, clean the underlying course or subgrade of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances in accordance with Item P-152. Correct ruts, soft yielding spots in the underlying courses, and subgrade areas having inadequate compaction and/or deviations of the surface from the specified requirements, by loosening and removing soft or unsatisfactory material, adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the overlying course by mixing the overlying course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the overlying course is placed. The underlying course shall be checked and accepted by the RPR before placing and spreading operations are started.

To protect the subgrade and to ensure proper drainage, spreading of the subbase shall begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

**154-3.3 Control Strip.** The first half-day of subbase construction shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling

necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

**154-3.4 Placement.** The material shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted. The material shall not be placed when the underlying course is soft or yielding.
The material shall meet gradation and moisture requirements prior to compaction. Material may be free-draining and the minimum moisture content shall be established for placement and compaction of the material.

The material shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

**154-3.5 Compaction.** The subbase material shall be compacted, adjusting moisture as necessary, to be within ±2% of optimum moisture. The field density of the compacted material shall be at least 100% of the maximum density as specified in paragraph 154-3.9a. If the specified density is not attained, the area of the lift represented by the test shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**154-3.6 Weather limitation**. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on subbase course shall not be conducted when the subgrade is wet or frozen or the subbase material contains frozen material.

**154-3.7 Maintenance**. No base or surface course shall be placed on the subbase until the subbase has been accepted by the RPR. The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, the Contractor shall verify that materials still meet all specification requirements before placement of additional material. Equipment may be routed over completed sections of subbase course, provided the equipment does not damage the subbase course and the equipment is routed over the full width of the completed subbase course. Any damage to the subbase course from routing equipment over the subbase course shall be repaired by the Contractor at their expense.

**154-3.8 Surface tolerance.** In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence

of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

**a. Smoothness.** The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

**154-3.9 Acceptance sampling and testing.** The aggregate base course shall be accepted for density and thickness on an area basis. Two test shall be made for density and thickness for each 1,200 square yards (1000 square meters). Sampling locations will be determined on a random basis per ASTM D3665.

**a. Density.** The RPR shall perform all density tests.

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM D1557. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, use methods in ASTM D1557 and the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

**b. Thickness.** The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. At the discretion of the RPR, topographic survey performed by the Contractor may be used to determine thickness. Survey is required before and after placement and compaction of P-154. Survey intervals shall be no greater than 15'. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

## METHOD OF MEASUREMENT

**154-4.1** Subbase course shall be measured by the number of cubic yards (cubic meters) of subbase course material placed and compacted to specified density and plan thickness requirements in the completed course. The quantity of subbase course material shall be measured in final position based upon depth tests or cores taken as directed by the RPR, at the rate of two test per each 1200 square yards (1000 square meters) of subbase course or survey of the completed work computed from elevations to the nearest 0.01 foot (3 mm). On individual depth measurements, thicknesses more than 1/2 inch (12 mm) in excess of that shown on the plans shall be considered as the specified thickness plus 1/2 inch (12 mm) in computing the yardage for payment. Subbase materials shall not be included in any other excavation quantities.

## BASIS OF PAYMENT

**154-5.1** Payment shall be made at the contract unit price per cubic yard (cubic meter) for subbase course. This price shall be full compensation for furnishing all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-154-1 | Subbase Course | per cubic yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM C117 | Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C136 | Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D75 | Standard Practice for Sampling Aggregates |
| ASTM D698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)) |
| ASTM D1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)) |
| ASTM D2487 | Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D4253 | Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table |
| ASTM D4759 | Practice for Determining the Specification Conformance of Geosynthetics |
| ASTM D4318 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D6938 | Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| M 288 | Geotextile Specification for Highway Applications |

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# ITEM P-209 Crushed Aggregate Base Course

## DESCRIPTION

**209-1.1** This item consists of a base course composed of crushed aggregate base constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

## MATERIALS

**209-2.1 Crushed aggregate base.** Crushed aggregate shall consist of clean, sound, durable particles of crushed stone or crushed gravel, and shall be free from coatings of clay, silt, organic material, clay lumps or balls or other deleterious materials or coatings. The method used to produce the crushed gravel shall result in the fractured particles in the finished product as consistent and uniform as practicable. Fine aggregate portion, defined as the portion passing the No. 4 (4.75 mm) sieve shall consist of fines from the coarse aggregate crushing operation. The fine aggregate shall be produced by crushing stone or gravel, that meet the coarse aggregate requirements for wear and soundness. Aggregate base material requirements are listed in the following table.

**Crushed Aggregate Base Material Requirements**

| Material Test | Requirement | Standard |
|---|---|---|
| **Coarse Aggregate** | | |
| Resistance to Degradation | Loss: 45% maximum | ASTM C131 |
| Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate | Loss after 5 cycles:<br>12% maximum using Sodium sulfate - or -<br>18% maximum using magnesium sulfate | ASTM C88 |
| Percentage of Fractured Particles | Minimum 90% by weight of particles with at least two fractured faces and 98% with at least one fractured face[1] | ASTM D5821 |
| Flat Particles, Elongated Particles, or Flat and Elongated Particles | 10% maximum, by weight, of flat, elongated, or flat and elongated particles [2] | ASTM D4791 |
| Clay lumps and friable particles | Less than or equal to 3 percent | ASTM C142 |
| **Fine Aggregate** | | |
| Liquid limit | Less than or equal to 25 | ASTM D4318 |
| Plasticity Index | Not more than five (5) | ASTM D4318 |

[1] The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

[2] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

**209-2.2 Gradation requirements.** The gradation of the aggregate base material shall meet the requirements of the gradation given in the following table when tested per ASTM C117 and ASTM C136. The gradation shall be well graded from coarse to fine and shall not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa.

**Gradation of Aggregate Base**

| Sieve Size | Design Range Percentage by Weight passing | Contractor's Final Gradation | Job Control Grading Band Tolerances[1] (Percent) |
|---|---|---|---|
| 2 inch (50 mm) | 100 | | 0 |
| 1-1/2 inch (37.5 mm) | 95-100 | | ±5 |
| 1 inch (25.0 mm) | 70-95 | | ±8 |
| 3/4 inch (19.0 mm) | 55-85 | | ±8 |
| No. 4 (4.75 mm) | 30-60 | | ±8 |
| No. 40[2] (425 µm) | 10-30 | | ±5 |
| No. 200[2] (75 µm) | 0-5 | | ±3 |

[1] The "Job Control Grading Band Tolerances for Contractor's Final Gradation" in the table shall be applied to "Contractor's Final Gradation" to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

[2] The fraction of material passing the No 200 (75 µm) sieve shall not exceed two-thirds the fraction passing the No 40 (425 µm) sieve.

**209-2.3 Sampling and Testing.**

**a. Aggregate base materials.** The Contractor shall take samples of the aggregate base in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraph 209-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

**b. Gradation requirements.** The Contractor shall take at least two aggregate base samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling shall be per ASTM D75. Material shall meet the requirements in paragraph 209-2.2. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

**209-2.4 Separation Geotextile**. Not used.

## CONSTRUCTION METHODS

**209-3.1 Control strip.** The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the RPR.

**209-3.2 Preparing underlying subgrade and/or subbase**. The underlying subgrade and/or subbase shall be checked and accepted by the RPR before base course placing and spreading operations begin. Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with Item P-152, at the Contractor's expense, may be required by the RPR if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed. To ensure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

**209-3.3 Production**. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 209-3.5, the approved material may be transported directly to the placement.

**209-3.4 Placement**. The aggregate shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

The aggregate shall meet gradation and moisture requirements prior to compaction. The base course shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications at the Contractor's expense.

**209-3.5 Compaction**. Immediately after completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade.

The field density of each compacted lift of material shall be at least 100% of the maximum density of laboratory specimens prepared from samples of the base material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with ASTM D1557. The moisture content of the material during placing operations shall be within ±2 percentage points of the optimum moisture content as determined by ASTM D1557. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**209-3.6 Weather limitations.** Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on base course shall not be conducted when the subgrade or subbase is wet or frozen or the base material contains frozen material.

**209-3.7 Maintenance.** The base course shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage

resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at the Contractor's expense.

**209-3.8 Surface tolerances.** After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

**a. Smoothness.** The finished surface shall not vary more than 3/8-inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

**209-3.9 Acceptance sampling and testing.** Crushed aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each 1,200 square yds (1000 $m^2$). Sampling locations will be determined on a random basis per ASTM D3665

**a. Density.** The RPR shall perform all density tests**.**

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM 1557. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

**b. Thickness.** Depth tests shall be made by test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

## METHOD OF MEASUREMENT

**209-4.1** The quantity of crushed aggregate base course will be determined by measurement of the number of cubic yards of material actually constructed and accepted by the RPR as complying with the plans and specifications and verified by survey. Base materials shall not be included in any other excavation quantities.

## BASIS OF PAYMENT

**209-5.1** Payment shall be made at the contract unit price per cubic yard (cubic meter) for crushed aggregate base course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-209-1 | Crushed Aggregate Base Course | per cubic yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM C29 | Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate |
| ASTM C88 | Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM C117 | Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C131 | Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136 | Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates |
| ASTM C142 | Standard Test Method for Clay Lumps and Friable Particles in Aggregates |
| ASTM D75 | Standard Practice for Sampling Aggregates |
| ASTM D698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)) |
| ASTM D1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2700 kN-m/m$^3$)) |
| ASTM D2167 | Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method |
| ASTM D2419 | Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate |
| ASTM D3665 | Standard Practice for Random Sampling of Construction Materials |
| ASTM D4318 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D4491 | Standard Test Methods for Water Permeability of Geotextiles by Permittivity |
| ASTM D4643 | Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating |
| ASTM D4751 | Standard Test Methods for Determining Apparent Opening Size of a Geotextile |

| | |
|---|---|
| ASTM D4791 | Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate |
| ASTM D5821 | Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate |
| ASTM D6938 | Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| ASTM D7928 | Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis |

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| M288 | Standard Specification for Geosynthetic Specification for Highway Applications |

**END OF ITEM P-209**

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# ITEM P-403 Asphalt Mix Pavement Base and Surface Course

## DESCRIPTION

**403-1.1** This item shall consist of pavement courses composed of mineral aggregate and asphalt binder mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

## MATERIALS

**403-2.1 Aggregate.** Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

a. Coarse aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

**Coarse Aggregate Material Requirements**

| Material Test | Requirement | Standard |
|---|---|---|
| Resistance to Degradation | Loss: 40% maximum for surface, asphalt binder, and leveling course<br>Loss: 50% maximum for base course | ASTM C131 |
| Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate | Loss after 5 cycles:<br>12% maximum using Sodium sulfate - or -<br>18% maximum using magnesium sulfate | ASTM C88 |
| Clay lumps and friable particles | 1.0 % maximum | ASTM C142 |
| Percentage of Fractured Particles | For pavements designed for aircraft gross weights of 60,000 pounds (27200 kg) or more:<br><br>Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face[1] | ASTM D5821 |
| Flat, Elongated, or Flat and Elongated Particles | 8% maximum, by weight, of flat, elongated, or flat and elongated particles with a value of 5:1 [2] | ASTM D4791 |
| Bulk density of slag[3] | Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter) | ASTM C29. |

[1] The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

[2] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

[3] Only required if slag is specified.

**b. Fine aggregate.** Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

**Fine Aggregate Material Requirements**

| Material Test | Requirement | Standard |
|---|---|---|
| Liquid limit | 25 maximum | ASTM D4318 |
| Plasticity Index | 4 maximum | ASTM D4318 |
| Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate | Loss after 5 cycles:<br>10% maximum using Sodium sulfate - or -<br>15% maximum using magnesium sulfate | ASTM C88 |
| Clay lumps and friable particles | 1.0 % maximum | ASTM C142 |
| Sand equivalent | 45 minimum | ASTM D2419 |
| Natural Sand | 0 to 15% maximum by weight of total aggregate | ASTM D1073 |

**c. Sampling.** ASTM D75 shall be used in sampling coarse and fine aggregate, and ASTM C183 shall be used in sampling mineral filler.

**403-2.2 Mineral filler.** Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

**Mineral filler Requirements**

| Material Test | Requirement | Standard |
|---|---|---|
| Plasticity Index | 4 maximum | ASTM D4318 |

**403-2.3 Asphalt binder.** Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) 76-28

**Asphalt Binder PG Plus Test Requirements**

| Material Test | Requirement | Standard |
|---|---|---|
| Elastic Recovery | 75% minimum | ASTM D6084[1] |

**[1]** Follow procedure B on RTFO aged binder.

**403-2.4 Anti-stripping agent.** Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

## COMPOSITION

**403-3.1 Composition of mixture.** The asphalt plant mix shall be composed of a mixture of well-graded aggregate, filler and anti-strip agent if required, and asphalt binder. The several aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

**403-3.2 Job mix formula (JMF) laboratory.** The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF, and listed on the accrediting authority's website. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the RPR prior to start of construction.

**403-3.3 Job mix formula (JMF).** No asphalt mixture shall be placed until an acceptable mix design has been submitted to the RPR for review and accepted in writing. The RPR's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 403-3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared and compacted using a Marshall compactor in accordance with ASTM D6926.

Should a change in sources of materials be made, a new JMF must be submitted to the RPR for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the RPR and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the RPR, will be borne by the Contractor.
The RPR may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates proposed for project use.

The submitted JMF shall be dated, and stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 403-2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 403-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 403-2.1 and 403-2.2.

- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each course and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles**,** elongated particles, and flat and elongated particles (and criteria).
- Percent of asphalt.
- Number of blows or gyrations.
- Laboratory mixing and compaction temperatures.
- Supplier recommended mixing and compaction temperatures.
- Plot of the combined gradation on the 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

**Table 1. Asphalt Design Criteria**

| Test Property | Value | Test Method |
|---|---|---|
| Number of blows/gyrations | 7**5** | |
| Air voids (%) | 3.5 | ASTM D3203 |
| Percent voids in mineral aggregate (VMA), minimum | See Table 2 | ASTM D6995 |
| TSR[1] | not less than 80 at a saturation of 70-80% | ASTM D4867 |
| Asphalt Pavement Analyzer (APA)[2,3] | Less than 10 mm @ 4000 passes | AASHTO T340 at 250 psi hose pressure at 64°C test temperature |

[1] Test specimens for TSR shall be compacted at 7 ± 1.0 % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

[2] AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used the required Value shall be less than 5 mm @ 8000 passes

[3] Where APA not available, use Hamburg wheel test (AASHTO T 324) 10 mm@ 20,000 passes at 50°C.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.
The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply, be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

**Table 2. Aggregate - Asphalt Pavements**

| Sieve Size | Percentage by Weight Passing Sieve |
|---|---|
| 1 inch (25.0 mm) | - |
| 3/4 inch (19.0 mm) | 100 |
| 1/2 inch (12.5 mm) | 90-100 |
| 3/8 inch (9.5 mm) | 72-88 |
| No. 4 (4.75 mm) | 53-73 |
| No. 8 (2.36 mm) | 38-60 |
| No. 16 (1.18 mm) | 26-48 |
| No. 30 (600 µm) | 18-38 |
| No. 50 (300 µm) | 11-27 |
| No. 100 (150 µm) | 6-18 |
| No. 200 (75 µm) | 3-6 |
| **Voids in Mineral Aggregate (VMA)[1]** | 15 |
| **Asphalt Percent:** | |
| Stone or gravel | 5.0-7.5 |
| Slag | 6.5-9.5 |
| **Recommended Minimum Construction Lift Thickness** | 2 inch |

[1]To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

**403-3.4 Reclaimed Asphalt Pavement (RAP).** RAP shall not be used**.**

**403-3.5 Control strip**. A control strip is not required.

## CONSTRUCTION METHODS

**403-4.1 Weather limitations.** The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the RPR, if requested; however, all other requirements including compaction shall be met.

**Table 4. Surface Temperature Limitations of Underlying Course**

| Mat Thickness | Base Temperature (Minimum) | |
|---|---|---|
| | Degrees F | Degrees C |
| 3 inches (7.5 cm) or greater | 40 | 4 |
| Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm) | 45 | 7 |

**403-4.2 Asphalt plant.** Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items:

**a. Inspection of plant.** The RPR, or RPR's authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

**b. Storage bins and surge bins.** The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the RPR determines there is an excessive heat loss, segregation or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

**403-4.3 Aggregate stockpile management.** Aggregate stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

**403-4.4 Hauling equipment.** Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the RPR. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

**403-4.4.1 Material transfer vehicle (MTV).** Material transfer Vehicles shall be required due to the improvement in smoothness and decrease in both physical and thermal segregation. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

**403-4.5 Asphalt pavers.** Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.11.

**403-4.6 Rollers.** The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

**403-4.6.1 Density device.** The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall also supply a qualified technician during all paving operations to calibrate the density gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the RPR upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

**403-4.7 Preparation of asphalt binder.** The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of the unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

**403-4.8 Preparation of mineral aggregate.** The aggregate for the asphalt shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

**403-4.9 Preparation of asphalt mixture.** The aggregates and the asphalt binder shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

**403-4.10 Application of Prime and Tack Coat.** Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A prime coat is not required.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

**403-4.11 Laydown plan, transporting, placing, and finishing.** Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the RPR.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to RPR that every lot of each lift meets the grade tolerances of paragraph 401-6.2e before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the RPR. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 10 except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

The RPR may at any time, reject any batch of asphalt, on the truck or placed in the mat, which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the RPR, and if it can be demonstrated in the laboratory, in the presence of the RPR, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

Areas of segregation in the surface course, as determined by the RPR, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

**403-4.12 Compaction of asphalt mixture.** After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.
In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed**.**

**403-4.13 Joints.** The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh asphalt against the joint.

Longitudinal joints which are have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. An asphalt tack coat or other product approved by the RPR shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

**403-4.14 Saw-cut grooving.** Saw-cut grooving is not required.

**403-4.15 Diamond grinding.** Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that causes ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

**403-4.16 Nighttime Paving Requirements.** The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the RPR prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

## CONTRACTOR QUALITY CONTROL (CQC)

**403-5.1 General.** The Contractor shall develop a CQCP in accordance with Item C-100. No partial payment will be made for materials that are subject to specific QC requirements without an approved CQCP**.**

**403-5.2 Contractor quality control (QC) facilities.** The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The RPR shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The RPR will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected**.**

**403-5.3 Quality Control (QC) testing.** The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP**.**

**a. Asphalt content.** A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

**b. Gradation.** Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444 and ASTM C136, and ASTM C117.

**c. Moisture content of aggregate.** The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C566.

**d. Moisture content of asphalt.** The moisture content of the asphalt shall be determined once per lot in accordance with AASHTO T329 or ASTM D1461.

**e. Temperatures.** Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt at the plant, and the asphalt at the job site.

**f. In-place density monitoring.** The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

**g. Smoothness for Contractor Quality Control.** The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) "straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the RPR. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using the FAA profile program, ProFAA, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement and between the start and stop of lanes place shall be evaluated separately for conformance with the plans.

**(1) Transverse measurements.** Transverse measurements shall be taken for each day's production placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

**(2) Longitudinal measurements.** Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 403-4.15 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3) Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

**h. Grade.** Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to the placement of the first lift and then prior to and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch

(12 mm) vertically and 0.1 feet (30 mm) laterally. The documentation will be provided by the Contractor to the RPR within 24 hours**.**

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 403-4.15.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus ½ inch and replacing with new material. Skin patching is not allowed.

**403-5.4 Sampling.** When directed by the RPR, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

**403-5.5 Control charts.** The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day shall be calculated and monitored by the QC laboratory.
Control charts shall be posted in a location satisfactory to the RPR and kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the RPR may suspend production or acceptance of the material.

**a. Individual measurements.** Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the JMF target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

**Control Chart Limits for Individual Measurements**

| Sieve | Action Limit | Suspension Limit |
|---|---|---|
| 3/4 inch (19.0 mm) | ±6% | ±9% |
| 1/2 inch (12.5 mm) | ±6% | ±9% |
| 3/8 inch (9.5 mm) | ±6% | ±9% |
| No. 4 (4.75 mm) | ±6% | ±9% |
| No. 16 (1.18 mm) | ±5% | ±7.5% |
| No. 50 (300 µm) | ±3% | ±4.5% |
| No. 200 (75 µm) | ±2% | ±3% |
| Asphalt Content | ±0.45% | ±0.70% |
| Minimum VMA | -0.5% | -1.0% |

**b. Range.** Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Contractor elect to perform more than two tests per lot,

the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

**Control Chart Limits Based on Range**
**(n = 2)**

| Sieve | Suspension Limit |
|---|---|
| 1/2 inch (12.5 mm) | 11% |
| 3/8 inch (9.5 mm) | 11% |
| No. 4 (4.75 mm) | 11% |
| No. 16 (1.18 mm) | 9% |
| No. 50 (300 µm) | 6% |
| No. 200 (75 µm) | 3.5% |
| Asphalt Content | 0.8% |

**c. Corrective action.** The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

(1) One point falls outside the Suspension Limit line for individual measurements or range; or

(2) Two points in a row fall outside the Action Limit line for individual measurements**.**

**403-5.6 Quality control (QC) reports.** The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with the CQCP described in Item C-100.

## MATERIAL ACCEPTANCE

**403-6.1. Quality Assurance Acceptance sampling and testing.** Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the RPR at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

**a. Quality Assurance (QA) testing laboratory.** The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

**b. Lot Size.** A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

Where more than one plant is simultaneously producing asphalt for the job, the lot sizes will apply separately for each plant.

**c. Asphalt air voids.** Plant-produced asphalt will be tested for air voids on a sublot basis.

**(1) Sampling.** Material from each sublot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not

less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

**(2) Testing.** Air voids will be determined for each sublot in accordance with ASTM D3203 for a set of three compacted specimens prepared in accordance with ASTM D6926**.**

**d. In-place asphalt mat and joint density.** Each sublot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

**(1) Sampling.** The Contractor will cut minimum 5 inches (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the RPR.

**(2) Bond.** Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the RPR to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the RPR.

**(3) Thickness.** Thickness of each lift of surface course will be evaluated by the RPR for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each sublot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or sublot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the RPR to circumscribe the deficient area.

**(4) Mat density.** One core shall be taken from each sublot. Core locations will be determined by the RPR in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each sublot sample by the TMD for that sublot.

**(5) Joint density.** One core centered over the longitudinal joint shall be taken for each sublot which contains a longitudinal joint. Core locations will be determined by the RPR in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

**403-6.2 Acceptance criteria.**

**a. General.** Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, grade.

**b. Air voids.** Acceptance of each lot of plant produced material for air voids will be based upon the average air void from the sublots. If the average air voids of the lot are equal to or greater than 2% and equal to or less than 5%, then the lot will be acceptable. If the average is below 2% or greater than 5%, the lot shall be removed and replaced at the Contractor's expense.

**c. Mat density.** Acceptance of each lot of plant produced material for mat density will be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so

established equals or exceeds 94%, the lot will be acceptable. If the average mat density of the lot is below 94%, the lot shall be removed and replaced at the Contractor's expense.

**d. Joint density.** Acceptance of each lot of plant produced asphalt for joint density will be based on the average of all of the joint densities taken from the sublots. If the average joint density of the lot so established equals or exceeds 92%, the lot will be acceptable. If the average joint density of the lot is less than 92%, the Contractor shall stop production and evaluate the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.

**e. Grade.** The final finished surface of the pavement of the completed project shall be surveyed to verify that the grade elevations and cross-sections shown on the plans do not deviate more than 1/2 inch (12 mm) vertically or 0.1 feet (30 mm) laterally.

Cross-sections of the pavement shall be taken at a minimum 50-foot (15-m**)** longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points shall include grade at centerline, ± 10 feet of centerline, and edge of taxiway pavement.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the sublot shall not be more than 95%.

**f. Profilograph roughness for QA Acceptance. Not used.**

**403-6.3 Resampling Pavement for Mat Density.**

**a. General.** Resampling of a lot of pavement will only be allowed for mat density and then, only if the Contractor requests same in writing, within 48 hours after receiving the written test results from the RPR. A retest will consist of all the sampling and testing procedures contained in paragraphs 403-6.1. Only one resampling per lot will be permitted.

**(1)** A redefined mat density will be calculated for the resampled lot. The number of tests used to calculate the redefined mat density will include the initial tests made for that lot plus the retests.

**(2)** The cost for resampling and retesting shall be borne by the Contractor.

**b. Payment for resampled lots.** The redefined mat density for a resampled lot will be used to evaluate the acceptance of that lot in accordance with paragraph 403-6.2.

**c. Outliers.** Check for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded, and density determined using the remaining test values.

## METHOD OF MEASUREMENT

**403-7.1 Measurement.** Plant mix asphalt mix pavement shall be measured by the number of tons (kg) of asphalt pavement used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

## BASIS OF PAYMENT

**403-8.1 Payment.** Payment for a lot of asphalt mixture meeting all acceptance criteria as specified in paragraph 403-6.2 shall be made at the contract unit price per ton (kg) for asphalt. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-403-1 Asphalt Mix Pavement Base and Surface Course (PG 76-28)
per ton

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM C29 | Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate |
| ASTM C88 | Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM C117 | Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C127 | Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate |
| ASTM C131 | Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136 | Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates |
| ASTM C142 | Standard Test Method for Clay Lumps and Friable Particles in Aggregates |
| ASTM C183 | Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement |
| ASTM C566 | Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying |
| ASTM D75 | Standard Practice for Sampling Aggregates |
| ASTM D242 | Standard Specification for Mineral Filler for Bituminous Paving Mixtures |
| ASTM D946 | Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction |
| ASTM D979 | Standard Practice for Sampling Bituminous Paving Mixtures |
| ASTM D1073 | Standard Specification for Fine Aggregate for Bituminous Paving Mixtures |
| ASTM D1074 | Standard Test Method for Compressive Strength of Bituminous Mixtures |
| ASTM D1461 | Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures |
| ASTM D2041 | Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures |

| | |
|---|---|
| ASTM D2172 | Standard Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures |
| ASTM D2419 | Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate |
| ASTM D2489 | Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures |
| ASTM D2726 | Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures |
| ASTM D2950 | Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods |
| ASTM D3203 | Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures |
| ASTM D3381 | Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction |
| ASTM D3665 | Standard Practice for Random Sampling of Construction Materials |
| ASTM D3666 | Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials |
| ASTM D4125 | Standard Test Methods for Asphalt Content of Bituminous mixtures by the Nuclear Method |
| ASTM D4318 | Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D4552 | Standard Practice for Classifying Hot-Mix Recycling Agents |
| ASTM D4791 | Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate |
| ASTM D4867 | Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures |
| ASTM D5444 | Standard Test Method for Mechanical Size Analysis of Extracted Aggregate |
| ASTM D5581 | Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen) |
| ASTM D5821 | Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate |
| ASTM D6307 | Standard Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method |
| ASTM D6373 | Standard Specification for Performance Graded Asphalt Binder |
| ASTM D6752 | Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method |
| ASTM D6925 | Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyratory Compactor |

| | |
|---|---|
| ASTM D6926 | Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus |
| ASTM D6927 | Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures |
| ASTM D6995 | Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm) |
| ASTM E11 | Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves |
| ASTM E178 | Standard Practice for Dealing with Outlying Observations |
| ASTM E2133 | Standard Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface |

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M156 | Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures |
| AASHTO T329 | Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method |
| AASHTO T 340 | Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA) |

Asphalt Institute (AI)

| | |
|---|---|
| MS-2 | Mix Design Manual, 7th Edition |
| MS-26 | Asphalt Binder Handbook<br>AI State Binder Specification Database |

FAA Orders

| | |
|---|---|
| 5300.1 | Modifications to Agency Airport Design, Construction, and Equipment Standards |

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder program

Software

FAARFIELD

**END OF ITEM P-403**

# Item P-603 Emulsified Asphalt Tack Coat

## DESCRIPTION

**603-1.1** This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

## MATERIALS

**603-2.1 Asphalt materials.** The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the Resident Project Representative (RPR) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

## CONSTRUCTION METHODS

**603-3.1 Weather limitations.** The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the RPR.

**603-3.2 Equipment.** The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the RPR.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

**603-3.3 Application of emulsified asphalt material.** The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the RPR prior to application.

**Emulsified Asphalt**

| Surface Type | Residual Rate, gal/SY (L/square meter) | Emulsion Application Bar Rate, gal/SY (L/square meter) |
|---|---|---|
| **New asphalt** | 0.02-0.05 (0.09-0.23) | 0.03-0.07 (0.13-0.32) |
| **Existing asphalt** | 0.04-0.07 (0.18-0.32) | 0.06-0.11 (0.27-0.50) |
| **Milled Surface** | 0.04-0.08 (0.18-0.36) | .0.06-0.12 (0.27-0.54) |
| **Concrete** | 0.03-0.05 (0.13-0.23) | 0.05-0.08 (0.23-0.36) |

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the RPR. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

**603-3.4 Freight and waybills** The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the RPR certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

## METHOD OF MEASUREMENT

**603-4.1** The emulsified asphalt material for tack coat shall be measured by the gallon (liter). Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

## BASIS OF PAYMENT

**603.5-1** Payment shall be made at the contract unit price per gallon (liter) of emulsified asphalt material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.
Payment will be made under:

| | | |
|---|---|---|
| Item P-603-1 | Emulsified Asphalt Tack Coat | per gallon |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM D1250 | Standard Guide for Use of the Petroleum Measurement Tables |
| ASTM D2995 | Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors |
| ASTM D3628 | Standard Practice for Selection and Use of Emulsified Asphalts |

## END ITEM P-603

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# ITEM P-605 Joint Sealants for Pavements

## DESCRIPTION

**605-1.1** This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

## MATERIALS

**605-2.1 Joint sealants.** Joint sealant materials shall meet the requirements of ASTM D6690 Type III or IV.
Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

**605-2.2 Backer rod.** The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be 25% ± 5 % larger in diameter than the nominal width of the joint.

**605-2.3 Bond breaking tapes.** Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

## CONSTRUCTION METHODS

**605-3.1 Time of application.** Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be 50°F (10°C) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

**605-3.2 Equipment.** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 14 days prior to use on the project.

**a. Tractor-mounted routing tool**. Not used.

**b. Concrete saw.** Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.

**c. Sandblasting equipment.** Sandblasting is not allowed.

**d. Waterblasting equipment**. The Contractor must demonstrate waterblasting equipment including the pumps, hose, guide and nozzle size, under job conditions, before approval in accordance with

paragraph 605-3.3. The Contractor shall demonstrate, in the presence of the RPR, that the method cleans the joint and does not damage the joint.

**e. Hand tools**. Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

**f. Hot-poured sealing equipment**. The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

**605-3.3 Preparation of joints.** Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method cleans the joint and does not damage the joint.

**a. Sawing**. All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

**b. Sealing**. Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by concrete saw or waterblaster as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

**c. Backer Rod.** When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod in accordance with paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

**d. Bond-breaking tape.** Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

**605-3.4 Installation of sealants.** Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the RPR before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch (6 mm) ±1/16 inch (2 mm) below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until

authorized by the RPR. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

**605-3.5 Inspection.** The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

**605-3.6 Clean-up.** Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

## METHOD OF MEASUREMENT

**605-4.1** Sawing and joint sealing material shall be measured by the linear foot (meter) of sawing and sealant in place, completed, and accepted. Joints which are mis-aligned, not sawn on the paving joint, not sawn on the initial saw cut, or which will not create a watertight seal will not be measured for payment.

## BASIS OF PAYMENT

**605-5.1** Payment for sawing and joint sealing material shall be made at the contract unit price per linear foot (meter). The price shall be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-605-1 | Sawing and Joint Sealing Filler - HMA | per linear foot |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM D789 | Standard Test Method for Determination of Relative Viscosity of Polyamide (PA) |
| ASTM D5249 | Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints |
| ASTM D6690 | Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt |

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5340-30 | Design and Installation Details for Airport Visual Aids |

**END ITEM P-605**

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# ITEM P-610 Concrete for Miscellaneous Structures

## DESCRIPTION

**610-1.1** This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

## MATERIALS

**610-2.1 General.** Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Resident Project Representative (RPR) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.
The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

**a. Reactivity.** Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the RPR. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20%, the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

**610-2.2 Coarse aggregate.** The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

*Coarse Aggregate Grading Requirements*

| Maximum Aggregate Size | ASTM C33, Table 3 Grading Requirements (Size No.) |
|---|---|
| 1 1/2 inch (37.5 mm) | 467 or<br>4 and 67 |
| 1 inch (25 mm) | 57 |
| ¾ inch (19 mm) | 67 |
| ½ inch (12.5 mm) | 7 |

**610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking.** Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted. Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test requirements but must meet all other quality tests specified in Item P-501.

**610-2.3 Fine aggregate.** The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

**610-2.4 Cement.** Cement shall conform to the requirements of C150 Type II or IIA.

**610-2.5 Cementitious materials.**

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the RPR.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**610-2.6 Water.** Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

**610-2.7 Admixtures.** The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the RPR may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the RPR from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

**a. Air-entraining admixtures**. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures**. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

**c. Other chemical admixtures**. The use of set retarding, and set-accelerating admixtures shall be approved by the RPR. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**610-2.8 Premolded joint material.** Premolded joint material for expansion joints shall meet the requirements of ASTM D1751.

**610-2.9 Joint filler.** The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

**610-2.10 Steel reinforcement.** Reinforcing shall consist of Reinforcing Steel or Welded Steel Wire Fabric conforming to the requirements of ASTM A615 or ASTM A1064.

**610-2.11 Materials for curing concrete.** Curing materials shall conform to ASTM C309 White-pigmented Liquid Membrane-Forming Compound, Type 2, Class B.

## CONSTRUCTION METHODS

**610-3.1 General.** The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the RPR.

**610-3.2 Concrete Mixture.** The concrete shall develop a compressive strength of 4000 psi 28 MPa in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cementitious material per cubic yard (280 kg per cubic meter). The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

**610-3.3 Mixing.** Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the RPRs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

**610-3.4 Forms**. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the RPR. Forms shall be of suitable material and shall be of the type, size, shape,

quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.
The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

**610-3.5 Placing reinforcement.** All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

**610-3.6 Embedded items.** Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

**610-3.7 Concrete Consistency**. The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

**610-3.8 Placing concrete.** All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the RPR. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

**610-3.9 Vibration.** Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

**610-3.10 Joints.** Joints shall be constructed as indicated on the plans.

**610-3.11 Finishing.** All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

**610-3.12 Curing and protection.** All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

**610-3.13 Cold weather placing.** When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

**610-3.14 Hot weather placing.** When concrete is placed in hot weather greater than 85ºF (30 ºC), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

## QUALITY ASSURANCE (QA)

**610-4.1 Quality Assurance sampling and testing**. Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The RPR will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

**610-4.2 Defective work.** Any defective work that cannot be satisfactorily repaired as determined by the RPR, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

## METHOD OF MEASUREMENT

**610-5.1** Concrete shall be measured by the number of cubic yards (cubic meters) in place of concrete complete in place and accepted.

**610-5.2** Reinforcing steel shall not be measured for payment but shall be considered incidental to the items requiring the steel.

No measurements or other compensation shall be made for reinforcing steel, drilling, dowels, epoxy, forms, falsework, cofferdams, pumping, bracing, expansion/contraction joints, control joints, finishing, protection, or other incidentals required.

## BASIS OF PAYMENT

**610-6.1** Payment shall be made at the contract price by the number of cubic yards (cubic meters) in place. This price shall be full compensation for furnishing all materials including reinforcement, embedded items, jointing, bulkheads, joint sealants and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-610-1 | Concrete Sidewalks | per cubic yard |
| Item P-610-2 | Concrete Pads | per cubic yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM A184 | Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement |
| ASTM A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A704 | Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement |

| | |
|---|---|
| ASTM A706 | Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement |
| ASTM A775 | Standard Specification for Epoxy-Coated Steel Reinforcing Bars |
| ASTM A884 | Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement |
| ASTM A934 | Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars |
| ASTM A1064 | Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM C31 | Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C33 | Standard Specification for Concrete Aggregates |
| ASTM C39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C94 | Standard Specification for Ready-Mixed Concrete |
| ASTM C136 | Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates |
| ASTM C114 | Standard Test Methods for Chemical Analysis of Hydraulic Cement |
| ASTM C136 | Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C143 | Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C171 | Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C172 | Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C231 | Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C260 | Standard Specification for Air-Entraining Admixtures for Concrete |
| ASTM C309 | Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C311 | Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete |
| ASTM C494 | Standard Specification for Chemical Admixtures for Concrete |
| ASTM C618 | Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C666 | Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing |
| ASTM C685 | Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing |
| ASTM C989 | Standard Specification for Slag Cement for Use in Concrete and Mortars |

| | |
|---|---|
| ASTM C1017 | Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete |
| ASTM C1077 | Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation |
| ASTM C1157 | Standard Performance Specification for Hydraulic Cement |
| ASTM C1260 | Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C1365 | Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis |
| ASTM C1602 | Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete |
| ASTM D1751 | Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types) |
| ASTM D1752 | Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction |

American Concrete Institute (ACI)

| | |
|---|---|
| ACI 305R | Hot Weather Concreting |
| ACI 306R | Cold Weather Concreting |
| ACI 308R | Guide to External Curing of Concrete |
| ACI 309R | Guide for Consolidation of Concrete |

**END OF ITEM P-610**

# Item P-620 Runway and Taxiway Marking

## DESCRIPTION

**620-1.1** This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR). The terms "paint" and "marking material" as well as "painting" and "application of markings" are interchangeable throughout this specification.

## MATERIALS

**620-2.1 Materials acceptance.** The Contractor shall furnish manufacturer's certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer's surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the Resident Project Representative (RPR) prior to the initial application of markings. The reports can be used for material acceptance or the RPR may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the RPR upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the RPR.

**620-2.2 Marking materials.**

**Table 1. Marking Materials**

| Paint[1] | | | | Glass Beads[2] | |
|---|---|---|---|---|---|
| **Type** | **Color** | **Fed Std. 595 Number** | **Application Rate Maximum** | **Type** | **Application Rate Minimum** |
| Waterborne Type II | White | 37925 | 115 $ft^2$/gal (2.8 $m^2$/l) | III | 10 lb/gal (1.2 kg/l) |
| Waterborne Type II | Yellow | 33538 or 33655 | 115 $ft^2$/gal (2.8 $m^2$/l) | III | 10 lb/gal (1.2 kg/l) |
| Waterborne Type II | Red | 31136 | 115 $ft^2$/gal (2.8 $m^2$/l) | I Gradation A | 5 lb/gal (0.61 kg/l) |
| Waterborne Type II | Black | 37038 | 115 $ft^2$/gal (2.8 $m^2$/l) | No Beads | No Beads |

[1] **See paragraph 620-2.2a**

[2] **See paragraph 620-2.2b**

**a. Paint**. Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

**Waterborne**. Paint shall meet the requirements of Federal Specification TT-P-1952F, Type II. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis.

**b. Reflective media.** Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type III.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

## CONSTRUCTION METHODS

**620-3.1 Weather limitations.** Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

**620-3.2 Equipment.** Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

**620-3.3 Preparation of surfaces.** Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminates that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the RPR. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

**a. Preparation of new pavement surfaces.** The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the RPR to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

**b. Preparation of pavement to remove existing markings.** Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the RPR minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

**c. Preparation of pavement markings prior to remarking.** Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the RPR. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the RPR prior to the initial application of markings.

**620-3.4 Layout of markings.** The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

**620-3.5 Application.** A period of 30 days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the RPR.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

**Marking Dimensions and Spacing Tolerance**

| Dimension and Spacing | Tolerance |
|---|---|
| 36 inch (910 mm) or less | ±1/2 inch (12 mm) |
| greater than 36 inch to 6 feet (910 mm to 1.85 m) | ±1 inch (25 mm) |
| greater than 6 feet to 60 feet (1.85 m to 18.3 m) | ±2 inch (50 mm) |
| greater than 60 feet (18.3 m) | ±3 inch (76 mm) |

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

**620-3.6 Application--preformed thermoplastic airport pavement markings.** Preformed thermoplastic pavement markings not used.

**620-3.7 Control strip.** Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the RPR. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

**620-3.8 Retro-reflectance**. Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

**Minimum Retro-Reflectance Values**

| Material | Retro-reflectance mcd/m$^2$/lux | | |
|---|---|---|---|
| | White | Yellow | Red |
| Initial Type I | 300 | 175 | 35 |
| Initial Type III | 600 | 300 | 35 |
| Initial Thermoplastic | 225 | 100 | 35 |
| All materials, remark when less than[1] | 100 | 75 | 10 |

[1] 'Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance.

**620-3.9 Protection and cleanup.** After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the RPR. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

## METHOD OF MEASUREMENT

**620-4.1a** The quantity of markings to be paid for shall be measured by the number of square feet of painting with or without glass beads. The quantity of glass beads and surface preparation shall not be measured separately but shall be considered incidental to the paint requiring them.

**620-4.1b** The quantity of paint marking removal to be paid for shall be the actual number of square feet of existing paint markings removed, as direct by the RPR.

## BASIS OF PAYMENT

**620-5.1** This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the RPR in accordance with these specifications.

**620-5.1b** Surface preparation shall be considered incidental and no separate payment shall be made.

**620-5.1c** Payment for temporary color markings shall be made at the contract unit price for the number of square feet (square meters) of painting. This price shall be full compensation for furnishing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

**620-5.1d** Payment for permanent color markings shall be made at the contract price for the number of square feet (square meters) of painting. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item. Payment for glass beads shall be considered incidental to this item.

**620-5.2e** Payment for marking removal shall be made at the contract price for the number of square feet (square meters) of pavement markings removed and accepted. This prices hall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item P-620-1 | Pavement Marking – Temporary Color | per square foot |
| Item P-620-2 | Pavement Marking – Permanent Color | per square foot |
| Item P-620-3 | Pavement Marking – Permanent Black | per square foot |
| Item P-620-4 | Pavement Marking – Removal | per square foot |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM D476 | Standard Classification for Dry Pigmentary Titanium Dioxide Products |
| ASTM D968 | Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM D1652 | Standard Test Method for Epoxy Content of Epoxy Resins |
| ASTM D2074 | Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method |
| ASTM D2240 | Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D7585 | Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments |
| ASTM E303 | Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester |
| ASTM E1710 | Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer |
| ASTM E2302 | Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer |
| ASTM G154 | Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials |

Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

Federal Specifications (FED SPEC)

| | |
|---|---|
| FED SPEC TT-B-1325D | Beads (Glass Spheres) Retro-Reflective |
| FED SPEC TT-P-1952F | Paint, Traffic and Airfield Marking, Waterborne |
| FED STD 595 | Colors used in Government Procurement |

Commercial Item Description

| | |
|---|---|
| A-A-2886B | Paint, Traffic, Solvent Based |

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5340-1 | Standards for Airport Markings |
| AC 150/5320-12 | Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces |

**END OF ITEM P-620**

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# Item D-701 Pipe for Storm Drains and Culverts

## DESCRIPTION

**701-1.1** This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

## MATERIALS

**701-2.1** Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

**701-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

| | |
|---|---|
| AASHTO M304 | Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter |
| ASTM C76 | Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Class V) |

**701-2.3 Concrete.** Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

**701-2.4 Rubber gaskets.** Rubber gaskets for rigid pipe shall conform to the requirem1ents of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the “RE” closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

**701-2.5 Joint mortar.** Pipe joint mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**701-2.6 Joint fillers.** Not used.

**701-2.7 Plastic gaskets.** Plastic gaskets shall conform to the requirements of ASTM C990.

**701-2.8. Controlled low-strength material (CLSM).** Not used.

**701-2.9 Precast box culverts.** Manufactured in accordance with and conforming to ASTM C1433.

**701-2.10 Precast concrete pipe.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association QCast Plant Certification program.

## CONSTRUCTION METHODS

**701-3.1 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than

the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

**701-3.2 Bedding.** The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

**a. Rigid pipe.** The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

**b. Flexible pipe.** For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

**Flexible Pipe Bedding**

| Pipe Corrugation Depth | | Minimum Bedding Depth | |
|---|---|---|---|
| **inch** | **mm** | **inch** | **mm** |
| 1/2 | 12 | 1 | 25 |
| 1 | 25 | 2 | 50 |
| 2 | 50 | 3 | 75 |
| 2-1/2 | 60 | 3-1/2 | 90 |

**c. Other pipe materials.** For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

**701-3.3 Laying pipe.** The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.
Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

**701-3.4 Joining pipe.** Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

**a. Concrete pipe.** Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required.

**b. Metal pipe.** Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

**c. PVC, Polyethylene, or Polypropylene pipe.** Joints for PVC, Polyethylene, or Polypropylene pipe shall conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764.

**d. Fiberglass pipe.** Joints and fittings shall be as detailed on the plans and in accordance with the manufacturers recommendations.

**701-3.5 Embedment and Overfill.** Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

**701-3.5-1 Embedment Material Requirements**

**a. Concrete Pipe.** Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

**b. Plastic and fiberglass Pipe.** Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

**c. Metal Pipe.** Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

**701-3.5-2 Placement of Embedment Material**

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level,

whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.
It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

**701-3.6 Overfill**

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be place and compacted in layers as required to achieve compaction to at least 95 percent standard proctor per ASTM D1557. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

**701-3.7 Inspection Requirements**

An initial post installation inspection shall be performed by the RPR no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.

Flexible pipes shall be inspected for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection. Determine whether the allowable deflection has been exceeded by use of a laser profiler for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment shall utilize low barrel distortion video equipment. Deflection of installed pipe shall not exceed the limits provided in the table below, as a percentage of the average inside diameter of the pipe.

Maximum Allowable Pipe Deflection

| Type of Pipe | Maximum Allowable Deflection (%) |
|---|---|
| Corrugated Metal Pipe | 5 |
| Concrete Lined CMP | 3 |
| Thermoplastic Pipe | 5 |
| Fiberglass | 5 |

If deflection readings in excess of the allowable deflection are obtained, remove the pipe with excessive deflection and replace with new pipe. Isolated areas may exceed allowable by 2.5% with concurrence of RPR. Repair or replace any pipe with cracks exhibiting displacement across the crack, bulges, creases, tears, spalls, or delaminations. The report for flexible pipe shall include as a minimum, the deflection results and final post installation inspection report. The inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design line and grade, and inspector's notes.

## METHOD OF MEASUREMENT

**701-4.1** The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The types and sizes of pipe shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

**701-4.2** The quantity of excavation, bedding, backfill, shoring, dewatering, coring of existing structures, or any other materials necessary to complete this item shall not be measured separately, but rather shall be considered included in the unit bid price for the pipe item. Select materials, such as P-154 Subbase Course or P-209 Crushed Aggregate Base Course will be paid for under their respective pay items. Where existing pipe is being removed prior to installation of new pipe, all excavation costs shall be incidental to the pipe removal pay item.

**701-4.3** The volume of rock shall be measured as per Specification Section P-152. No measurement for rock shall be made under this specification section.

## BASIS OF PAYMENT

**701-5.0** These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.
**701-5.1** Payment will be made at the contract unit price per linear foot (meter) for 12-Inch Reinforced Concrete Pipe (Class V) & 6-Inch PVC Drain Pipe.

Payment will be made under:

| | | |
|---|---|---|
| Item D-701-1 | 12-Inch Reinforced Concrete Pipe (Class V) | per linear foot |
| Item D-701-2 | 6-Inch PVC Drain Pipe | per linear foot |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M167 | Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches |
| AASHTO M190 | Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches |
| AASHTO M196 | Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains |
| AASHTO M219 | Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches |
| AASHTO M243 | Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches |
| AASHTO M252 | Standard Specification for Corrugated Polyethylene Drainage Pipe |
| AASHTO M294 | Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter |
| AASHTO M304 | Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter |
| AASHTO MP20 | Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter |

ASTM International (ASTM)

| | |
|---|---|
| ASTM A760 | Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains |
| ASTM A761 | Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches |
| ASTM A762 | Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains |
| ASTM A849 | Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe |
| ASTM B745 | Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains |
| ASTM C14 | Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe |
| ASTM C76 | Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C94 | Standard Specification for Ready Mixed Concrete |
| ASTM C144 | Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C443 | Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets |
| ASTM C506 | Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe |

| | |
|---|---|
| ASTM C507 | Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe |
| ASTM C655 | Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe |
| ASTM C990 | Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants |
| ASTM C1433 | Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers |
| ASTM D1056 | Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber |
| ASTM D3034 | Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3212 | Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |
| ASTM D3262 | Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe |
| ASTM D3282 | Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes |
| ASTM D4161 | Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals |
| ASTM D6690 | Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements |
| ASTM F477 | Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F667 | Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings |
| ASTM F714 | Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter |
| ASTM F794 | Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter |
| ASTM F894 | Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe |
| ASTM F949 | Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings |
| ASTM F2435 | Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe |
| ASTM F2562 | Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage |
| ASTM F2736 | Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe |

| | |
|---|---|
| ASTM F2764 | Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications |
| ASTM F2881 | Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications |

National Fire Protection Association (NFPA)

| | |
|---|---|
| NFPA 415 | Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways |

**END ITEM D-701**

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# Item D-705 Pipe Underdrains for Airports

## DESCRIPTION

**705-1.1** This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

## MATERIALS

**705-2.1 General.** Materials shall meet the requirements shown on the plans and specified below.

**705-2.2 Pipe.** The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

AASHTO M252 Standard Specification for Corrugated Polyethylene Drainage Pipe

**705-2.3 Joint mortar.** Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**705-2.4 Elastomeric seals.** Elastomeric seals shall conform to the requirements of ASTM F477.

**705-2.5 Porous backfill.** Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

**Table 1. Gradation of Porous Backfill**

| Sieve Designation (square openings) | Percentage by Weight Passing Sieves |
|---|---|
| | Porous Material No. 2 |
| 1-1/2 inch (37.5 mm) | 100 |
| 1 inch (25.0 mm) | 90-100 |
| 3/8 inch (9.5 mm) | 25-60 |
| No. 4 (4.75 mm) | 5-40 |
| No. 8 (2.36 mm) | 0-20 |

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

**705-2.6 Granular material.** Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

**705-2.7 Filter fabric.** The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

**Table 2. Fabric Properties**

| Fabric Property | Test Method | Test Requirement |
|---|---|---|
| **Grab Tensile Strength, lbs** | ASTM D4632 | 125 min |
| **Grab Tensile Elongation %** | ASTM D4632 | 50 min |
| **Burst Strength, psi** | ASTM D3785 | 125 min |
| **Trapezoid Tear Strength, lbs** | ASTM D4533 | 55 min |
| **Puncture Strength, lbs** | ASTM D4833 | 40 min |
| **Abrasion, lbs** | ASTM D4886 | 15 max loss |
| **Equivalent Opening Size** | ASTM D4751 | 70-100 |
| **Permittivity $sec^{-1}$** | ASTM D4491 | 0.80 |
| **Accelerated Weathering (UV Stability) (Strength Retained - %)** | ASTM D4355 *(500 hrs exposure) | 70 |

**705-2.8 Controlled low-strength material (CLSM).** CLSM is not used.

## CONSTRUCTION METHODS

**705-3.1 Equipment.** All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the RPR before construction is permitted to start.

**705-3.2 Excavation.** The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the RPR. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the RPR and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and 1-1/2 inch when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has

reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

**705-3.3 Laying and installing pipe.**

**a. Concrete pipe.** Not used.

**b. Metal pipe.** Not used.

**c. PVC, fiberglass, or polyethylene pipe.** PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

**d. All types of pipe.** The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the RPR.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

**e. Filter fabric.** The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

**705-3.4 Mortar.** The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

**705-3.5 Joints in concrete pipe.** Not used.

**705-3.6 Embedment and Backfill**

**a. Earth.** All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the RPR. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the RPR. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the RPR, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

**b. Granular backfill.** When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the RPR, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 2.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

**c. Controlled low-strength material (CLSM).** CLSM is not used.

**705-3.7 Flexible Pipe Ring Deflection.** The flexible pipe shall be inspected by the Contractor during and after installation to ensure that the internal diameter of the pipe barrel has not been reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices.

**705-3.8 Connections.** When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

**705-3.9 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the RPR. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

## METHOD OF MEASUREMENT

**705-4.1** The length of pipe shall be the number of linear feet (meters) of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to

the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

**705-4.2** Not used.

**705-4.3** Not used.

**705-4.4**. The quantity of perforated pipe underdrains removed and replaced shall be made at the contract unit price per linear foot (meter) complete, including excavation, removal of existing underdrain sections, installation of new underdrain sections, porous backfill, filter fabric, and connecting to existing pipe underdrain. Any bypass pumping required shall be considered incidental.

**705-4.5** The quantity of perforated pipe underdrains and solid outlet pipes for building foundations, shall be made at the contract unit price per linear foot (meter) complete, including excavation, installation of new drain sections, porous backfill, filter fabric, and connecting to existing foundation drain. Any bypass pumping required shall be considered incidental.

## BASIS OF PAYMENT

**705-5.1** Payment will be made at the contract unit price per linear foot (meter) for pipe underdrains of the type, class, and size designated.

**705-5.2 Porous backfill.**

**a.Porous backfill.** Payment for porous backfill shall not be made separately but shall be considered incidental to Item D-705-1.

**705-5.3. Filter fabric.** Payment for filter fabric shall not be made separately but shall be considered incidental to Item D-705-1.

**705-5.4 Pipe underdrains, Complete Remove and Replace**. Perforated pipe underdrains, complete removed and replaced (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot (meter) complete (including porous backfill and filter fabric.

**705-5.5 Pipe Underdrains for Foundations.** Payment perforated pipe underdrains and solid outlet pipe for building foundations (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot (meter) complete (including porous backfill and filter fabric.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item D-705-1 | Remove & Replace 6" Perforated Underdrain Pipe | per linear foot |
| Item D-705-2 | Pipe Underdrains for Foundations | per linear foot |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM A760 | Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains |
| ASTM A762 | Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains |
| ASTM C136 | Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates |
| ASTM C144 | Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C444 | Standard Specification for Perforated Concrete Pipe |
| ASTM C654 | Standard Specification for Porous Concrete Pipe |
| ASTM D2321 | Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications |
| ASTM D3262 | Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe |
| ASTM D4161 | Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals |
| ASTM F477 | Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F758 | Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage |
| ASTM F794 | Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter |
| ASTM F949 | Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings |
| ASTM F2562 | Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage |

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M190 | Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches |
| AASHTO M196 | Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains |
| AASHTO M252 | Standard Specification for Corrugated Polyethylene Drainage Pipe |
| AASHTO M288 | Standard Specification for Geotextile Specification for Highway Applications |
| AASHTO M294 | Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter |
| AASHTO M304 | Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter |

| | |
|---|---|
| AASHTO MP20 | Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter |
| AASHTO | Standard Specifications for Highway Bridges |

**END OF ITEM D-705**

# ITEM D-751 Manholes, Catch Basins, Inlets and Inspection Holes

## DESCRIPTION

**751-1.1** This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the RPR.

## MATERIALS

**751-2.1 Brick.** The brick shall conform to the requirements of ASTM C32, Grade MS.

**751-2.2 Mortar.** Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

**751-2.3 Concrete.** Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

**751-2.4 Precast concrete pipe manhole rings.** Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

**751-2.5 Corrugated metal.** Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

**751-2.6 Frames, covers, and grates.** The castings shall conform to one of the following requirements:

**a.** ASTM A48, Class 35B: Gray iron castings

**b.** ASTM A47: Malleable iron castings

**c.** ASTM A27: Steel castings

**d.** ASTM A283, Grade D: Structural steel for grates and frames

**e.** ASTM A536, Grade 65-45-12: Ductile iron castings

**f.** ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

**751-2.7 Steps.** The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

**751-2.8 Precast inlet structures.** Manufactured in accordance with and conforming to ASTM C913.

## CONSTRUCTION METHODS

**751-3.1 Unclassified excavation.**

**a.** The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the RPR may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

**b.** Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the RPR. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

**c.** The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

**d.** All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

**e.** After excavation is completed for each structure, the Contractor shall notify the RPR. No concrete or reinforcing steel shall be placed until the RPR has approved the depth of the excavation and the character of the foundation material.

**751-3.2 Brick structures.** Not used.

**751-3.3 Concrete structures.** Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

**751-3.4 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned

and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

**751-3.5 Corrugated metal structures.** Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

**751-3.6 Inlet and outlet pipes.** Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

**751-3.7 Placement and treatment of castings, frames, and fittings.** All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the RPR, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the RPR. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

**751-3.8 Installation of steps.** The steps shall be installed as indicated on the plans or as directed by the RPR. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures they shall meet the requirements of ASTM C478. The steps shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the RPR.

**751-3.9 Backfilling.**

**a.** After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

**b.** Backfill shall not be placed against any structure until approved by the RPR. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

**c.** Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

**751-3.10 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the RPR. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

## METHOD OF MEASUREMENT

**751-4.1** Manholes, catch basins, inlets, and inspection holes shall be measured by the unit.

## BASIS OF PAYMENT

**751-5.1** The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

| | | |
|---|---|---|
| Item D-751-1 | 48-Inch Diameter Catch Basin | per each |
| Item D-751-2 | Tie Into New Perimeter Drain System | per lump sum |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM A27 | Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A47 | Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A48 | Standard Specification for Gray Iron Castings |
| ASTM A123 | Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A536 | Standard Specification for Ductile Iron Castings |
| ASTM A897 | Standard Specification for Austempered Ductile Iron Castings |

| | |
|---|---|
| ASTM C32 | Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale) |
| ASTM C144 | Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C443 | Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets. |
| ASTM C478 | Standard Specification for Precast Reinforced Concrete Manhole Sections |
| ASTM C913 | Standard Specification for Precast Concrete Water and Wastewater Structures. |

American Association of State Highway and Transportation Officials (AASHTO)

| | |
|---|---|
| AASHTO M36 | Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains |

**END OF ITEM D-751**

# Item T-901 Seeding

## DESCRIPTION

**901-1.1** This item shall consist of soil preparation, seeding**,** fertilizing, and liming the areas shown on the plans or as directed by the RPR in accordance with these specifications.

## MATERIALS

**901-2.1 Seed.** The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the RPR duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

**Seed Properties and Rate of Application**

| Seed | Minimum Seed Purity (Percent) | Minimum Germination (Percent) | Rate of Application lb/acre (or lb/1,000 S.F.) |
|---|---|---|---|
| Creeping Red Fescue | 96 | 85 | 63 |
| Perennial Ryegrass | 98 | 90 | 30 |
| Redtop | 95 | 80 | 5 |
| Alsike Clover | 97 | 90 | 5 |
| Birdsfoot Trefoil | 98 | 80 | 5 |

Seeding shall be performed during the period between April 1 and June 1 and August 15 and October 15 inclusive, unless otherwise approved by the RPR.

**901-2.2 Lime.** Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 (850 µm) mesh sieve and 50% will pass through a No. 100 (150 µm) mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium

lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of 1 Ton per acre. All liming materials shall conform to the requirements of ASTM C602.

**901-2.3 Fertilizer**. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.
The fertilizers may be supplied in one of the following forms:

a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;

b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or

c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be 20-20-20 commercial fertilizer and shall be spread at the rate of 500 lbs per acre.

**901-2.4 Soil for repairs.** The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

## CONSTRUCTION METHODS

**901-3.1 Advance preparation and cleanup.** After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

**901-3.2 Dry application method.** Not used.

**901-3.3 Wet application method.**

**a. General.** The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

**b. Spraying equipment.** The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire

range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

**c. Mixtures.** Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor shall identify to the RPR all sources of water at least two (2) weeks prior to use. The RPR may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the RPR following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

**d. Spraying.** Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the RPR, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

**901-3.4 Maintenance of seeded areas.** The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.
When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

## METHOD OF MEASUREMENT

**901-4.1** The quantity of seeding to be paid for shall be the number of units square yards measured on the ground surface, completed and accepted.

## BASIS OF PAYMENT

**901-5.1** Payment shall be made at the contract unit price per square yard, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

| | | |
|---|---|---|
| Item T-901-1 | Seeding | per square yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM C602 | Standard Specification for Agricultural Liming Materials |

Federal Specifications (FED SPEC)

| | |
|---|---|
| FED SPEC | JJJ-S-181, Federal Specification, Seeds, Agricultural |

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5200-33 | Hazardous Wildlife Attractants on or Near Airports |

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

**END OF ITEM T-901**

# Item T-905 Topsoil

## DESCRIPTION

**905-1.1** This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

## MATERIALS

**905-2.1 Topsoil.** Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 µm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

**905-2.2 Inspection and tests.** Within 10 days following acceptance of the bid, the RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

## CONSTRUCTION METHODS

**905-3.1 General.** Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.
Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR before the various operations are started.

**905-3.2 Preparing the ground surface.** Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade

soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

**905-3.3 Obtaining topsoil.** Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the RPR. The Contractor shall notify the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

**905-3.4 Placing topsoil.** The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.
After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. after spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

## METHOD OF MEASUREMENT

**905-4.1** Topsoil obtained on or off the site shall be measured by the number of square yards of topsoil measured in its final position and accepted by the RPR. Topsoil stockpiled by others and removed for topsoil by the Contractor shall be measured under Item P-152 Unclassified Excavation. There shall be no measurement of stockpiling or rehandling of the material if it cannot be immediately screened and placed in its final position.

## BASIS OF PAYMENT

**905-5.1** Payment will be made at the contract unit price per square yard for topsoil (obtained on or off the site). This price shall be full compensation for furnishing all materials and for all preparation, screening, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

| | | |
|---|---|---|
| Item T-905-1 | Topsoil (obtained on or off the site)- 4" Depth | per square yard |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM C117 | Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing |

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5200-33 | Hazardous Wildlife Attractants on or Near Airports |

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

## END OF ITEM T-905

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# Item T-908 Mulching

## DESCRIPTION

**908-1.1** This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the RPR.

## MATERIALS

**908-2.1 Mulch material.** Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

- **a. Hay**. Hay shall not be used.
- **b. Straw.** Straw shall not be used.
- **c. Hay mulch containing seed**. Hay mulch containing seed shall not be used.
- **d. Manufactured mulch**. Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications.
- **e. Asphalt binder.** Asphalt binder material shall conform to the requirements of ASTM D977, Type SS-1 or RS-1.

**908-2.2 Inspection.** The RPR shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the approval of the RPR and any materials brought on the site that do not meet these standards shall be rejected.

## CONSTRUCTION METHODS

**908-3.1 Mulching.** Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.
Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the RPR. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1-1/2 inches (38 cm) nor more than 3 inches (75 mm). Other organic material shall be spread at the rate directed by the RPR. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than one inch (25 mm) nor more than 2 inches (50 mm).

**908-3.2 Securing mulch.** The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, asphalt binder, or other adhesive material approved by the RPR. Where

mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

If the "peg and string" method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

**908-3.3 Care and repair.**

**a.** The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the RPR, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

**b.** The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the RPR, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

**c.** If the "asphalt spray" method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m), or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the asphalt material.

**d.** If the "asphalt mix" method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

## METHOD OF MEASUREMENT

**908-4.1** Mulching will not be measured for payment rather it will be considered incidental to seeding.

## BASIS OF PAYMENT

**908-5.1** Mulching is incidental to seeding and no separate payment will be made.

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D977 Standard Specification for Emulsified Asphalt

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-908

# Item F-162 Chain-Link Fence

## DESCRIPTION

**162-1.1** This item shall consist of furnishing and erecting a chain-link fence in accordance with these specifications, the details shown on the plans, and in conformity with the lines and grades shown on the plans or established by the RPR.

## MATERIALS

**162-2.1 Fabric.** The fabric shall be woven with a 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A392, Class 2.

**162-2.2 Barbed wire.** Barbed wire shall be 3-strand 12-1/2 gauge zinc-coated wire with 4-point barbs and shall conform to the requirements of ASTM A121, Class 3, Chain Link Fence Grade.

**162-2.3 Posts, rails, and braces.** Line posts, rails, and braces shall conform to the requirements of ASTM F1043 or ASTM F1083 as follows:

- Galvanized tubular steel pipe shall conform to the requirements of Group IA, (Schedule 40) coatings conforming to Type A, or Group IC (High Strength Pipe), External coating Type B, and internal coating Type B or D.

Posts, rails, and braces, with the exception of galvanized steel conforming to ASTM F1043 or ASTM F1083, Group 1A, Type A, or aluminum alloy, shall demonstrate the ability to withstand testing in salt spray in accordance with ASTM B117 as follows:

- External: 1,000 hours with a maximum of 5% red rust.
- Internal: 650 hours with a maximum of 5% red rust.

The dimensions of the posts, rails, and braces shall be in accordance with Tables I through VI of Federal Specification RR-F-191/3.

**162-2.4 Gates.** Gate frames shall consist of galvanized steel pipe and shall conform to the specifications for the same material under paragraph 162-2.3. The fabric shall be of the same type material as used in the fence.

**162-2.5 Wire ties and tension wires.** Wire ties for use in conjunction with a given type of fabric shall be of the same material and coating weight identified with the fabric type. Tension wire shall be 7-gauge marcelled steel wire with the same coating as the fabric type and shall conform to ASTM A824.

All material shall conform to Federal Specification RR-F-191/4.

**162-2.6 Miscellaneous fittings and hardware.** Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A153. Barbed wire support arms shall withstand a load of 250 pounds (113 kg) applied vertically to the outermost end of the arm.

**162-2.7 Concrete.** Concrete shall have a minimum 28-day compressive strength of 3000 psi (2670 kPa).

**162-2.8 Marking.** Each roll of fabric shall carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

## CONSTRUCTION METHODS

**162-3.1 General.** The fence shall be constructed in accordance with the details on the plans and as specified here using new materials. All work shall be performed in a workmanlike manner satisfactory to the RPR. The Contractor shall layout the fence line based on the plans . The Contractor shall span the opening below the fence with barbed wire at all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manmade features such as drainage ditches. The new fence shall be permanently tied to the terminals of existing fences as shown on the plans. The Contractor shall stake down the woven wire fence at several points between posts as shown on the plans.

The Contractor shall arrange the work so that construction of the new fence will immediately follow the removal of existing fences. The length of unfenced section at any time shall not exceed 300 feet (90 m). The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence.

**162-3.2 Clearing fence line.** Clearing shall consist of the removal of all stumps, brush, rocks, trees, or other obstructions that will interfere with proper construction of the fence. Stumps within the cleared area of the fence shall be grubbed or excavated. The bottom of the fence shall be placed a uniform distance above ground, as specified in the plans. When shown on the plans or as directed by the RPR, the existing fences which interfere with the new fence location shall be removed by the Contractor as a part of the construction work unless such removal is listed as a separate item in the bid schedule. All holes remaining after post and stump removal shall be refilled with suitable soil, gravel, or other suitable material and compacted with tampers.

The cost of removing and disposing of the material shall not constitute a pay item and shall be considered incidental to fence construction.

**162-3.3 Installing posts.** All posts shall be set in concrete at the required dimension and depth and at the spacing shown on the plans.

The concrete shall be thoroughly compacted around the posts by tamping or vibrating and shall have a smooth finish slightly higher than the ground and sloped to drain away from the posts. All posts shall be set plumb and to the required grade and alignment. No materials shall be installed on the posts, nor shall the posts be disturbed in any manner within seven (7) days after the individual post footing is completed.

Should rock be encountered at a depth less than the planned footing depth, a hole 2 inches (50 mm) larger than the greatest dimension of the posts shall be drilled to a depth of 12 inches (300 mm). After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of one part Portland cement and two parts mortar sand. Any remaining space above the rock shall be filled with concrete in the manner described above.

In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation shall be made for rock excavation.

**162-3.4 Installing top rails.** The top rail shall be continuous and shall pass through the post tops. The coupling used to join the top rail lengths shall allow for expansion.

**162-3.5 Installing braces.** Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts.

**162-3.6 Installing fabric.** The wire fabric shall be firmly attached to the posts and braced as shown on the plans. All wire shall be stretched taut and shall be installed to the required elevations. The fence shall generally follow the contour of the ground, with the bottom of the fence fabric no less than one inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Grading shall be performed where necessary to provide a neat appearance.
At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used and multiple strands of barbed wire stretched to span the opening below the fence. The vertical clearance between strands of barbed wire shall be 6 inches (150 mm) or less.

**162-3.7 Electrical grounds.** Electrical grounds shall be constructed where a power line passes over the fence and at 500 feet (150 m) intervals. The ground shall be accomplished with a copper clad rod 8 feet (2.4 m) long and a minimum of 5/8 inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction. The Contractor shall comply with FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.

**162-3.8 Cleaning up.** The Contractor shall remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. All disturbed areas shall be seeded per T-901.

## METHOD OF MEASUREMENT

**162-4.1** Chain-link fence will be measured for payment by the linear foot (meter). Measurement will be along the top of the fence from center to center of end posts, excluding the length occupied by gate openings.

**162-4.2** Gates will be measured as complete units.

**162-4.3** Chain-link fence and gate removal will be measured by the linear foot (meter). Measurement will be along the top of the fence from center to center of end posts, including the length occupied by gate openings.

## BASIS OF PAYMENT

**162-5.1** Payment for chain-link fence will be made at the contract unit price per linear foot (meter).

**162-5.2** Payment for vehicle or pedestrian gates will be made at the contract unit price for each gate. The price shall be full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor equipment, tools, and incidentals necessary to complete the item.

**162-5.3** Payment for chain-link fence and gate removal will be made at the contract unit price per linear foot (meter).

Payment will be made under:

| | | |
|---|---|---|
| Item F-162-1 | 8' Tall Chain Link Fence with Barbed Wire | per linear foot |
| Item F-162-2 | 10' Tall Chain Link Fence with Barbed Wire | per linear foot |
| Item F-162-3 | 16' Swing Gate, 10' Tall with Barbed Wire | per each |
| Item F-162-4 | Remove Chain Link Fence and Gates | per linear foot |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM A121 | Standard Specification for Metallic-Coated Carbon Steel Barbed Wire |
| ASTM A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A392 | Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric |
| ASTM A491 | Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric |
| ASTM A824 | Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence |
| ASTM B117 | Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM F668 | Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and other Organic Polymer Coated Steel Chain-Link Fence Fabric |
| ASTM F1043 | Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework |
| ASTM F1083 | Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures |
| ASTM F1183 | Standard Specification for Aluminum Alloy Chain Link Fence Fabric |
| ASTM F1345 | Standard Specification for Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Chain-Link Fence Fabric |
| ASTM G152 | Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |
| ASTM G153 | Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |
| ASTM G154 | Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials |
| ASTM G155 | Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials |

Federal Specifications (FED SPEC)

| | |
|---|---|
| FED SPEC RR-F-191/3 | Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces) |

FED SPEC RR-F-191/4 Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

FAA Standard

| | |
|---|---|
| FAA-STD-019 | Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment |

FAA Orders

| | |
|---|---|
| 5300.38 | AIP Handbook |

**END OF ITEM F-162**

# Item F-163 Wildlife Deterrent Fence Skirt

## DESCRIPTION

**163-1.1** This item shall consist of furnishing and installing chain-link fence fabric underground along an existing chain link fence or wildlife fabric fence, constructing concrete pads at existing fence gates in accordance with these specifications and the details shown on the drawings and in conformity with the lines and grades shown on the plans or established by the RPR.

## MATERIALS

**163-2.1 Chain link fence fabric.** The fabric shall be woven with a 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and shall meet the requirements of ASTM A392, Class II. The fabric shall be 5 feet (1.5 m) wide.

**163-2.2 Barbed wire.** Barbed wire shall be 3-strand 12-1/2 gauge zinc-coated wire with 4-point barbs and shall conform to the requirements of ASTM A121, Class 3.

**163-2.3 Wire ties and tension wires.** Wire fabric ties, wire ties, and tension wire for a given type of fabric shall be the same material as the fabric type. The tension wire shall be 7-gauge coiled spring wire coated similarly to the respective wire fabric being used.

Wire fabric ties shall be hog rings of galvanized steel wire not less than 9-gauge.

All material shall conform to Federal Specification RR-F-191/4.

**163-2.4 Miscellaneous fittings and hardware.** Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric shall be of commercial grade steel or better quality, wrought or cast as appropriate to the fitting or hardware, and sufficient in strength to provide a balanced design when used with fabric, posts, and wires of the specified quality. All steel fittings and hardware shall be protected with a zinc coating applied in conformance with ASTM A153.

**163-2.5 Concrete pads at gates.** Not used.

**163-2.6 Marking.** Each roll of fabric shall carry a tag showing the kind of base metal, kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings shall be identified as to manufacturer, kind of base metal, and kind of coating.

**163-2.7 Weed control material.** A commercially available weed control material shall be applied at the manufacturer's recommended rate.

## CONSTRUCTION METHODS

**163-3.1 General.** The fence shall be constructed in accordance with the details on the plans and as specified here using new materials. All work shall be performed in a workmanlike manner satisfactory to the RPR. The Contractor shall layout the fence line based on the plans. The work shall progress in this manner and at the close of the working day the newly constructed fence shall be tied to the existing fence.

**163-3.2 Clearing fence line.** All brush, stumps, logs, and other debris which would interfere with the construction of the fence shall be removed on either side of the fence centerline before starting fencing

operations. The material removed and disposed of shall not constitute a pay item and shall be considered incidental to fence construction.

**163-3.3 Installing fabric.** Excavate ground to the depth required for proper installation of the fabric. Obtain RPR's approval of depth of excavation before placing the wire fabric. Place the fabric and lap splice it to existing fence fabric and tie with wire ties at 2-foot (0.6-m) spacing. Cut wire fabric around fence post footing to allow proper placement. Backfill with native soil to original grade and compact. Gate concrete pads shall be installed at each gate or as shown on the plans.

**163-3.4 Weed control application.** Not used.

**163-3.5 Electrical grounds.** Electrical grounds shall be constructed where a power line passes over the fence. The ground shall be accomplished with a copper clad rod 8 feet (2.4 m) long and a minimum of 5/8 inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods shall not constitute a pay item and shall be considered incidental to fence construction. The Contractor shall comply with FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.

**163-3.6 Cleaning up.** The Contractor shall remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. All disturbed areas shall be seeded per Item T-901.

## METHOD OF MEASUREMENT

**163-4.1 Wildlife Deterrent Fence Skirt.** Wildlife deterrent fence skirt fabric will not be measured for payment, rather it will be considered incidental to installation of the new chain-link fence or installation of new chain-link fence items.

**163-4.2 Borrow fill material.** Borrow material for fill will be furnished by the Contractor. This item will not be measured for payment, rather it will be considered incidental to the wildlife deterrent fence skirt item.

## BASIS OF PAYMENT

**163-5.1** Wildlife Deterrent Fence Skirt is incidental to installation of new chain-link fence and no separate payment will be made.

**163-5.2** Borrow fill material is incidental to the wildlife deterrent fence skirt and no separate payment will be made.

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

| | |
|---|---|
| ASTM A121 | Standard Specification for Metallic-Coated Carbon Steel Barbed Wire |
| ASTM A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A392 | Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric |

Federal Specifications (FED SPEC)

FED SPEC RR-F-191/4 Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)

FAA Standard

FAA-STD-019 Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment

FAA Orders

5300/38 AIP Handbook

**END OF ITEM F-163**

# Item L-100 Airfield Lighting Control and Monitoring System

## DESCRIPTION

### 100-1.1 Qualifications.

**a.** The ALCMS manufacturer shall be ISO 9001 certified and provide a copy of the ISO certification during the submittal process.

**b.** The ALCMS manufacturer shall be listed in the FAA Approved Equipment List, AC 150/5345-53 (current edition) as a FAA approved supplier of L-890 Airfield Lighting Computer and Monitoring Systems in accordance with AC 150/5345-56 (current edition), and be a FAA approved supplier of L-827/L-829 Constant Current Regulator Monitors in accordance with AC 150/5345-10 (current edition).

**c.** The ALCMS manufacturer shall have a minimum of five (5) years of experience in computerized airfield lighting control and monitoring systems and shall have installed at least five (5) advanced control and monitoring systems of similar size and complexity to the one specified herein.

### 100-1.2 Project Scope.

**a.** The ALCMS Manufacturer shall furnish and commission a complete and functional computerized distributed control and monitoring airfield lighting system based on an industry standard Ethernet network.

**b.** This system shall include software, programming, computers, manuals, on-site commissioning, on-site testing, on-site training and any other materials, tools and equipment to provide a fully functional system to the satisfaction of the owner.

### 100-1.3 Project Coordination.

**a.** The ALCMS Manufacturer shall provide an experienced and qualified engineering, sales and service staff to support the contractor and airport throughout the installation and life of the system.

The project shall follow this basic cycle of events:

| | **Milestone** | **Description** |
|---|---|---|
| 1. | Submittal | The ALCMS Manufacturer shall submit ALCMS specifications to the contractor. |
| 2. | Submittal Review and Approval | Submittal is reviewed by the contractor, airport, and engineer(s). |
| 3. | Production Release | The ALCMS Manufacturer shall release approved system to manufacturing. |
| 4. | Demo CD<br>35% Software Completion | The ALCMS Manufacturer shall send to the contractor, airport, and engineers a Demo CD of the planned layout of the touchscreen that will be used for the control of the ALCMS system for review and approval. |
| 5. | Production | System is manufactured. |
| 6. | Production Testing | System is tested by the ALCMS Manufacturer. |
| 7. | Factory Acceptance Testing | System is available for Factory Acceptance Testing (FAT) |

| | | |
|---|---|---|
| | | witnessed by airport/owner. |
| 8. | Shipment of system | Approved system is shipped to installation site. |
| 9. | Installation | Contractor installs equipment and completes external wiring. |
| 10. | Commissioning | The ALCMS Manufacturer shall arrive at installation site to complete commissioning of system and verify contractor installation and wiring. |
| 11. | System Readiness Check | The ALCMS Manufacturer shall perform a system readiness check to verify proper operation of all equipment prior to cut over. |
| 12. | System Cut-over | The ALCMS Manufacturer and Contractor shall cut over the new system and bring it on-line and operational. |
| 13. | System Acceptance Testing | System is available for System Acceptance Testing (SAT) which shall be witnessed the by airport/owner and/or engineer. |
| 14. | Manuals / As-Built drawings | The ALCMS Manufacturer shall issue operator manuals, maintenance manuals and ATC manuals and final as-built drawings. |
| 15. | On-Site Training | The ALCMS Manufacturer shall complete on-site training of maintenance, Operations, and ATC personnel. |
| 16. | Final Owner Acceptance | Upon completion of all contractual requirements, system is accepted in writing by the airport/owner. |
| 17. | Warranty and Support | The ALCMS Manufacturer shall provide warranty and support per the contractual requirements. |

**100-1.4 Factory Acceptance Test (FAT).**

**a.** Before shipment, the ALCMS system shall be assembled as an operating system at the ALCMS Manufacturer's test facilities.

**b.** At a minimum, the FAT shall allow for one (1) day of testing and review, but may require additional time depending on the results of the testing.

**c.** The ALCMS Manufacturer shall incur the costs of setting up and performing the test excluding airport/owner and engineer related travel and accommodations.

**d.** During the FAT, minor software comments shall be finalized and incorporated into the final system.

**100-1.5 Contractor Installation Requirements.**

**a.** The installing contractor shall be responsible for the physical installation of all associated ALCMS components. At a minimum, this includes the Constant Current Regulators (CCRs), computer cabinets, touchscreen control stations, field wiring, Ethernet radios, and Distributed Control and Monitoring Units (DCMU).

**b.** The Contractor shall furnish, install, relocate, connect and test all equipment, equipment accessories, conduit cables, wires, buses, grounds and support necessary to insure a complete and operable electrical distribution facility for the airport lighting system as specified in the submittal package.

**c.** The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction.

**1. Wire and Connections.**

**i.** The Contractor shall make all necessary electrical connections at each location in accordance with the ALCMS manufacturer's wiring diagrams.

**ii.** All wires called out in the drawings associated with equipment that is to be controlled or monitored should be pulled, terminated, tested, and dressed at the appropriate terminal blocks and at the associated equipment.

**iii.** The Contractor shall leave sufficient extra wire length on each control/monitoring lead to make future changes in connections at the terminal block.

**2. Marking and Labeling.**

**i.** All equipment, control wires, terminal blocks, etc., shall be tagged, marked or labeled as specified below:

- Wire Identification: The Contractor shall furnish and install labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks.
- Wire labels shall be of the self-sticking, pre-printed type and of the manufacturer's recommended size for the wire involved. Identification markings designated in the plans shall be followed.
- Tags shall be nonferrous metal or plastic. Each tag shall be securely tied to the proper wire by a nonmetallic cord or plastic wire tie.

**3. Installation of Data Cables.**

**i.** The Contractor shall install, terminate and test all data cables required for the project. This includes all of the following components: Data cables, terminal cabinets and jumper cables.

**ii.** All associated data cables shall be tested upon completion of the cable installation and termination of connectors.

**iii.** Tests shall include verification of point-point continuity of each wire.

**iv.** All test data shall be recorded and included in a test report that shall be submitted to the Engineer for approval.

**v.** Commissioning of the system shall not begin until all test reports are submitted and approved and a copy provided to ALCMS Manufacturer.

**4. Contractor Fiber Optic Communication Equipment Installation.**

**i.** The Contractor shall install, terminate and test all fiber optic communications required for the project. This includes all of the following components:

- Fiber optic cable
- Fiber optic patch panels
- Fiber optic jumper cables
- Fiber connectors / couplings
- Fiber junction boxes

**ii.** Installation of the fiber optic communication equipment shall be done by a trained and qualified fiber optic specialist.

**iii.** The qualifications of the company and specialist that installs the fiber optic equipment shall be submitted to the Engineer for approval.

**iv.** All associated fiber optic equipment including fiber cables, splices and jumper cables shall be tested upon completion of the fiber cable installation and termination of connectors.
**v.** Tests shall include verification that the dB loss is within acceptable limits versus the distance of the fiber pull.
**vi.** All test data shall be recorded and included in a test report that shall be submitted to the airport / owner for approval.
**vii.** Commissioning of the system shall not begin until all test reports have been submitted and approved.

**5. Contractor Hard-wire Data Cable Installation.**

**i.** The Contractor shall install, terminate and test all hard-wire communications required for the project. This includes all of the following components:
- ALCMS manufacturer specified data cable
- Data cable termination panels
- Data cable jumper cables
- Connectors / couplings
- Junction boxes

**ii.** Installation of the data cable shall be done by a trained and qualified specialist.
**iii.** All associated cabling, splices and jumper cable shall be tested upon completion of the cable installation and termination of connectors.
**iv.** Tests shall include verification that the signal strength loss is within acceptable limits versus the distance of the cable pull.
**v.** All test data shall be recorded and included in a test report that shall be submitted to the airport / owner for approval.
**vi.** Commissioning of the system shall not begin until all test reports have been submitted and approved.

**6. Contractor Wireless Communication Equipment Installation.**

**i.** The antenna and lightning protection shall be provided by the ALCMS manufacturer.

**ii.** The antenna mast shall be provided and installed by the electrical contractor.

**iii.** The supply, installation and termination of the interconnecting cable (between the antenna and wireless communication equipment) and associated equipment including connectors and couplings shall be the responsibility of the electrical contractor.

**iv.** The Contractor shall install and terminate all wireless communication equipment required for the project. This includes all of the following components:

- Ethernet radio(s)
- Mast(s)
- Lightning arrestors
- Ground connections
- CAT 6A Ethernet cable (Run between ethernet radio and computer)

**v.** Installation of the wireless communication equipment shall be done by a trained and qualified RF specialist.

**vi.** The qualifications of the company and specialist that installs the wireless communication equipment shall be submitted to the Engineer for approval.

**vii.** All associated RF equipment, including antennas and RF cables, shall be tested upon completion of the cable installation and termination of connectors.

**viii.** All test data shall be recorded and included in a test report that shall be submitted to the airport / owner for approval.

**ix.** Commissioning of the system shall not begin until all test reports have been submitted and approved by the ALCMS manufacturer.

**100-1.6 ALCMS Manufacturer Commissioning.**

**a.** ALCMS Manufacturer shall perform the following installation and commissioning tasks:

**1.** Verify Contractor connections including power, control and monitoring.
**2.** Verify proper labeling of equipment.
**3.** Verify communication connections.
**4.** Perform system testing including control, monitoring and diagnostics.
**5.** Training on ALCMS related equipment.
**6.** Perform System Acceptance Testing (SAT).

**100-1.7 System Acceptance Test (SAT).**

**a.** Following the final installation and commissioning of the system, the ALCMS Manufacturer shall perform a demonstration of the system performance. This demonstration shall include the following:

**1.** Lighting control functions
**2.** Monitoring functions
**3.** Alarm functions
**4.** Print and Display functions

**b.** The ALCMS Manufacturer shall develop a SAT test plan in accordance with the specifications and issue this to the contractor for approval from the Engineer.

**c.** The SAT shall be witnessed by owner representatives, the contractor and the engineer.

**100-1.8 Manuals.**

**a. Maintenance Manuals.**

**1.** The ALCMS Manufacturer shall provide six (6) hard copies of the operation and maintenance manuals that are hard-covered and suitable for daily operation and maintenance of the system. The manuals shall include the following information:

**i.** Operational overview and system description

**ii.** Graphical User Interface (GUI) Screen operation

**iii.** System Block Diagram

**iv.** Detailed external wiring diagrams (Electrical Contractor wiring)

**v.** Detailed input/output terminal diagrams

**vi.** Detailed assembly drawings and wiring diagrams

**vii.** Original Equipment Manufacturer (OEM) Manuals

**2.** The manuals shall be spiral bound or supplied in 3-ring binders. The cover of each binder shall be labeled with all project-related information.

**b. FAA Air Traffic Control Manuals.**

**1.** The ALCMS Manufacturer shall provide six (6) hard copies of the operation manuals for Air Traffic Controller (ATC) use. The manuals shall be hard-covered and suitable for daily operation of the system. At a minimum, the manuals shall include the following information:

**i.** Touchscreen operation (graphical user interface)

**ii.** Touchscreen maintenance (i.e. calibration)

**2.** The manuals shall be spiral bound or supplied in 3-ring binders. The cover of each binder shall be labeled with all project-related information.

**100-1.9 As-Installed Drawings.**

**a.** The ALCMS Manufacturer shall provide six (6) hard copies of As-Installed drawings after system acceptance. The As-Installed drawings shall include the following information:

**1.** System Block Diagram (1-line drawings)
**2.** System External Wiring Diagrams
**3.** Assembly Drawings
**4.** Assembly Wiring Diagrams

**b.** The As-Installed drawings shall be 11" X 17" in size and shall be bound or supplied in 3-ring binders. The cover of each binder shall be labeled with all project-related information.

**100-1.10 On-Site Training.**

**a.** The ALCMS Manufacturer shall provide to the contractor a final training course syllabus and training schedule thirty (30) days before on-site training. The contractor shall provide this information to the Engineer and airport upon receipt.

**b.** All training sessions shall be held in a facility provided by the airport. This facility should have tables, chairs, projection screen and sufficient space to lay out manuals and drawings. The ALCMS Manufacturer shall provide all required visual aids and projectors.

**1. FAA Training**

**i.** FAA Air Traffic Control should designate a Training Coordinator that shall be responsible for scheduling and organizing on-site training for their personnel. In addition, this coordinator shall be responsible for training other personnel that were absent or unable to attend the training sessions.

**ii.** The ALCMS Manufacturer shall provide two (2), 1-hour User Training Class for Air Traffic Control (ATC) personnel. ATC Training Coordinator should be present for both classes. This training shall include discussion and review of the following:

- ALCMS General System Overview
- Touchscreen Operations
- Using the Control System (GUI)
- Command and Control Sequences
- Alarm and Warning Messages
- Failsafe Conditions
- Granting Local Control to the Vault

**iii.** Training classes for FAA ATC personnel should be limited to a maximum of 4-6 people per class.

**2. Maintenance Training.**

**i.** Maintenance should designate a Training Coordinator that shall be responsible for scheduling and organizing on-site training for their personnel. In addition, this coordinator shall be responsible for training other personnel that were absent or unable to attend the training sessions.

**ii.** The ALCMS Manufacturer shall provide two (2), 8 hour (one day) training classes for maintenance personnel. This training shall include discussion and review of the following:

- System Block Diagram
- System Assemblies and Wiring Diagrams
- Touchscreen Operation
- Graphical User Interface (GUI) Screens
- Maintenance and Troubleshooting
- Granting Local Control to the Vault
- Power Up and Power Down Sequences
- Failsafe Operations
- Implementing Airfield Lighting Changes
- Maintenance Report Generation

**iii.** Training classes for maintenance personnel should be limited to a maximum of 4-6 people per class.

**100-1.11 Owner System Acceptance and Warranty Start Date.**

**a.** Upon successful completion of the SAT and on-site training the owner shall issue the ALCMS Manufacturer a written notice of system acceptance within five (5) working days.

**b.** The date the final acceptance letter is received or five (5) days following successful completion of the SAT (whichever occurs first) represents the start of the warranty period. Please refer to the Warranty section for more information regarding the ALCMS warranty guarantee.

**100-1.12 System Warranty.**

**a.** All equipment shall be warranted against defects in workmanship, hardware and software for a period of one (1) year from owner system acceptance.

**c.** During this time period the ALCMS manufacturer shall provide all parts, labor and technical support with the following conditions:

**1.** The manufacturer shall correct by repair or replacement, equipment or parts which fail because of mechanical, electrical or physical defects, provided that the goods have been properly handled and stored prior to installation, properly installed and properly operated after installation.

**2.** The manufacturer may examine any goods upon which a claim is made in the same condition as when defect therein is discovered and may require the return of the goods to establish any claim.

**3.** The manufacturer's liability under no circumstances shall exceed the contract price of goods claimed to be defective.

**4.** Any returns under this guarantee are to be on a transportation charge prepaid basis.

**100-1.13 System Service and Support.**

**a.** The ALCMS Manufacturer shall provide technical assistance and support for a period of (2) years following owner system acceptance.

**b.** The ALCMS Manufacturer shall provide a 7 day a week / 24 hours a day support phone line.

**c.** The ALCMS Manufacturer shall provide technical phone support within four (4) hours of the initial call.

**d.** The ALCMS Manufacturer shall provide free phone consultation and technical support as required during the service and support period and if necessary shall be on-site within 24 hours.

**e.** At the request of the airport/owner, the ALCMS Manufacturer shall provide information about preventative maintenance programs and extended warranty packages.

**100-1.14 Spare Parts.**

**a.** A spare parts package shall be included as part of the bid to the contractor.

**b.** At a minimum, the spare parts package shall include the following components:

| Qty | Part Number | Description |
|---|---|---|
| 1 | | Touchscreen |
| 3 | | Distributed Control and Monitoring Equipment (DCMU) Main Board |
| 3 | | Current / Voltage Module (CVM) |
| 3 | | Insulation Resistance Module (IRM) |
| 2 | | Ethernet Fiber Optic Transceiver |
| 2 | | Network Interface Card (NIC) |
| 1 | | Redundant PC |

## EQUIPMENT AND MATERIALS

**100-2.1 General**

**a.** The ALCMS system shall be based on a network ready system that operates within a Windows 10 operating environment at a minimum.

**b.** The ALCMS shall be a PC-based system and shall not use any Programmable Logic Controller (PLC) components for control or monitoring.

**c.** An Ethernet communication network shall be used for data transfer between the electrical vault, control tower, and maintenance center.

**d.** The computerized airfield lighting control and monitoring system shall consist of the following major hardware components:

**1.** Touchscreen control station located in the tower cab.
**2.** Tower computer subsystem consisting of an industrial enclosure, industrial tower computer and communication equipment.
**3.** Vault computer subsystem consisting of an industrial enclosure, industrial vault computer, communication equipment, and a redundant vault control / monitoring network.
**4.** Maintenance Center subsystem consisting of an industrial computer and LaserJet printer.

**e.** Within the airfield lighting vault shall be a distributed control and monitoring system which operates on a redundant communication network.

**f.** The Distributed Control and Monitoring Equipment (DCME) shall be of a distributed nature that shall be installed locally at each controlled element within the vault. The vault industrial computer communicates to each DCME via CAT6a cable.

**g.** The system shall monitor the operation of the various lighting systems per AC 150/5345-10 (current edition) requirements.

**100-2.2 Communication Network**

**a.** The tower, electrical vault, and maintenance center computer shall communicate with each other via two or more of the following communication networks.

**1. Fiber Optic Ethernet, single mode**

**i.** (2) Fiber optic ethernet communication links shall be provided between the tower and vault

**ii.** Supply, installation, termination and testing of the fiber optic cable and associated equipment including fiber cable, fiber patch panels, fiber patch cables, LC connectors and couplings shall be the responsibility of the electrical contractor.

**iii.** The fiber optic cables shall be single mode, 1310nm wavelength, 9/125 micron fiber cable. Each fiber communication link requires 2 fibers.
**iv.** All fiber optic cable shall be terminated at a fiber optic patch panel within each subsystem before being terminated at the communication equipment.
**v.** Fiber optic jumper cables shall be provided from the fiber patch panel to the computer equipment enclosures.
**vi.** Fiber optic cable shall be terminated with LC style connectors at the fiber optic transceivers located within the vault computer cabinet.
**vii.** Fiber optic runs shall not exceed 20km (65,000 feet) when using single mode fiber optic cable.
**viii.** Fiber optic runs shall be direct point-point runs with no splices when possible.
**ix.** Fifty percent (50%) spare fiber cables shall be pulled and terminated within the fiber optic patch panel for future expansion.
**x.** Upon completion of fiber optic installation, the contractor shall provide airport/owner with a test report which shall include dB loss test results.

**2. Wireless Ethernet.**

**i.** A wireless ethernet link shall be provided between the vault and tower as a backup means of communication. Additional wireless ethernet links shall be provided between the vault and maintenance center, and the vault and airport beacon.
**ii.** The antennas shall be provided by the ALCMS manufacturer.
**iii.** The antenna masts shall be provided and installed by the electrical contractor.
**iv.** The supply, installation and termination of the interconnecting cable (between the antenna and wireless communication equipment) and associated equipment including connectors and couplings shall be the responsibility of the electrical contractor.

**v.** All Wireless Network components shall be provided by the ALCMS manufacturer and meet the following minimum specifications:

- Shall be a single module, defined as a self-contained RF device with both radio circuitry and antennae incorporated into a single outdoor unit.
- Shall be enclosed in an outdoor UV stabilized plastic body with a wind survivability of 125 mph and wind loading of no more than 11 lbf at this wind speed.
- Shall use the 5.0 GHz ISM band and allow license-free operation.
- Shall provide the ability to generate detailed spectral analysis to help identify noise signatures and plan and fine-tune network links to minimize interference and optimize channel selection.
- Shall be capable of 10, 20, 30, 40, 50, 60, and 80 Mhz wide channels and achieve a data rate of 8 x 256QAM.
- Shall have gigabit Ethernet interfaces and be powered by 24V, 0.5A Power-over-Ethernet (PoE).
- Shall have an operating temperature range from -40 to 176 deg. F. and operating humidity range from 5 to 95% Noncondensing.
- Shall be designed to be install outdoors, passing MIL-STD-810 G Method 506.5 for wind-driven rain tests.
- The Wireless Network radios shall use dual linear polarized internal antennae.

**vi.** The ALCMS manufacturer's Wireless Network system shall be based on direct line-of-site communication between all radios.

**vii.** No repeaters shall be necessary.

### 3. Virtual Private Network (VPN)

**i.** The VPN shall ensure maximum security by requiring 2 factor authentication.

**ii.** All VPN traffic with the Internet shall be encrypted utilizing an x.509 certificate.

**iii.** The VPN connection shall comply with all the security standards stipulated by the National Institute of Standards and Technology for encryption and key negotiation.

**iv.** Ethernet connection with access to the Internet shall be provided by the Airport at the maintenance center.

**100-2.3 Computers.**

**a. Industrial Computer**

**1.** All the industrial-grade computers in the ALCMS system are identical and have the following technical specifications**:**

| ID | Options | Description |
|---|---|---|
| a) | Type | Industrial-grade computer.<br>Arista or approved equal |
| b) | Processor Type | Intel ATOM E3845 ® Processor (or greater) |
| c) | Processor Clock Rate | 1.9 GHz or better |
| d) | Memory Capacity | 4 GB DDR3 800 RAM (Memory Clock 200 MHz, Data Rate 800 MT/s) (or greater) |
| e) | Hard Disk<br>**See details to follow** | 120GByte Solid State Flash Drive<br>**Standard rotating drives are not acceptable** |
| f) | Compact Flash Card<br>**See details to follow** | 16 GB CFast Card (or greater)<br>**Stores compressed "Ghost" image of Flash Drive, airport specific programs and configurations** |
| g) | Video (Integrated) | SVGA, 8MB VRAM, minimum support 1280 x 1024 |
| h) | Operating System | Window 10 |

Table 1: Industrial Computer Specifications

**2.** All the industrial-grade computers in the ALCMS system shall be designed using a fanless box pc architecture.

**i.** The computer shall contain passive cooling, no moving fans.

**ii.** The computer shall be powered by 24VDC.

**iii.** The computer shall be either desk, wall, or DIN-rail mountable.

**iv.** The computer shall be rated IP50 or greater.

**b. Flash Drive.**

**1.** The computer shall use a solid state Flash Drive (no moving parts) and it shall be a Samsung or approved equal.
**2.** The Flash Drive shall have a minimum of storage capacity of 64GB SSD.
**3.** The Flash Drive shall operate at temperatures from 0 degrees C to +70 degrees C
**4.** The Flash Drive shall have 1000G operating shock and 15G operating vibration rating.
**5.** The drive shall have a MTBF of greater than 1,000,000 hours.
**6.** The Flash Drive shall have a manufacture warranty of 3 years.
**7.** The Flash Drive shall store the operating system and any programs that require erase/read/write cycles.
**8.** Flash Drive specification sheets shall be provided with Submittal showing proposed flash drive meets specification requirements.

**c. Compact Flash Card**

1. The computer shall use an external Compact Flash (CF) Card which shall be installed using an internal 3 ½" bay with a compact flash card reader.
2. The CF Card shall be a minimum of 4 GB
3. No erase and/or write cycles shall occur to the Compact Flash Card.
4. The CF Card shall store programs and configuration files that are only read during power-up. These files should be the airport specific programs and configurations.
5. The CF Card shall contain a "Ghost" image (Exact image of the original drive) of the Flash Drive which allows for easy Flash Drive replacement and repair.

**d. Flash Drive Service / Repair**

1. The touchscreen computer shall be able to be rebuilt using a new blank Flash Drive or blank standard Hard Drive.
2. The computer shall be able to boot from the CF Card and execute a "Ghost" image rebuild program.
3. The rebuild program shall extract and copy the "Ghost" image, all configurations and airport specific programs from the CF Card to the new blank Flash Drive.
4. Upon completion of the rebuild program, the touchscreen computer shall be able to be rebooted and be completely operational.

**e. Vault Computer**

1. The vault computer shall be capable of independently carrying out the following functions:

**i.** Decode all commands received and transfer them to the corresponding Distributed Control and Monitoring Equipment (DCME) unit for execution.

**ii.** Interrogate all the DCME units to determine the status of the Constant Current Regulators (CCRs) and other controllable items.

**iii.** Transfer the status of the CCRs and other controllable items to the control tower computer and maintenance center computer.

**iv.** Continuously check for proper operation of all the communication links connected to the computer.

**v.** Continuously check for proper operation of the vault distributed control and monitoring network.

**vi.** Duplicate the tower control and graphical displays for allowing authorized control from the vaults.

**vii.** The vault shall also duplicate the maintenance center status information.

**viii.** Provide hard copies of real-time and historical information on the status of the airfield lighting systems and other controlled and monitored items.

**ix.** The vault computer application shall not be able to initiate lighting commands unless the control tower authorizes control to Vault.

**x.** Vault computer shall house the system database.

**f. Tower Computer**

**1.** The Tower computer shall be capable of independently carrying out the following functions:

**i.** Receive commands from the Touchscreen control station and transfer lighting control commands to the vault for execution.

**ii.** Receive the airfield lighting status information from the vault and transfer the status to the Touchscreen display.

**g. Maintenance Computer**

**1.** The maintenance computer shall be capable of independently carrying out the following functions:

**i.** Provide real-time and historical information on the status of the airfield lighting systems and other controlled and monitored items.

**ii.** Provide information as to the time, type, location and nature of system problems, alarms or warnings.

**iii.** Provide hard copies of real-time and historical information on the status of the airfield lighting systems and other controlled and monitored items.

**iv.** The Maintenance center computer application shall not be able to initiate lighting commands unless the control Tower authorizes control to the maintenance center.

**v.** Provide remote dial-in and diagnostics for the ALCMS Manufacturer technical service personnel.

**vi.**

**h. Wireless Roaming Maintenance Computer – Wireless Service**

1. Two (2) wireless maintenance computers shall be provided to allow for remote connection to the ALCMS system from a maintenance vehicle or other remote location.
2. The maintenance computer shall be a notebook computer with docking station to allow the unit to be docked and re-charged.
3. The computer shall provide real-time control and monitoring of the airfield lighting system when in range of the wireless coverage.
4. The wireless computer shall use wireless Ethernet to provide wireless roaming access to the ALCMS system.
5. The ALCMS manufacturer shall provide all peripherals, computer cards and wireless equipment required to configure the computer to work with the Ethernet network.

**i. Roaming Maintenance Laptop Computer Technical Specifications**

A. All roaming maintenance computers in the ALCMS system shall have the following technical specifications:

| ID | Options | Description |
|---|---|---|

| | | |
|---|---|---|
| a) | Type | Panasonic Toughbook or equal |
| b) | Processor Type | Intel Pentium® 4 |
| c) | Processor Clock Rate | 2.5 GHz or better |
| d) | Memory Capacity | 1 GB RAM or better |
| e) | Hard Disk Drive | 32 Gb or larger |
| f) | 2 X USB Ports | 2 USB Ports |
| g) | Cache Memory | L2 512KB |
| h) | CD-ROM | 52X |
| i) | Video (Integrated) | SVGA, 8MB VRAM, minimum support 1280 x 1024 |
| j) | LCD Screen | 12” diagonal viewing area or greater |
| k) | Operating System | Windows 10 Pro |
| l) | Connectivity | 802.11n or greater, available 3g/4g connection |

Table 2: Laptop Computer Specifications

**100-2.4 Touchscreen Control Stations.**

**a. Technical Specifications**

**1.** Touchscreen technology shall be integrated into the display monitor and shall have the following technical specifications:

| | **Options** | **Description** |
|---|---|---|
| a. | Technology | AccuTouch Five-Wire Resistive |
| b. | Screen Resolution | 1280 x 1024 (minimum) |
| c. | Touch Resolution | Touchpoint controller resolution of 4096 x 4096 |
| d. | Input method | Finger or stylus |
| e. | Positional Accuracy | Standard deviation error less than 0.080” (2mm) |
| f. | Agency Approvals | UL, CE, FCC Class A |
| g. | Chemical Resistance | The active area of the Touchscreen is resistant to all chemicals that do not affect glass. |
| h. | Temperature / Relative Humidity | -10°C to 50°C at 90% RH, non-condensing |
| i. | Electrostatic | Per EN 61000-4-2 |
| j. | Light Transmission | 80% +/- 5% at 550nm wavelength |
| k. | Face Plate | Anti-glare |
| l. | Expected Life | 35 million touches in one location without failure |

**b. Touchscreen Monitor Specifications**

**1.** The touchscreen video graphics display shall have the following technical specifications:

Standard Screen

| | **Options** | **Description** |
|---|---|---|
| a. | Type | LCD, active matrix |
| b. | Mounting | Flush Mount |

| | | |
|---|---|---|
| c. | Size | 17” Diagonal viewable<br>4:3 aspect ratio |
| d. | Screen Resolution | 1280 x 1024 (minimum) |

**2.** The tower touchscreen video graphics display shall be designed to be installed flush into a cabinet console. A minimum four (4) inch clearance must be provided around the perimeter of the touchscreen installation to allow for proper heat dissipation.

**3.** Installation of the touchscreen and all cabinetry work and modifications is the responsibility of the Contractor.

**4.** The Contractor shall install to match existing cabinet construction and color.

**100-2.5 Subsystem Equipment.**

**a. Tower Equipment**

**1. Computer**

**i.** The Tower computer shall be a 19” industrial rack-mount type.

**ii.** The computer shall meet previously specified technical requirements.

**iii.** 120 VAC, uninterruptible power shall be supplied to the computer and the Tower Touchscreen Monitor.

**2. Touchscreen Monitors**

**i.** Touchscreen shall be mounted in the Tower cab console.

**ii.** 120 VAC, uninterruptible power shall be supplied to the Tower Touchscreen.

**3. Video / USB Communication Extension Equipment**

**i.** A Video / USB Communication extension Receiver box shall be installed in conjunction with the Touchscreen display under the tower cab console.

**ii.** A Video / USB Communication extension Transmitter box shall be installed in conjunction with the tower computer located in the tower sub-junction.

**iii.** The video extension transmitter shall allow for simultaneous connection of the local service monitor and the remote touchscreen monitor.

**iv.** A shielded category 6a communications cable shall be installed between the Receiver and Transmitter. A spare shielded CAT 6a cable shall also be installed, for use as a future troubleshooting aid.

**4. Service Monitor (LCD)**

**i.** The service display shall use a 19” LCD monitor.

**ii.** The monitor shall be located on a shelf within the tower equipment enclosure.

**iii.** 120 VAC, uninterruptible power shall be supplied to the monitor.

**5. Audible Alarm assembly**

**i.** An audible speaker shall be installed in conjunction with the Touchscreen display.

**ii.** An audio and volume control cable shall be installed between the audible speaker and the tower computer located in the tower sub-junction.

**6. Uninterruptible Power System**

**i.** An uninterruptible power system (UPS) shall be provided for supporting power to the equipment.

**ii.** The UPS shall be capable of supplying full load power for 10 minutes after loss of main input power.

**iii.** The UPS shall be a 19" rack-mount unit installed in the tower computer equipment enclosure.

**7. Industrial Enclosures**

**i.** A NEMA 12 industrial enclosure shall be provided for housing associated tower computer equipment.
**ii.** The enclosure shall be designed for indoor use to provide protection against dust, dirt, dripping water and external condensation of non-corrosive liquids.
**iii.** The enclosure shall be an industry standard 19" rack-mount type enclosure.
**iv.** The industrial enclosure shall include a pagoda top with exhaust fan and ventilation kit for proper convection cooling.
**v.** The environmental conditions within the area of the enclosure installation shall not exceed 122°F (50°C) or fall below 32°F (0°C).
**vi.** Installation of the tower equipment shall be the responsibility of the electrical contractor. The electrical contractor with the airport, FAA technical operations, and FAA tower chief shall coordinate the installation and location of the tower equipment.

**b. Vault Equipment**

**1. Computer**

**i.** The vault computer shall be a 19" industrial rack-mount type.

**ii.** The computer shall meet previously specified technical requirements.

**iii.** 120 VAC, uninterruptible power shall be supplied to the computer.

**2. Monitor (LCD)**

**i.** The service display shall use a 19" LCD monitor.

**ii.** The monitor shall be located on a shelf within the vault equipment enclosure.

**iii.** 120 VAC, uninterruptible power shall be supplied to the monitor.

**3. Uninterruptible Power System: Vault Computer Equipment**

**i.** An uninterruptible power system (UPS) shall be provided for supporting power to the vault equipment.

**ii.** The UPS shall be capable of supplying full load power for 10 minutes after loss of main input power.

**iii.** The UPS shall be a 19” rack-mount unit installed in the vault computer equipment enclosure.

**4. Uninterruptible Power System: DCME Control and Monitoring Equipment**

**i.** An uninterruptible power system (UPS) shall be provided for supporting power to the DCME equipment.

**ii.** The UPS shall be capable of supplying full load power for 10 minutes after loss of main input power.

**iii.** The UPS shall be a 19” rack-mount unit installed in the vault computer equipment enclosure.

**5. Industrial Enclosures**

**i.** A NEMA 12 industrial enclosure shall be provided for housing associated vault computer equipment.

**ii.** The enclosure is designed for indoor use to provide protection against dust, dirt, dripping water, and external condensation of non-corrosive liquids.

**iii.** The enclosure shall be an industry standard 19” rack-mount type enclosure.

**iv.** The industrial enclosure shall include a pagoda top with exhaust fan and ventilation kit for proper convection cooling.

**v.** The environmental conditions within the area of the enclosure installation shall not exceed 122°F (50°C) or fall below 32°F (0°C).

**vi.** Vault rack shall include a housekeeping manufactured to fit the rack enclosure.

**c. Maintenance Equipment**

**1. Computers**

**i.** The maintenance center computer shall be a 19” industrial rack-mount type and meet previously specified technical requirements.

**ii.** There shall be a 17” desktop LCD monitor in the maintenance center.

**2. Uninterruptible Power System**

**i.** An uninterruptible power system (UPS) shall be provided for supporting power to the maintenance center computer equipment.

**ii.** The UPS shall be capable of supplying full load power for 10 minutes after loss of main input power.

**3. Printer**

**i.** The printer shall be a black and white LaserJet printer.

**4. Industrial Enclosures**

**i.** A NEMA 12 industrial enclosure shall be provided for housing associated vault computer equipment.

**ii.** The enclosure is designed for indoor use to provide protection against dust, dirt, dripping water, and external condensation of non-corrosive liquids.

**iii.** The enclosure shall be an industry standard 19” “half-height” rack-mount type enclosure.

**iv.** The industrial enclosure shall include a pagoda top with exhaust fan and ventilation kit for proper convection cooling.

**v.** The environmental conditions within the area of the enclosure installation shall not exceed 122°F (50°C) or fall below 32°F (0°C).

**5.** Installation of the maintenance center equipment shall be the responsibility of the electrical contractor. The electrical contractor with the airport shall coordinate the installation and locations of the maintenance center equipment.

**6.** Any computer desks or tables required for the maintenance center computer equipment shall be provided by the airport. No additional office equipment shall be provided.

**100-2.6 Distributed Control Equipment.**

**a.** The control and monitoring equipment shall be of a distributed nature and shall not be PLC based.

**b.** The DCME units shall be installed locally at each device (i.e. CCR) which requires control and/or monitoring within the airfield lighting electrical vault.

**1. General**

**i.** Each CCR shall include an integral DCME and each controllable item shall be connected to a DCME.

**ii.** The DCME shall be a microprocessor-based module that includes all of the communication, control commands, input/output connections and failsafe functionality.

**iii.** The DCME shall communicate via a redundant (2 independent communication links) communications network.

**iv.** Connections to the communication network shall be via quick disconnect terminal connectors that can easily be plugged and unplugged from the communication equipment.

**v.** The DCME shall communicate back to the Vault computer via either of the networks.

**vi.** Removal of any DCME units from the vault network shall not affect the operation of the ALCMS system.

**vii.** The DCME shall be a universal device that can be used on any type of CCR and/or controlled element from any manufacturer.

**viii.** To minimize spare parts needs, each DCME shall be identical and have interchangeable components.

**ix.** The DCME unit shall provide optical isolation from all high voltage equipment including the CCR output current, CCR output voltage and CCR input voltage.

**x.** All high voltage interfaces to the DCME unit shall be via fiber optic cable.

**2. Redundant Vault Control Network**

**i.** The DCME redundant communication network shall use at least two (2) independent communication network cables installed in the electrical vault.

**ii.** The vault network shall use two (2) CAT6a redundant, radial distributed ethernet cables.

**iii.** The network shall be used to control and monitor all the various controllable elements located within the vault such as CCRs, ATS, and Generator.

**iv.** Any malfunction in one network shall not affect the operation of the other communications network.

**v.** Any malfunction in one of the DCME communication ports shall transfer communication to the remaining port without affecting system functions.

**3. Overview of Operation [Externally Mounted DCME]**

**i.** Each DCME unit shall have a unique factory set address and a field programmable communication address.

**ii.** Each DCME unit shall have a 7" easily readable, full color, touchscreen display.

**iii.** Each DCME unit shall be able to be fully configured from the front panel display, without the need for a separate PC and/or specialized software.

**iv.** The DCME receives commands via the vault network, executes those commands, and transfers back the status of the element to the vault computer.

**v.** The DCME shall perform the following functions:

- ON/OFF control as required by the controlled element (i.e. generator may only require ON/OFF control).
- Perform all failsafe functions.
- Communication via both networks to the vault computer.
- Self-diagnostic function to monitor for proper operation.
- Locally store all data and parameters specific to the controlled element.

**vi.** For maintenance purposes, the DCME shall have an internal ON/OFF switch and shall have a front hinged access door.

**4. Overview of Operation [CCR Integrated DCME]**

**i.** Each DCME unit shall have a unique factory set address and a field programmable communication address.

**ii.** Each DCME unit shall have a 7" easily readable, full color, touchscreen display.

**iii.** Each DCME unit shall be able to be fully configured from the front panel display, without the need for a separate PC and/or specialized software.

**iv.** The DCME receives commands via the vault network, executes those commands, and transfers back the status of the element to the vault computer.

**v.** The DCME shall perform the following functions:

- Brightness setting control of the CCRs or ON/OFF control as required by the controlled element (i.e. generator may only require ON/OFF control).
- Perform all failsafe functions.
- Communication via both networks to the vault computer.
- Self-diagnostic function to monitor for proper operation.
- Locally store all data and parameters specific to the controlled element.

**5. Basic DCME components [Externally Mounted DCME]**

The DCME shall consist of the following basic components and functions:

**i.** Default Input / Output Board

- Shall provide eight (6) mechanical latching output points. These control points shall also be self-monitored and provide back-indication to the Vault computer verifying proper execution of the control command.

- Shall provide eight (3) optical-isolated input points.
- Shall provide quick-disconnect terminal blocks that can be easily plugged and unplugged from the I/O board.

**ii.** Main Board
- Shall provide redundant communication network circuitry.
- Shall provide quick-disconnect terminal blocks for redundant communication network connections.
- Receives and transmits data to the vault computer.

**iii.** Digital Display
- Shall provide visual display of all DCME monitored values on one screen (Power, communications and monitoring).
- Brightness Step: display indicating the commanded step of the CCR.
- Communication status: display indicating the status of channel A of the redundant communication network.

**iv.** Current and Voltage Monitoring Unit
- Shall provide real-time measurements of the output current of the CCR
- Shall provide real-time measurements of the output voltage of the CCR

**6. Basic DCME components [CCR Integrated DCME]**

The DCME shall consist of the following basic components and functions:

**i.** Monitor Board
- Shall provide redundant communication network circuitry.
- Shall provide quick-disconnect terminal blocks for redundant communication network connections.
- Receives and transmits data to the vault computer.

**ii.** Digital Display
- Shall provide visual display of all DCME monitored values on one screen (Power, communications and monitoring).
- Brightness Step: display indicating the commanded step of the CCR.
- Communication status: display indicating the status of channel A of the redundant communication network.

**100-2.7 Distributed Monitoring Equipment.**

The DCME shall provide the following minimum monitoring:

**a. L-827/9 Monitoring (Internally mounted)**

**1.** The DCME unit shall provide full FAA L-827/9 monitoring per FAA AC 150/5345-10 (current edition).

**2.** The DCME shall include the monitoring board and provide the following information for each CCR:

**i.** Loss of input power to the CCR.
**ii.** CCR shutdown by open-circuit / over-current protective devices.
**iii.** Drop of more than 10% in the CCR VA load.
**iv.** Failure of the CCR to deliver the selected output current.

**v.** The number of burnt-out lamps (L-850, L-852, L-861, L-861 series) in each series circuit. For best accuracy, all lamps/transformers are the same wattage and no film disc cutouts are used.
**vi.** Remote / Local status of the CCR.
**vii.** Actual CCR output current
**viii.** Actual CCR output voltage
**ix.** Actual CCR output load wattage (W)
**x.** Actual CCR output load Volts-Amps (VA)
**xi.** Actual CCR input voltage

**3.** The DCME digital display shall provide local indication of the CCR status including
**i.** Remote/Local: display indicating the status of the remote / local switch of the CCR.
**ii.** Primary Power: display indicating the status of the input power to the CCR.
**iii.** Over current: display indicating over current, protective shutdown.
**iv.** Open circuit: display indicating open circuit status.

**4.** The DCME shall interface to the regulator control board of the CCR. The regulator control board shall collect current and voltage information and provide this information to the DCME. The regulator control board shall meet the following minimum requirements.
**i.** Collects analog current and voltage samples at a high sample rate of 50,000 samples/second.
**ii.** Transmits current and voltage samples to the DCME.

**b. Insulation Resistance Monitoring**

**1.** The DCME unit shall provide insulation resistance monitoring as an integral component of the DCME unit.
**2.** The IRMS is capable of automatically or manually monitoring and reporting the insulation resistance value of the series circuit cabling (one IRMS per circuit).
**3.** The measured resistance shall be displayed locally at the DCME digital display.
**4.** The DCME unit shall be capable of reading and recording resistance values from less than 20k Ohms to 2G Ohms.
**5.** The DCME shall interface to an external insulation resistance module (IRM). The IRM shall meet the following minimum requirements.
**i.** Collects insulation resistance samples.
**ii.** Transmits insulation resistance samples to the DCME.
**iii.** Provide digital fiber optical isolation between the DCME and the output of the CCR.
**iv.** Quick disconnect fiber optic connections for interfacing to the DCME.

*Fiber optic communication shall be used between the IRM board and the DCME.* The ALCMS manufacturer shall provide the fiber optic cables between the IRM board and the DCME.

**6.** The IRMS system shall be capable of taking resistance readings on circuits that are energized or de-energized. This shall allow the system to be used as a troubleshooting tool for assisting in locating circuit faults.

**7.** The IRMS system shall provide database record keeping that allows for graphical trend analysis of the insulation resistance readings.

**8.** The IRMS shall provide configurable insulation resistance warning and alarm limit notification to the system.

**9.** The IRMS shall be able to be configured for a minimum of two (2) reading times per day.

**10.** The IRMS shall be able to be configured to take readings hourly, daily, weekly or monthly.

**11.** All user programmable variables shall be able to be changed at any specified computer within the ALCMS system.

**12.** All the IRMS data shall be viewable either as real-time or as historical data at any specified computer location. The IRMS information shall be available at all times and shall not require any special transfer of data between the IRMS system and the control system (since the IRMS is an integral component of the ALCMS).

**100-2.8 Latching Failsafe**

**a.** Each DCME unit shall provide a self-contained latching failsafe feature that shall perform the following functions:

**1.** Ensure default operation of the airport lighting, even if the entire airport lighting control system is not functioning.

**2.** Display the commands sent by the computer to the CCRs and/or to the other controllable items.

**3.** Adaptable to each CCR regardless of internal or external control voltage.

**4.** Permits maintenance of portions of the control system, without changing the operational status of the lighting system.

**b.** The failsafe mode of each DCME unit shall be "Smart Failsafe" (Latching) mode.
**c.** If the CCR was switched ON before the failure, it shall remain ON at the same brightness level.
**d.** If the CCR was switched OFF before the failure, it shall be commanded ON to a predetermined level.
**e.** Failsafe shall be able to be bypassed by selecting the CCR locally to any desired brightness level.

**1. Failsafe Technical Specifications**

**2.** The failsafe system shall operate independently of the computer, providing failsafe interfacing to the CCR and/or other controllable elements.
**3.** The failsafe system shall be based on electromechanical latching relays with the following characteristics:

| **Specification** | **Rating** |
|---|---|
| Maximum switching voltage | 240VAC, 125VDC |
| Nominal switching capacity | 8A / 250VAC<br>5A / 30VDC |
| Rated current (resistive) | 1A |
| Operational Life | Mechanical $5X10^7$<br>Electrical $10^5$ |
| Protection | IP67 (protection against ingress of dust and water in harmful quantities) |

**4.** Mode of Operation

**1.** The commands executed by the DCME to switch the CCR and/or controllable element shall be momentary commands.
**2.** The control commands shall be mechanically latched upon execution.

**3.** Failure of the DCME and/or loss of communication to the network shall not change the status of the airport lighting.

### 100-2.9 DCME Mounting

The DCME equipment shall be mounted integral to each ADB Safegate CCR.

## GRAPHICAL USER INTERFACE OPERATION

### 100-3.1 General

**a.** The Tower Touchscreen display shall control and monitor the airfield lighting system. The display shall show real-time information on the operational status of the airfield lighting systems.

**b.** The Touchscreen control stations shall consist of multiple Touchscreen 'pages' each with a specific function. These Touchscreen 'pages' are defined as follows:

**1.** **Preset:** Consists of pre-defined preset buttons used to simplify airfield lighting control commands.

**2.** **Runway Lights:** Consists of runway control touch buttons used to individually control runway circuits. Multiple runway pages may be necessary for airports with several runways.

**3.** **Taxiway Lights:** Consists of taxiway control touch buttons used to individually control taxiway circuits if required.

**4.** **Utilities:** Consists of miscellaneous functions for calibrating the Touchscreen, granting lighting control to other locations, setting the date and time, etc.

**c.** All preset and control configurations shall be defined by the airport/owner in conjunction with Air Traffic Control requirements.

**d.** The ALCMS manufacturer shall provide preset tables to be used by the airport/owner to define the configuration settings.

**100-3.2 Overview of Operation**

**a.** Airfield lighting control commands are entered into the system by touching the corresponding touch button on the Touchscreen video display. When a command is entered, the Touchscreen shall respond by graphically displaying the button as being depressed and change the button color.

**b.** The associated circuit graphics shall alternately flash indicating the airfield lighting section that shall be affected when this command is "confirmed".

**c.** Once confirmed, the Tower Touchscreen shall register the command, generate a data instruction and transmit the command to the vault computer for implementation. The command is also simultaneously transmitted to the maintenance computer and all other computers connected to the network.

**d.** The tower Touchscreen shall receive confirmation from the vault that the corresponding equipment has responded to the control command and displays the current system status on the Touchscreen display.

**e.** In the event that communications is lost between the tower and vault, an alarm is indicated at each computer location.

**f.** In the event of a predefined alarm condition, the effected airfield lighting circuit graphic shall flash red and an audible alarm tone shall alert operators to the alarm condition.

**100-3.3 ALCMS Alarm Functions**

**a. Touchscreen Audible Alarm**

1. The audible alarm shall sound at each Touchscreen display when an alarm condition occurs. In addition, the 'ALARM ACK' button shall flash and the associated airfield circuit graphics shall change to red.

2. The audible alarm shall stop automatically after three (3) seconds unless the 'ALARM ACK' button is pressed.

3. If the alarm is not acknowledged, the audible shall cease for sixty (60) seconds while the 'ALARM ACK' continues to flash. If the 'ALARM ACK' is still not pressed after the sixty (60) seconds, the audible shall sound again for three (3) seconds.

4. This sequence shall repeat indefinitely until the alarm is acknowledged.

**b. Circuit Alarms**

1. The ALCMS shall continuously monitor the status of all of the circuits per the monitoring requirements as specified previously.
2. If there are any monitoring discrepancies (i.e. incorrect CCR output current, loss of primary power) an alarm shall be generated at the Touchscreen display for the associated circuit.

**100-3.4 Touchscreen Command Sequences**

**a.** The Touchscreen control station shall allow the airfield lighting circuits to be controlled individually (i.e. RWY Edge) or as a group based on preset tables (See following section).

**b.** Each control command shall require two distinct operator actions in order for the command to initiate any state changes in the airfield lighting. The command sequence shall be as follows:

1. ***Select circuit:*** Operator selects the desired circuit to be changed.

2. ***Select intensity:*** Operator selects the desired brightness step that the circuit is to be changed to.

3. ***Graphics flash:*** The graphics associated with the selected circuit shall begin to flash visually indicating to the operator the airfield lighting section that is going to be affected by the command.

4. ***Confirm/Reject:*** Operator selects the 'CONFIRM' button to accept the selection and initiate the lighting change. Operator selects the 'REJECT' button to cancel the selections and make another selection.

**100-3.5 Touchscreen Preset Sequences**

**a.** The Touchscreen control station shall allow simultaneous airfield lighting circuit changes to be accomplished using preset lighting sequences.

**b.** The preset lighting sequences shall be defined by the airport in airfield lighting preset tables.

**c.** Each preset lighting change shall be based on the following operator inputs:

**1.** **Active Runway Selection:** Operator selects the runway(s) that shall be active. This is based on runway direction (i.e. "RWY 9")

**2.** **Day/Night Setting:** Operator selects the day/night setting. The day/night setting shall control the intensity of the circuits.

**3.** **Visibility:** Operator selects a single visibility setting that is based upon the current airport visibility.

**4.** **Confirm/Reject:** Operator selects the 'CONFIRM' button to accept the preset selections and initiate the lighting change. Operator selects the 'REJECT' button to cancel the selections and make another preset selection.

**d.** Upon confirmation of the preset selections, the intensity of all the circuits associated with the preset condition shall automatically change to match the visibility requirement.

**e.** The preset visibility setting of the CCRs is based on FAA document 7110.65 (current version). Presets shall also be coordinated with the airport and the FAA to properly define airfield lighting operational usage.

**f.** The visibility settings shall include Intensity and Preset Invalid monitoring. This indicates when a preset or intensity setting on the airfield is different than the selected preset intensity.

**g.** According to FAA document 7110.65 (current version), the visibility settings for the 5-step CCRs shall be based on the following table:

| Visibility | Day (Brightness step) | Night (Brightness step) |
|---|---|---|
| Less than 1 mile | 5 | 4 |
| 1 to but not including 2 miles | 4 | 3 |
| 2 to but not including 3 miles | 3 | 3 |
| 3 to 5 miles inclusive | 0 | 2 |
| More than 5 miles | 0 | 1 |

Table 2: 5-step Regulators

**h.** According to FAA document 7110.65 (current version), the visibility settings for the 3-step CCRs shall be based on the following table:

| Visibility | Day (Brightness step) | Night (Brightness step) |
|---|---|---|
| Less than 1 mile | 3 | 2 |
| 1 to but not including 2 miles | 0 | 1 |
| 2 to but not including 3 miles | 0 | 1 |
| 3 to 5 miles inclusive | 0 | 1 |
| More than 5 miles | 0 | 1 |

Table 3: 3-step Regulators

**i.** According to FAA document 7110.65J, the visibility settings for the Rotating Beacon shall be based on the following table:

| Visibility | Day (Brightness step) | Night (Brightness step) |
|---|---|---|
| Less than 1 mile | ON | ON |
| 1 to but not including 2 miles | ON | ON |
| 2 to but not including 3 miles | ON | ON |
| 3 to 5 miles inclusive | OFF | ON |
| More than 5 miles | OFF | ON |

Table 5: Beacon

### 100-3.6 Graphical Airport Pictorial

**a.** The ALCMS display screens shall display a graphical pictorial representation of the airport runways, taxiways and other requested airport features.

**b.** When there is a change in lighting system status, the appropriate graphical detail shall indicate the status by changing color.

**c.** The circuit intensity display colors shall be represented as seen in the legend as follows.

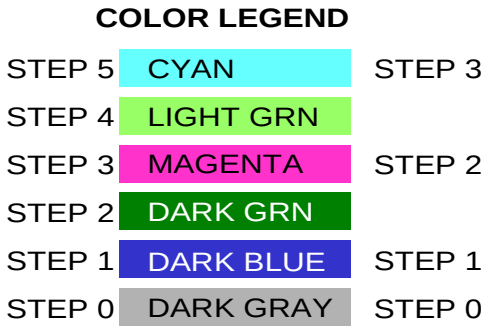



Figure 1: Brightness Step Color Legend

**d.** The status monitoring display colors shall be represented as seen in the legend as follows. This includes ATS monitoring, generator monitoring and communications monitoring:

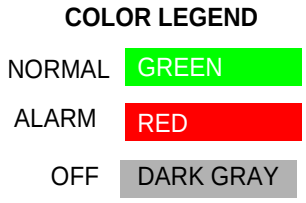



Figure 2: Status Monitoring Color Legend

**100-3.7 Vault Emergency Generator Control**

**a.** The ALCMS shall provide control of the emergency diesel generator located in the airfield lighting vault from all of the control stations.

**b.** The ALCMS shall provide one (1) optically isolated, dry-contact output point at the Vault.

**c.** The ALCMS shall close the output to command the generator ON and open the output to turn the generator OFF.

**d.** Locating and wiring of the output points within the Generator equipment shall be completed by the Contractor in coordination with the airport/engineer and equipment manufacturer (if required).

**100-3.8 Vault Automatic Transfer Switch (ATS) and Generator Monitoring**

**a.** The ALCMS shall provide the optically isolated digital inputs to monitor the following feedback points:

1. Utility Available
2. Utility On-line
3. Generator Available
4. Generator On-line
5. Generator Alarm

**b.** Locating and wiring of the monitoring points within the ATS and generator equipment shall be completed by the contractor in coordination with the equipment manufacturer.

**100-3.9 Beacon Control**

**a.** The ALCMS shall provide control of the rotating beacon from the vault ALCMS node via an ethernet radio link.

**b.** The ALCMS shall provide one (1) optically isolated, dry-contact output point at the beacon control enclosure. The contact shall be rated 1A at 120Vac.

**c.** The ALCMS shall close the output to command the beacon ON and open the output to turn the beacon OFF.

**d.** A current sensor shall be provided by the ALCMS manufacturer provide a contact closure feedback point.

**e.** The beacon control and monitoring interface equipment, including ethernet I/O device, terminal blocks, internal wiring, relay, and contactor shall be provided complete, installed within an equipment enclosure by the ALCMS manufacturer.

**f.** Locating and wiring of the output points within the Beacon equipment shall be completed by the Contractor in coordination with the engineer and equipment manufacturer.

## METHOD OF MEASUREMENT

**100-4.1**

**a.** The new hardware furnished by the designated Airfield Lighting Control and Monitoring System manufacturer as required by the drawings and these specifications shall be measured for payment as part of this specification. Hardware includes, but is not limited to, tower touchscreen, tower equipment assembly and enclosure, tower communication equipment, UPS, computer, vault equipment assembly and enclosure, vault communications equipment, UPSs, computer, distributed control units, maintenance equipment assembly and enclosure, maintenance communications equipment, computer, portable laptops, spare equipment package and beacon communications and control equipment.

**b.** All work performed by the Contractor to support the installation of the Airfield Lighting Control and Monitoring System shall also be measured for payment as part of this lump sum. Measurement shall include work by the Contractor to assist vendor with the system commissioning, recording of training sessions, escorting, as well as badging, fees and any incidental required to complete the work.

Costs incurred by the system vendor while on-site such as commissioning, testing, training, provision of drawings and manuals as well as travel shall be included for payment under this item.

**c.** Costs incurred by the system vendor to host the Factory Acceptance Testing shall be included for payment under this item.

**d.** All material, equipment and labor to complete the fiber optic link between the Vault and ATCT shall not be included in this lump sum but shall be paid under other items of these specifications. Excluded work includes, but is not limited to, relocated fiber optic cable, patch panel, and terminations.B B B BVBBBBBBBBBBVBV

**e.** BBVBBVBB to complete the installation as shown on the Contract Drawings shall be included as part of this pay item.

**f.** All work in the maintenance building to support the ALCMS installation including cable and conduit installation, cored holes, firestopping, cable terminations and tagging and all incidentals to complete the installation as shown on the Contract Drawings shall be included as part of this pay item.

**g.** All work at the beacon high mast pole to support the ALCMS installation including control equipment enclosure, ethernet radio, cable, terminations, and all incidentals to complete the installation as shown on the Contract Drawings shall be included as part of this pay item. Removal and replacement of the beacon control equipment shall be paid for under other items of these specifications.

## BASIS OF PAYMENT

**100-5.1**

Payment shall be made at the Lump Sum price for the complete and accepted ALCMS Equipment and Service. This price shall be full compensation for all services and items included in the designated allowance item, preparation, assembly, delivery, transportation, and installation of materials and equipment, labor, equipment, tools, and incidentals necessary to complete this item.

Payment shall be made under:

Item L-100-1 Furnish and Install ALCMS by System Manufacturer - Per Lump Sum

**END OF ITEM L-100**

# Item L-105 Alterations, Removal and Demolition

## GENERAL

**105-1.1 Definitions.**

**a.** Alterations shall mean any change or rearrangement in the component parts, including structural, mechanical, electrical systems, or internal or external arrangements of an existing structure.

**b.** Removal shall mean the dismantling of existing materials, components, equipment, and utilities. Removed items shall be handled, prepared for storage, transported to storage areas as specified.

**c.** Demolition shall mean the dismantling and disposal of existing materials, components, equipment, and utilities which cannot or will not be reused or which will have no salvage value, or which cannot be reused due to unrepairable damage caused by age, non-demolition related reasons, etc. All demolished items not designated to be turned over to the Owner shall be disposed of in a safe manner and at a location acceptable to the Owner.

All items to be turned over to the Owner shall be properly enclosed or boxed to protect the items from damage and transported by the Contractor to a location on the airport, designated by the RPR and/or the Owner.

The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow the work schedule established in the plans and specifications or as directed by the RPR. The system shall be installed in accordance with the National Electrical Code and/or local code requirements.

The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways which must remain open. The Contractor shall check all temporary circuits before dark each day to assure that they are operational. In the event of failure, the Contractor shall immediately take steps to restore operation.

**105-1.2 Condition of existing facilities.** The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

Whenever the scope of work requires connection to an existing circuit, the circuit's insulation resistance shall be tested, in the presence of the Owner and RPR. The Contractor shall record the results on the forms included in these specifications. When the circuit is returned to its final condition, the circuit's insulation resistance shall be checked again in the presence of the Owner and RPR. The Contractor shall record the results on the forms included in these specifications. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in Operation and Maintenance Manuals.

**105-1.3 Classification of removed/demolished items**. Existing materials and equipment indicated to be removed shall be presented to the owner for salvage. All materials and equipment not selected for salvage

shall become the property of the contractor and be disposed of legally off site.

**a. Reusable salvaged items.** Salvaged materials and equipment shall be reused in the work as described on the contract drawings, unless noted otherwise.

Items not selected for salvage shall be legally disposed of off the airport property. The cost of such disposal shall be included in the cost of other items of work.

**b. Retained salvage items.** Salvaged materials and equipment to be retained by the Owner, but not reused in the work shall be turned over to the Airport at a site at the facility to be determined by the RPR. Retained salvaged items shall be stored on the Airport property where indicated by the RPR.

## CONSTRUCTION METHODS

**105-2.1 Disconnecting utilities.** Prior to the start of work, the necessary utilities serving each area of alteration or removal will be shut off and sealed by the Contractor, as required. The contractor shall properly lockout/tagout all circuits prior to performing work.

**105-2.2 Removal work.** The Contractor shall not disturb the existing construction beyond that indicated or necessary for installation of new work.

**105-2.3 Salvageable materials and equipment.** The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. Removed items which are to be retained by the Owner shall be carefully handled, stored, and protected. The Contractor shall provide identification tags on all items boxed or placed in containers, indicating the type, size, and quantity of materials. All materials and equipment shall be secured to a pallet. Components shall be protected from moisture with shrink wrap. Contractor shall provide a type written list of all items on each pallet. Equipment list shall identify each item per pallet. Coordinate with the RPR and the airport to deliver pallets to location at the airport as determined by the airport salvageable equipment returned to the airport shall include; light fixtures, isolation transformers, and guidance signs

**105-2.4 Electrical Equipment and Fixtures**. Not used.

**105-2.5 Reaming of Existing Ducts or Conduits**. Not used.

## DEMOLITION AND DISPOSAL

**105-3.1 Demolition Operations.** Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Owner and to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities.

The sequence of operations shall be such that maximum protection from inclement weather will be provided for materials and equipment located in partially dismantled structures.

**105-3.2 Maintaining Traffic.** Demolition operations and removal of debris to disposal areas shall be conducted to ensure minimum interference with runways, taxiways, aprons, roads, streets, walks, and other facilities occupied and used by the Owner.

Streets, walks, runways, taxiways and other facilities occupied and used by the Owner shall not be closed or obstructed without written permission from the Owner.

**105-3.3 Reference Standards Requirements.** Demolition operations shall be conducted to ensure the safety of persons in accordance with ANSI A 10.6 Safety Requirements for Demolition.

Demolition shall be conducted in accordance with OSHA, State and local requirements.

**105-3.4 General Disposal.** The Contractor shall dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from demolition operations. Demolished materials shall not be stored or disposed of on Airport property.

**105-3.5 Removal from Owner Property.** Materials not selected for salvage shall be transported from Airport property and legally disposed of at no additional cost to the Owner. Permits and fees for disposal shall be paid by the Contractor.

## METHOD OF MEASUREMENT

**105-4.1** The quantity of cables removed from existing electrical ducts shall be measured by the linear foot along the length of each duct from which they are removed. Multiple cables in a duct shall be measured by the length of the duct, shall be removed in a single pull and shall be measured once for all cables contained in the length of the duct. Cables removed from a duct shall not be measured individually. Any other removals required shall be considered incidental to the bid items provided. Measurement for this item shall not include slack.

No separate measurement or payment will be made for cables removed from within building perimeters. All cables removed from within building perimeters shall be measured and payed for under other items of these specifications

**105-4.2** The Contractor shall be compensated for "Demolition of Existing ALCMS System" on a lump sum basis. This shall consist of the demolition, removal, and disposal of the existing equipment, conduit and cables associated with the removal of the obsolete system as shown on the Contract Drawings. Demolition of all components located within the existing lighting vault, ATCT, maintenance Center and Beacon location shall be measured as part of the lump sum for this item.

## BASIS OF PAYMENT

**105-5.1** Payment for Cable Removal will be made at the contract unit price per linear foot as accepted by the RPR. This price shall be full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work. It shall also include the installation of a new pull wire.

**105-5.2** Payment for "Demolition of Existing ALCMS System" will be made at the contract lump sum price for the complete demolition, removal, and disposal of existing equipment, conduit, wiring, and incidentals as shown on the Contract Drawings and as accepted by the RPR. This price shall be full compensation for furnishing all materials and for all preparation and assembly of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment shall be made under:

| | |
|---|---|
| L-105-1 | Cable Removal - per linear foot |
| L-105-2 | Demolition of Existing ALCMS System -per lump sum |

**END OF ITEM L-105**

# Item L-108 Underground Power Cable for Airports

## DESCRIPTION

**108-1.1** This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. ~~It includes excavation and backfill of trench for direct-buried cables only.~~ Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the RPR. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

## EQUIPMENT AND MATERIALS

### 108-2.1 General.

**a.** Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the RPR.

**c.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

**d.** All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**e.** The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. `The Contractor's submittals shall be electronically submitted in pdf format.` The RPR reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

**f.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least `twelve (12) months` from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in

new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

**108-2.2 Cable.** Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. ~~Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 [ Type B, Type C ], 5,000 volts, non-shielded, with [ ethylene propylene insulation, cross-linked polyethylene insulation ]~~. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

**108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods).** Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet (2.54 m) long and 3/4 inch (19 mm) in diameter.

**108-2.4 Cable connections.** In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

**a. The cast splice.** A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

**b. The field-attached plug-in splice.** Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

**c. The factory-molded plug-in splice.** Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

**d. The taped or heat-shrink splice.** Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

**108-2.5 Splicer qualifications.** Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the RPR proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

**108-2.6 Concrete. [** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. **]**

**108-2.7 Flowable backfill.** Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**108-2.8 Cable identification tags.** Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

**108-2.9 Tape.** Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

**108-2.10 Electrical coating.** Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

**108-2.11 Existing circuits.** Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the RPR. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the RPR. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the RPR. The Contractor shall record the results on forms acceptable to the RPR. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

**108-2.12 Detectable warning tape.** Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

## CONSTRUCTION METHODS

**108-3.1 General.** The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the RPR or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the RPR.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

**108-3.2 Installation in duct banks or conduits.** This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the RPR prior to any cable installation. If required by the RPR, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the RPR. Cable pull tensions shall be recorded by the Contractor and reviewed by the RPR. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the RPR, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

**108-3.3 Installation of direct-buried cable in trenches.** Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S-curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

**a. Trenching.** Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

- When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

**(1)** Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

**(2)** Trenching, etc., in cable areas shall then proceed, with approval of the RPR, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

**b. Backfilling.** After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall encompass all cables ; be 3 inches (75 mm) deep, loose measurement; and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement

and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent material. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be [ to a minimum of 100 percent of ASTM D1557 ][ backfill with controlled low strength material (CLSM) in accordance with P-153 ].

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the RPR. If not shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inches (200 mm) minimum below finished grade.

**c. Restoration.** Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the [ sodding ][ topsoiling ][ fertilizing ][ liming ][ seeding ][ sprigging ][ mulching ] as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be [ to a minimum of 100 percent of ASTM D1557 ][ backfill with controlled low strength material (CLSM) in accordance with P-153 ]. Restoration shall be considered incidental to the pay item of which it is a component part.

**108-3.4 Cable markers for direct-buried cable.** The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word "CABLE" and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Stencils shall be used for cable marker lettering; no hand lettering shall be permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, a concrete marker slab shall be installed to mark the location of the connection/splice. The Contractor shall impress the word "SPLICE" on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the RPR. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the RPR. Furnishing and installation of cable markers is incidental to the respective cable pay item.

**108-3.5 Splicing.** Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

**a. Cast splices.** These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer's instructions and to the satisfaction of the RPR.

**b. Field-attached plug-in splices.** These shall be assembled per the manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**c. Factory-molded plug-in splices.** These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

**d. Taped or heat-shrink splices.** A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminates prior to application.

**e. Assembly.** Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean

all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

**108-3.6 Bare counterpoise wire installation for lightning protection and grounding.** If shown on the plans or included in the job specifications, bare solid **[** #6 AWG **]** copper counterpoise wire shall be installed for lightning protection of the underground cables. The RPR shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

**a. Equipotential.** [ The counterpoise size is as shown on the plans. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

**(1)** The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

**(2)** The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

~~**b. Isolation.** [ Counterpoise size is as shown on the plans. The isolation method is an alternate method for use only with edge lights installed in turf and stabilized soils and raceways installed parallel to and adjacent to the edge of the pavement. NFPA 780 uses 15 feet to define "adjacent to".~~

~~The counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable being protected.~~

The counterpoise conductor shall be installed 8 inches (203 mm) minimum below grade. The counterpoise is not connected to the light base or mounting stake. An additional grounding electrode is required at each light base or mounting stake. The grounding electrode is bonded to the light base or mounting stake with a 6 AWG solid copper conductor.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Isolation Method of lightning protection.][not used]

**c. Common Installation requirements. [** When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

When a nonmetallic light base is used, the grounding electrode shall be bonded to the metallic light fixture or metallic base plate with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor. **]**

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

**d. Parallel Voltage Systems.** Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

**108-3.7 Counterpoise installation above multiple conduits and duct banks.** Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

**108-3.8 Counterpoise installation at existing duct banks.** When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

**108-3.9 Exothermic bonding.** Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the RPR. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the RPR, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

**a.** All slag shall be removed from welds.

**b.** Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.

**c.** If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

**108-3.10 Testing.** The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the RPR. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the RPR. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

**a.** Earth resistance testing methods shall be submitted to the RPR for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the RPR. All such testing shall be at the sole expense of the Contractor.

**b.** Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The RPR shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the RPR the following:

**c.** That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

**d.** That all affected circuits (existing and new) are free from unspecified grounds.

**e.** That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than **[** 50 **]** megohms. Verify continuity of all series airfield lighting circuits prior to energization.

**f.** That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

**g.** That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

**h.** That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

**i.** That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the RPR prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the RPR. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved "repair" procedures for items that have failed testing other than complete replacement.

***Ground Resistance Testing Procedure for Clamp-On Meter***

1. ***Install all counterpoise cable and associated ground rods as shown on Contract Documents. Exothermically weld each ground rod to cable. Each ground rod shall be minimum 10ft long by 3/4" minimum copper clad ground rod as shown on Contract Documents. Document location of each rod and provide unique number for each rod. Measure resistance to earth for each rod by attaching clamp on meter on rod below counterpoise wire. Document results on approved testing form in the presence of the Resident Engineer or Airport Representative. If value is higher than 25 ohms for any rod confirm results with Resident Engineer and proceed to step 2.***

2. ***For any ground rod not meeting a maximum value of 25 ohms, disconnect counterpoise wire, attach a coupling to top of rod, attach a new 10ft section of rod and drive into earth. Exothermically weld new rod to original using bare #6 AWG copper counterpoise wire. Measure resistance to earth of new 20' sectional ground rod by attaching clamp on meter on rod below counterpoise wire. If results are unsatisfactory, repeat procedure until rock is encountered, equipment is unable to drive the rod, or a total depth of 40ft is achieved. Proceed to step 3.***

3. ***Install another 10ft long by 3/4" ground rod in a 6" augered hole. Locate new rod 20' from other ground rods. Surround ground rod with an approved earthing enhancement material up to within 6" of top of rod. Connect the rods with a bare #6 AWG copper conductor via exothermic weld. Measure resistance to earth of new ground rod and document results.***

***Ground Resistance Testing Procedure for 3-Point Meter Fall-of-Potential Method***

1. ***Install ground rod as shown on Contract Documents. Each ground rod shall be minimum 10ft long by 3/4" minimum copper clad ground rod as shown on Contract Documents. Document location of each rod and provide unique number for each rod. Do not connect counterpoise cable to rod. Measure resistance to earth for each rod and document results on approved testing form in the presence of the Resident Engineer or Airport Representative. If value is higher than 25 ohms for any rod confirm results with Resident Engineer and proceed to step 2.***

2. ***For any ground rod not meeting a maximum value of 25 ohms, attach a coupling to top of rod, attach a new 10ft section of rod and drive into earth. Measure resistance to earth of new 20' sectional ground rod. If results are unsatisfactory, repeat procedure until rock is encountered, equipment is unable to drive the rod, or a total depth of 40ft is achieved. Measure resistance to earth of new ground rod and document results. Exothermically weld new rod to original using bare #6 AWG copper counterpoise wire. Proceed to step 3.***

3. ***Install another 10ft long by 3/4" ground rod in a 6" augered hole. Locate new rod 20' from other ground rods. Surround ground rod with an approved earthing enhancement material up to within 6" of top of rod. Measure resistance to earth of new ground rod and document results. Connect the rods with a bare #6 AWG bare copper conductor via exothermic weld***

## *METHOD OF MEASUREMENT*

***108-4.1 Cable. Cables and counterpoise wire installed in new or existing conduit shall be measured by the number of linear feet installed and accepted as satisfactory. Separate measurement shall be made for each cable installed in duct bank or conduit. The measurement for this item shall not include additional quantities required for slack. Cable slack is considered incidental to this item and is included in the Contractor's unit price. No separate measurement or payment will be made for cable slack or change in elevation. Counterpoise cable shall be measured separately for payment.***

***No separate measurement or payment will be made for cables installed within building perimeters. All cables installed within building perimeters shall be measured and payed for under other items of these specifications.***

***108-4.2 Ground rods shall be measured by each 10 foot section installed complete including exothermic connections. Augered hole and earthing enhancement material, if used, will not be measured separately for payment but will be included in the unit cost of a 10' ground rod.***

## *BASIS OF PAYMENT*

***108-5.1 Payment will be made at the contract unit price for bare counterpoise wire installed above ductbank, or cable and equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.***

***108-5.2 Payment will be made at the contract unit price for each 10-foot section of ground rod installed in place by the Contractor and accepted by the RPR. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals to complete this item.***

***Payment will be made under:***

| | |
|---|---|
| ***Item L-108-1*** | ***No. 8 AWG, 5 kV, L-824, Type C Cable, Installed in Duct Bank or Conduit - per linear foot*** |
| ***Item L-108-2*** | ***No. 6 AWG, Solid, Bare Copper Counterpoise Wire, Installed Above the Duct Bank or Conduit, Including Connections/Terminations - per linear foot*** |

***Item L-108-3 ¾" Dia. x 10' Copper Clad Steel Ground Rod – per each***

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

| | |
|---|---|
| AC 150/5340-26 | Maintenance of Airport Visual Aid Facilities |
| AC 150/5340-30 | Design and Installation Details for Airport Visual Aids |
| AC 150/5345-7 | Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits |
| AC 150/5345-26 | Specification for L-823 Plug and Receptacle, Cable Connectors |
| AC 150/5345-53 | Airport Lighting Equipment Certification Program |

Commercial Item Description

| | |
|---|---|
| A-A-59544A | Cable and Wire, Electrical (Power, Fixed Installation) |
| A-A-55809 | Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic |

ASTM International (ASTM)

| | |
|---|---|
| ASTM B3 | Standard Specification for Soft or Annealed Copper Wire |
| ASTM B8 | Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM B33 | Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes |
| ASTM D4388 | Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes |

Mil Spec

| | |
|---|---|
| MIL-PRF-23586F | Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical |
| MIL-I-24391 | Insulation Tape, Electrical, Plastic, Pressure Sensitive |

National Fire Protection Association (NFPA)

| | |
|---|---|
| NFPA-70 | National Electrical Code (NEC) |
| NFPA-780 | Standard for the Installation of Lightning Protection Systems |

American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

| | |
|---|---|
| ANSI/IEEE STD 81 | IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

Federal Aviation Administration Standard

| | |
|---|---|
| FAA STD-019E | Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment |

**END OF ITEM L-108**

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# Item L-110 Airport Underground Electrical Duct Banks and Conduits

## DESCRIPTION

**110-1.1** This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

## EQUIPMENT AND MATERIALS

### 110-2.1 General.

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the Engineer. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the Engineer and replaced with materials, that comply with these specifications, at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The Engineer reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**110-2.2 Steel conduit**. Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10-mil thick coat of asphaltum sealer or shall have a factory-bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mils of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

**110-2.3 Plastic conduit.** Plastic conduit and fittings-shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

**a.** Type I–Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.

**b.** Type II–Schedule 40 PVC suitable for either above ground or underground use.

**c.** Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

**d.** Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

**110-2.4 Split conduit**. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

**110-2.5 Conduit spacers**. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

**110-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures***. Where reinforced duct banks are specified, reinforcing steel shall conform to ASTM A615 Grade 60. Concrete and reinforcing steel are incidental to the respective pay item of which they are a component part.***

**110-2.7 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another Engineer approved third party certification program. Precast concrete structures shall conform to ASTM C478.

**110-2.8 Flowable backfill.** Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

**110-2.9 Detectable warning tape**. Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches wide. Detectable tape is incidental to the respective bid item.

***110-2.10 Pull Rope. Provide pull rope in all innerduct with minimum pull strength of 1250 pounds for outdoor applications and 900 pounds for indoor applications. The pull rope must extend 6 feet beyond the termination at each end.***

***110-2.11. Duct Plugs and Conduit Seals. Duct plugs and conduit/innerduct seals must be constructed of high impact plastic and fully corrosion resistant. Where fasteners are required they must be stainless steel. The duct plugs and conduit/innerduct seals must provide a water tight and gas tight installation. The devices must be easily installed or removed. The design must be of a split type configuration for retrofitting without any disassembly of existing conduits, innerducts, or cables. The compressible gaskets must be elastic, expandable, and durable for a permanent or temporary installation. Where conduits or innerducts contain pull ropes or cords the plug devices must have internal fastening loops to secure the rope or cord with slack within the conduit or innerduct for access at a later date during cable installations.***

- ***a. Blank Duct Plugs – Compression type mechanical plugs must be installed to seal spare conduits and spare innerducts of various sizes at all building/facility entrances and at the first manhole or handhole outside of the building/facility entrance. Plugs are to be sized per conduit inside diameters as required.***
- ***b. Innerduct Seals – Compression type mechanical seals must be provided to seal annular space around innerducts within conduits at all building entrances and at the first manhole or handhole outside of the building/facility entrance. Seals must be split type that can be installed around existing innerducts that are in place with or without cable.***
- ***c. Cable Seals – Compression type mechanical seals must be provided to seal all cable entrances in conduits and all cable entrances in innerduct at all building entrances and at the first manhole or handhole outside of the building/facility entrance. Fiber optic cable are installed individually, one cable of various diameter within one innerduct. 5KV or 600 volt power cables must have seals selected per total number of cables, diameter of cables, and conduit sizes as required.***

***110-2.12 Pulling Lubricant***

- ***a. A water based propylene glycol solution must be used when placing innerduct into ductbanks as well as placing cable into innerduct.***
- ***b. The lubricant must have characteristics intended for the pulling of MDPE and HDPE fiber sheaths through PVC innerduct.***
- ***c. Provide all fittings, terminations, connectors, etc. for a complete integrated raceway system.***
- ***d. Acceptable innerduct manufacturers are Carlon, EW&C and Innerduct.***

## CONSTRUCTION METHODS

**110-3.1 General**. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The Engineer shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches per 100 feet. On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches below the subgrade; in other locations, the top of the duct bank or underground conduit shall be not less than 18 inches below finished grade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor’s expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the Engineer of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet.

Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. Flowable backfill may alternatively be used

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the Engineer. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet.

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the Engineer, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the Engineer.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion control per federal, state, and local requirements is incidental to Item L-110.

Unless otherwise specified, excavated materials that are deemed by the Engineer to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the Engineer and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

**a.** Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

**b.** Trenching, etc., in cable areas shall then proceed with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

**110-3.2 Duct banks**. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet beyond the edges of the pavement or 3 feet beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches thick prior to its initial set. The Contractor shall space the conduits not less than 3 inches apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches wide tape, 8 inches minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch wide tape only for single conduit runs. Utilize the 6-inch wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the Engineer shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the Engineer.

**110-3.3 Conduits without concrete encasement**. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6.3 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

**110-3.4 Markers.** The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word "DUCT" or "CONDUIT" on each marker slab. Impression of letters shall be done in a manner, approved by the RPR, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the RPR. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the RPR. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

**110-3.5 Backfilling for conduits.** For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the RPR.

**110-3.6 Backfilling for duct banks**. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches in diameter. In addition to the requirements of Item P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet of duct bank or one work period’s construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

**110-3.7 Restoration**. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include topsoiling and seeding with fiber mulch as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

## METHOD OF MEASUREMENT

**110-4.1** Underground conduits and duct banks shall be measured by the linear feet of conduits and duct banks installed, including conduit, encasement, reinforcement, locator tape, trenching, coring/connection to structures, backfill with designated material, and restoration, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

***Backfill of ductbank sections installed in pavement shall not be included for measurement as part of the ductbank installation. This cost is covered as part of the civil construction. See civil specifications for payment.***

***Counterpoise wire is not included for measurement but is paid under another section of these specifications.***

## BASIS OF PAYMENT

**110-5.1** Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including conduit, trenching, concrete encasement, reinforcement, locator tape, coring/connection to structures, and backfill with the designated material. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

***Payment will be made under:***

| | | |
|---|---|---|
| ***Item L-110-1*** | ***Reinforced, Concrete Encased Schedule 40 PVC Electrical Conduit, 20-Way 4-inch, in Mill and Overlay Full Strength Pavement*** | ***Per Linear Foot*** |
| ***Item L-110-2*** | ***Concrete Encased Schedule 40 PVC Electrical Conduit, 20-Way 4-inch, in Turf*** | ***Per Linear Foot*** |
| ***Item L-110-3*** | ***Concrete Encased Schedule 40 PVC Electrical Ductbank, 8-Way 4-inch, in Turf*** | ***Per Linear Foot*** |
| ***Item L-110-4*** | ***Concrete Encased Schedule 40 PVC Electrical Conduit, 12-Way 4-inch, in Turf*** | ***Per Linear Foot*** |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circular (AC)

| | |
|---|---|
| AC 150/5340-30 | Design and Installation Details for Airport Visual Aids |
| AC 150/5345-53 | Airport Lighting Equipment Certification Program |

ASTM International (ASTM)

| | |
|---|---|
| ASTM A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |

National Fire Protection Association (NFPA)

| | |
|---|---|
| NFPA-70 | National Electrical Code (NEC) |

Underwriters Laboratories (UL)

| | |
|---|---|
| UL Standard 6 | Electrical Rigid Metal Conduit - Steel |
| UL Standard 514B | Conduit, Tubing, and Cable Fittings |
| UL Standard 514C | Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL Standard 1242 | Electrical Intermediate Metal Conduit Steel |
| UL Standard 651 | Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings |
| UL Standard 651A | Type EB and A Rigid PVC Conduit and HDPE Conduit |

**END OF ITEM L-110**

# Item L-115 Electrical Manholes and Junction Structures

## DESCRIPTION

**115-1.1** This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the RPR. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the RPR, including removal of existing manholes and junction structures as shown on the plans.

## EQUIPMENT AND MATERIALS

**115-2.1 General.**

**a.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the RPR.

**b.** Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

**c.** All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

**d.** The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications**.** The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

**e.** All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

**115-2.2 Concrete structures.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**115-2.3 Precast concrete structures.** Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand 100,000 lb aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the RPR shall be submitted by the Contractor to allow for a full evaluation by the RPR. The RPR shall review per the process defined in the General Provisions.

**115-2.4 Junction boxes.** Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes shall be provided with both internal and external ground lugs.

**115-2.5 Mortar.** The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

**115-2.6 Concrete.** Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

**115-2.7 Frames and covers.** The frames shall conform to one of the following requirements:

**a.** ASTM A48 Gray iron castings

**b.** ASTM A47 Malleable iron castings

**c.** ASTM A27 Steel castings

**d.** ASTM A283, Grade D Structural steel for grates and frames

**e.** ASTM A536 Ductile iron castings

**f.** ASTM A897 Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of 250 psi and maximum load of 100,000 lbs.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

**115-2.8 Ladders.** Not used.

**115-2.9 Reinforcing steel.** All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

**115-2.10 Bedding/special backfill.** Bedding or special backfill shall be as shown on the plans.

**115-2.11 Flowable backfill.** Not used.

**115-2.12 Cable trays.** Cable trays shall be of plastic**.** Cable trays shall be located as shown on the plans.

**115-2.13 Plastic conduit.** Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

**115-2.14 Conduit terminators.** Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

**115-2.15 Pulling-in irons.** Pulling-in irons shall be manufactured with 7/8-inch diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch diameter with an ultimate strength of 270,000 psi). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

**115-2.16 Ground rods.** Ground rods shall be one piece, copper clad steel**.** The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet long nor less than 5/8 inch in diameter.

## CONSTRUCTION METHODS

**115-3.1 Unclassified excavation.** It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the RPR without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the RPR. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the RPR. Structures shall be placed after the RPR has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the RPR as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

**115-3.2 Concrete structures.** Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

**115-3.3 Precast unit installations.** Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

**115-3.4 Placement and treatment of castings, frames and fittings.** All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the RPR and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the RPR and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor’s expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

**115-3.5 Installation of ladders.** Not used.

**115-3.6 Removal of sheeting and bracing.** In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The RPR may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

**115-3.7 Backfilling.** After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

Backfill shall not be placed against any structure until approval is given by the RPR. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the RPR establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the RPR may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

**115-3.8 Connection of duct banks.** To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

**115-3.9 Grounding.** A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtails shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

**115-3.10 Cleanup and repair.** After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer’s recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

**115-3.11 Restoration.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

**115-3.12 Inspection.** Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

**115-3.13 Manhole elevation adjustments.** Not used.

**115-3.14 Duct extension to existing ducts.** Not used.

## METHOD OF MEASUREMENT

**115-4.1** Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering:; sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing

## BASIS OF PAYMENT

**115-5.1** The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

| | |
|---|---|
| Item L-115-1 | Electrical Manhole 8’x10’, Aircraft Rated - Per Each |

## REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

| | |
|---|---|
| ANSI/IEEE STD 81 | IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |

Advisory Circular (AC)

| | |
|---|---|
| AC 150/5345-7 | Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits |

| | |
|---|---|
| AC 150/5345-26 | Specification for L-823 Plug and Receptacle, Cable Connectors |
| AC 150/5345-42 | Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories |
| AC 150/5340-30 | Design and Installation Details for Airport Visual Aids |
| AC 150/5345-53 | Airport Lighting Equipment Certification Program |

Commercial Item Description (CID)

| | |
|---|---|
| A-A 59544 | Cable and Wire, Electrical (Power, Fixed Installation) |

ASTM International (ASTM)

| | |
|---|---|
| ASTM A27 | Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A47 | Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A48 | Standard Specification for Gray Iron Castings |
| ASTM A123 | Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A283 | Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates |
| ASTM A536 | Standard Specification for Ductile Iron Castings |
| ASTM A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A897 | Standard Specification for Austempered Ductile Iron Castings |
| ASTM C144 | Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C206 | Standard Specification for Finishing Hydrated Lime |

FAA Engineering Brief (EB)

| | |
|---|---|
| EB #83 | In Pavement Light Fixture Bolts |

Mil Spec

| | |
|---|---|
| MIL-P-21035 | Paint High Zinc Dust Content, Galvanizing Repair |

National Fire Protection Association (NFPA)

| | |
|---|---|
| NFPA-70 | National Electrical Code (NEC) |

**END OF ITEM L-115**

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# Item 260526 Grounding and Bonding for Electrical Systems

## DESCRIPTION

### 260526-1.1 Related documents.

**a.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 260526-1.2 Summary.

**a.** Section includes grounding and bonding systems and equipment.

**b.** Section includes grounding and bonding systems and equipment, plus the following special applications:
**1.** Underground distribution grounding.
**2.** Ground bonding common with lightning protection system.
**3.** Foundation steel electrodes.

### 260526-1.3 Action Submittals.

**a.** Product Data: For each type of product indicated.

### 260526-1.4 Informational Submittals.

**a.** As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
**1.** Ground rods.
**2.** Ground rings.
**3.** Grounding arrangements and connections for separately derived systems.

**b.** Qualification Data: For testing agency and testing agency's field supervisor

**c.** Field quality-control reports.

### 260526-1.5 Closeout Submittals.

**a.** Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

**1.** In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

i. Instructions for periodic testing and inspection of grounding features at ground ring, and grounding connections for separately derived systems based on NETA MTS.

**1)** Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

**2)** Include recommended testing intervals.

**260526-1.6 Quality Assurance.**

**a.** Testing Agency Qualifications: Certified by NETA.

## EQUIPMENT AND MATERIALS

**260526-2.1 System Description.**

**a.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** Comply with UL 467 for grounding and bonding materials and equipment

**260526-2.2 Conductors.**

**a.** Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

**b.** Bare Copper Conductors:

**1.** Solid Conductors: ASTM B 3.

**2.** Stranded Conductors: ASTM B 8.

**3.** Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

**4.** Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

**c.** Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

**260526-2.3 Connectors.**

**a.** Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

**b.** Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

**c.** Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

**d.** Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

**e.** Cable-to-Cable Connectors: Compression type, copper or copper alloy.

**f.** Conduit Hubs: Mechanical type, terminal with threaded hub.

**g.** Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

**h.** U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

**260526-2.4 Grounding Electrodes.**

**a.** Ground Rods: Copper-clad steel, 3/4 inch by 10 feet (19 mm by 3 m).

## CONSTRUCTION METHODS

**260526-3.1 Applications.**

**a.** Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

**b.** Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
**1.** Bury at least 24 inches (600 mm) below grade.

**c.** Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
**1.** Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.

**d.** Conductor Terminations and Connections:
**1.** Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
**2.** Underground Connections: Welded connectors except as otherwise indicated.
**3.** Connections to Structural Steel: Welded connectors

**260526-3.2 Grounding at the service.**

**a.** Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

**260526-3.3 Grounding separately derived systems.**

**a.** Generator: Connect the equipment grounding conductor and the frame of the generator to the building grounding ring.

**260526-3.4 Grounding underground distribution system components.**

**a.** Comply with NFPA 70 grounding requirements.

**b.** Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

**c.** Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

**260526-3.5 Equipment grounding.**

**a.** Install insulated equipment grounding conductors with all feeders and branch circuits.

**b.** Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

**1.** Feeders and branch circuits.
**2.** Lighting circuits.
**3.** Receptacle circuits.
**4.** Single-phase motor and appliance branch circuits.
**5.** Three-phase motor and appliance branch circuits.
**6.** Flexible raceway runs.
**7.** Armored and metal-clad cable runs.

**b.** Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

**260526-3.6 Installation.**

**a.** Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

**b.** Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

**c.** Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.

**1.** Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

**d.** Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

**1.** Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
**2.** Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
**3.** Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

**e.** Grounding and Bonding for Piping:
**1.** Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

**f.** Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

**g.** Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.

**1.** Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
**2.** Bury ground ring not less than 5 feet from building's foundation.

**260526-3.7 Field Quality Control.**

**a.** Perform tests and inspections.

**b.** Tests and Inspections:

**1.** After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
**2.** Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
**3.** Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal at individual ground rods. Make tests at ground rods before any conductors are connected.
i. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

ii. Perform tests by fall-of-potential method according to IEEE 81.

**4.** Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

**c.** Grounding system will be considered defective if it does not pass tests and inspections.

**d.** Prepare test and inspection reports.

**e.** Report measured ground resistances that exceed the following values:

**1.** Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
**2.** Manhole Grounds: 10 ohms.

**f.** Excessive Ground Resistance: If resistance to ground exceeds specified values, corrective action shall be taken, as approved by the Engineer, at no additional cost to the owner.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 260526

# Item 260529 - Hangers and Supports for Electrical Systems

## DESCRIPTION

### 260529-1.1 Related Documents.

**a.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 260529-1.2 Summary.

**a.** Section Includes:
- **i.** Hangers and supports for electrical equipment and systems.
- **ii.** Construction requirements for concrete bases.

### 260529-1.3 Action Submittals.

**a.** Product Data: For each type of product.

- **i.** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
  1. Hangers.
  2. Steel slotted support systems.
  3. Nonmetallic support systems.
  4. Trapeze hangers.
  5. Clamps.
  6. Turnbuckles.
  7. Sockets.
  8. Eye nuts.
  9. Saddles.
  10. Brackets.
- **ii.** Include rated capacities and furnished specialties and accessories.

**b.** Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

- **i.** Trapeze hangers. Include product data for components.
- **ii.** Steel slotted-channel systems.
- **iii.** Nonmetallic slotted-channel systems.
- **iv.** Equipment supports.
- **v.** Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

**c.** Delegated-Design Submittal: For hangers and supports for electrical systems.

- **vi.** Include design calculations and details of trapeze hangers.

**260529-1.4 Informational Submittals.**

**a.** Welding certificates.

**260529-1.5 Quality Assurance.**

**b.** Welding Qualifications: Qualify procedures and personnel according to the following:
**i.** AWS D1.1/D1.1M.
**ii.** AWS D1.2/D1.2M.

## EQUIPMENT AND MATERIALS

**260529-2.1 Performance Requirements**

**a.** Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
**i.** Flame Rating: Class 1.
**ii.** Self-extinguishing according to ASTM D 635.

**260529-2.2 Support, Anchorage, and Attachment Components.**

**a.** Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
**i.** Material: Galvanized steel.
**ii.** Channel Width: 1-5/8 inches (41.25 mm).
**iii.** Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
**iv.** Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
**v.** Channel Dimensions: Selected for applicable load criteria.

**b.** Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

**c.** Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

**d.** Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

**e.** Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

**i.** Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

**ii.** Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

**iii.** Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

**iv.** Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

**v.** Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

**vi.** Toggle Bolts: All-steel springhead type.

**vii.** Hanger Rods: Threaded steel.

**260529-2.3 Fabricated Metal Equipment Support Assemblies.**

**a.** Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

## CONSTRUCTION METHODS

**260529-3.1 Application.**

**a.** Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.

**b.** Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

**c.** Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

**d.** Secure raceways and cables to these supports with two-bolt conduit clamps.

**260529-3.2 Support Installation.**

**a.** Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

**b.** Raceway Support Methods: In addition to methods described in NECA 1, EMTs and RMCs may be supported by openings through structure members, according to NFPA 70.

**c.** Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

**d.** Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

**i.** To Wood: Fasten with lag screws or through bolts.
**ii.** To New Concrete: Bolt to concrete inserts.
**iii.** To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
**iv.** To Existing Concrete: Expansion anchor fasteners.
**v.** Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
**vi.** To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
**vii.** To Light Steel: Sheet metal screws.
**viii.** Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

**e.** Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

**260529-3.3 Installation of Fabricated Metal Supports.**

**a.** Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

**b.** Field Welding: Comply with AWS D1.1/D1.1M.

**260529-3.4 Concrete Bases.**

**a.** Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

**b.** Use 4,000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Item P-610 Concrete for Miscellaneous Structures.

**c.** Anchor equipment to concrete base as follows:

**i.** Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
**ii.** Install anchor bolts to elevations required for proper attachment to supported equipment.
**iii.** Install anchor bolts according to anchor-bolt manufacturer's written instructions.

**260529-3.5 Painting.**

**a.** Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

**i.** Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

**b.** Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 260529

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# Item 260533 Raceways and Boxes for Electrical Systems.

## DESCRIPTION

### 260533-1.1 Summary.

**a.** Section Includes:
- **i.** Metal conduits, tubing, and fittings.
- **ii.** Nonmetal conduits, tubing, and fittings.
- **iii.** Metal wireways and auxiliary gutters.
- **iv.** Surface raceways.
- **v.** Boxes, enclosures, and cabinets.
- **vi.** Handholes and boxes for exterior underground cabling.

**b.** Related Requirements:
- **i.** Item L-110 “Airport Underground Electrical Duct Banks and Conduits” for ductbanks and underground utility construction.

### 260533-1.2 Definitions.

**a.** GRC: Galvanized rigid steel conduit.

### 260533-1.3 Action Submittals.

**a.** Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

**b.** Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

## EQUIPMENT AND MATERIALS

### 260533-2.1 Metal Conduits, Tubing, and Fittings.

**a.** Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** GRC: Comply with ANSI C80.1 and UL 6.

**c.** PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
- **i.** Comply with NEMA RN 1.
- **ii.** Coating Thickness: 0.040 inch (1 mm), minimum.

**d.** EMT: Comply with ANSI C80.3 and UL 797.

**e.** FMC: Comply with UL 1; zinc-coated steel.

**f.** LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

**g.** Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
- **i.** Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
- **ii.** Fittings for EMT:
  1. Material: Steel.
  2. Type: Compression.
- **iii.** Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- **iv.** Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

**h.** Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

**260533-2.2 N onmetallic Conduits, Tubing, and Fittings.**

**a.** Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

**c.** LFNC: Comply with UL 1660.

**d.** Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

**e.** Fittings for LFNC: Comply with UL 514B.

**f.** Solvents and Adhesives: As recommended by conduit manufacturer.

**260533-2.3 Metal Wireways and Auxiliary Gutters.**

**a.** Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
- **i.** Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

**i.** Wireway Covers: Screw-cover type unless otherwise indicated.

**j.** Finish: Manufacturer's standard enamel finish.

**260533-2.4 Boxes, Enclosures, and Cabinets.**

**a.** General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

**b.** Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

**c.** Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- **i.** Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**d.** Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

**e.** Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

**f.** Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

**g.** Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.
- **i.** Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- **ii.** Nonmetallic Enclosures: Fiberglass.
- **iii.** Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

**h.** Cabinets:
- **i.** NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
- **ii.** Hinged door in front cover with flush latch and concealed hinge.
- **iii.** Key latch to match panelboards.
- **iv.** Nonmettalic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## CONSTRUCTION METHODS

**260533-3.1 Raceway Application.**

**a.** Outdoors: Apply raceway products as specified below unless otherwise indicated:
- **i.** Exposed Conduit: GRC.
- **ii.** Underground Conduit: Refer to Item L-110 for requirements.
- **iii.** Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
- **iv.** Boxes and Enclosures, Aboveground: NEMA 250.

**b.** Indoors: Apply raceway products as specified below unless otherwise indicated:
- **i.** Exposed, Not Subject to Physical Damage: EMT.
- **ii.** Exposed, Not Subject to Severe Physical Damage: EMT.

**iii.** Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
**iv.** Damp or Wet Locations: GRC.
**v.** Boxes and Enclosures: NEMA 250, Type 1.

**c.** Minimum Raceway Size: 3/4-inch (21-mm) trade size.

**d.** Raceway Fittings: Compatible with raceways and suitable for use and location.
**i.** Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
**ii.** PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
**iii.** EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
**iv.** Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

**e.** Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

**f.** Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

**g.** Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

**260533-3.2 Installation.**

**a.** Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

**b.** Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

**c.** Complete raceway installation before starting conductor installation.

**d.** Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

**e.** Arrange stub-ups so curved portions of bends are not visible above finished slab.

**f.** Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

**g.** Support conduit within 12 inches (300 mm) of enclosures to which attached.

**h.** Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

**i.** Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

**j.** Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

**k.** Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install grounding type bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat grounding type metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts.

**l.** Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

**m.** Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

**n.** Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

**o.** Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

**p.** Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

**q.** Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

- **i.** Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
- **ii.** Where an underground service raceway enters a building or structure.
- **iii.** Where otherwise required by NFPA 70.

**r.** Comply with manufacturer's written instructions for solvent welding RNC and fittings.

**s.** Expansion-Joint Fittings:

- **i.** Install where indicated on plans.
- **ii.** Install expansion fittings at all locations where conduits cross building or structure expansion joints.
- **iii.** Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

**t.** Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  **i.** Use LFMC in damp or wet locations.

**u.** Mount boxes at heights indicated on Drawings.

**v.** Locate boxes so that cover or plate will not span different building finishes.

**w.** Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

**260533-3.3 Sleeve and Sleeve-Seal Installation for Electrical Penetrations.**

**a.** Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

**260533-3.4 Firestopping.**

**a.** Install firestopping at penetrations of fire-rated floor and wall assemblies.

**260533-3.5 Protection.**

**a.** Protect coatings, finishes, and cabinets from damage and deterioration.
  **i.** Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  **ii.** Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 260533

# Item 260543 Underground Duct

## DESCRIPTION

### 260543.1-1.1 Summary.

**a.** Section Includes: Concrete encased and direct-buried underground duct banks for electrical and other special wiring systems (telephone, security, data, communications and fire alarm).

**b.** Related Sections

**i.** SECTION P-610 - CONCRETE FOR MISCELLANEOUS STRUCTURES for earthwork, concrete, rebar

**ii.** SECTION 260526 – GROUNDING

### 260543.1-1.2 References.

**a.** Underground systems installation and components shall comply with NFPA 70 (National Electrical Code), state codes, local codes and requirements of authorities having jurisdiction.

**b.** Comply with additional references as specified in Articles under PART 2 of this Section.

**c.** NEC Article No. 346 – Galvanized Rigid Conduit

**d.** ANSI C80.1 - Rigid Steel Conduit

**e.** NEC Article No. 348 – Flexible Metal Conduit

**f.** UL 797 – Electrical Metallic Tubing (Steel)

**g.** NEC Article No. 350 – Liquid-tight Flexible Metal Conduit

**h.** NEC Article No. 351 – Electrical Plastic Tubing

**i.** UL 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

**j.** NEC Article No. 347 – Heavy Non-Metal Conduit

**k.** FS WC1094 – Conduit Fittings Plastic Rigid Conduit

**l.** NEMA STD TC2 – Electrical Polyvinyl Chloride (PVC) Conduit

**m.** NEC Article No. 346 – Galvanized Rigid Conduit

**n.** UL. 6 – Electrical Rigid Metal Conduit (Steel)

**o.** ANSI C80.1 – Electric Rigid Steel Conduit

**p.** FS WW-C-581D – Rigid Metal Conduit

**q.** NEC Article No. 370 – Boxes, Conduit Bodies and Fittings

### 260543.1-1.3 Definitions.

**a.** ANSI – American National Standards Institute

**b.** NEC – National Electrical Code

**c.** UL – Underwriter’s Laboratory

**d.** NEMA – National Electrical Manufacturers Association

**e.** EMT – Electrical Metallic Tubing

**f.** FS – Federal Specification

### 260543.1-1.4 Submittals.

**a.** All submittals shall include the manufacturers: Model number, capacity, performance data and electrical characteristics.

**b.** All information shall be clearly shown and marked for the specific item of equipment to be furnished and installed on the project.

**c.** Product Data: Provide catalog cuts and data information on manufactured components used in underground system as follows:

**i.** Conduit

**ii.** Coatings

**iii.** Spacers

**iv.** Warning Tape

**d.** Shop Drawings: Drawings include coordinated dimensioned layouts and bill of materials for the following:

**i.** Duct Banks

### 260543.1-1.5 Quality Assurance.

**a.** Types of materials for which there are Underwriters Laboratories standard requirements, listing and labels, shall be listed and labeled by Underwriters Laboratories.

**b.** Where materials have industry certification, labeling or standards (i.e., NEMA - National Electrical Manufacturers Association), this material shall be labeled as certified, or complying with standards.

**c.** Material shall be new, and conform to grade, quality and standards specified. Materials of the same type shall be the product of same manufacturer throughout.

**d.** Each length of conduit shall be identified with manufacturer's trademark and UL label.

## EQUIPMENT AND MATERIALS

### 260543.1-2.1 Manufacturers.

**a.** Provide products of manufacturers as named in individual Articles.

**b.** Where no manufacturer is specified, provide products of manufacturers in compliance with requirements.

### 260543.1-2.2 Rigid Metal Conduit (RMC).

**a.** Steel Conduit and Couplings: Standard wall, hot-dipped galvanized steel, inside and outside, with zinc-coated threads, outer coating of zinc bichromate, and in compliance with NEC 344, ANSI C80.1 and UL 6.

**i.** Joints: Standard pipe thread furnished with coupling and shipped with thread protector up to 2 inches in size.

**ii.** Manufacturers: Allied Tube and Conduit Corp, Triangle, Wheatland, Owner approved equal.

**b.** Fittings (includes couplings, connectors, bushings, hubs, elbows and nipples): Threaded, zinc-coated malleable iron or steel. Connectors, hubs and bushings shall have insulated throats. Threadless fittings shall not be used.

**i.** Expansion Fittings: With ground jumper or internal bearing assembly, manufactured by O-Z/Gedney, Appleton Electric Co., or Crouse-Hinds.

**ii.** Conduit Hubs: Grounding, raintight, manufactured by O-Z/Gedney, Thomas & Betts, or Meyers.

**iii.** Conduit End Bells: Threaded malleable iron or steel, O-Z/Gedney Type TNS.

**260543.1-2.3 Rigid Nonmetallic Conduit (RNC).**

**a.** Manufacturers

**i.** Carlon

**ii.** Sedco Pipe Products

**iii.** Triangle PWC Inc

**iv.** Owner approved equal.

**b.** Conduit and Fittings: Schedule 40 and 80, Type EB and A Rigid PVC, polyvinyl chloride (PVC), 90 degrees C rated, conform to NEC 352, UL 651, NEMA TC-2 and TC-3.

**c.** Conduit shall have a tensile strength of 5,800 psi at 73.4 degrees F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.

**d.** Conduit, fittings and cement shall be products of same manufacturer.

**e.** Material: PVC, equal to Carlon "PV-DUIT" Schedule 40, 90 degrees C manufactured from C2000 impact modified resin. Conduit, fittings and cement shall be products of same manufacturer. Material shall sustain UL impact 600 ft. lb. test.

**f.** Joints: Chemical bond, solvent cement

**260543.1-2.4 RMC Coatings.**

**a.** Asphalt, manufactured by Karnak No. 118, Black Asphalt Coating.

**260543.1-2.5 Duct Spacers.**

**a.** Manufactured, high impact, plastic spacers used to maintain horizontal and vertical separation of ducts. Manufactured by Underground Devices Inc. or Carlon Electrical Products Co.

**b.** Field fabricated welded rebar frame assemblies.

**260543.1-2.6 Concrete and Rebar.**

**a.** SECTION 260001 - BASIC ELECTRICAL MATERIALS AND METHODS.

**260543.1-2.7 Conduit/Cabinet Sealing Bushings.**

**a.** Conduit Ends: Galvanized, malleable iron, O-Z/Gedney, Type KR.

**b.** Conduits Entering Cabinets: Galvanized, malleable iron, O-Z/Gedney, Type GRK.

**260543.1-2.8 Grounding Materials.**

**a.** SECTION 260526 - GROUNDING

**260543.1-2.9 Buried Line Warning Tape.**

**a.** Permanent, detectable, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 2 inches wide by 4 mils thick for detectable type. Printed legend identifies type of underground line below for power, signal, and communications. Manufacturers: Brady USA, Seton Name Plate Co. or Carlton Industries, Inc.

## CONSTRUCTION METHODS

**260543.1-3.1 General.**

**a.** Examine areas and conditions under which raceways will be installed. Do not proceed with the Work until satisfactory conditions have been achieved.

**b.** Install conduit and accessories to be mechanically secure and electrically correct in a neat manner. Connect metallic raceways to provide a continuous effective ground path for short circuit currents.

**c.** Comply with NEC.

**d.** Keep underground and exterior conduit watertight by coating threaded joints with pipe-joint compound.

**e.** Coat rigid steel conduit in direct contact with earth with a minimum of two coats of bitumastic paint.

**f.** For requirements on earthwork, trenching, backfilling, concrete and reinforcing, refer to SECTION 260001 - BASIC ELECTRICAL MATERIALS AND METHODS.

**g.** Use rigid nonmetallic conduit (PVC), minimum size of 1", for underground Work with transition couplings for connecting to conduit of different materials. Refer to drawings for sizes used.

**h.** Rigid Metallic Conduit (Steel)

**i.** Install conduit with threads painted with corrosion-inhibiting joint compound before couplings are assembled.

**ii.** Paint or coat steel conduit with asphalt type coating where conduit leaves encasement at point where concrete and soil meet.

**i.** Slope duct lines 4 inches (minimum) per 100 feet of run. Slope toward manholes, away from buildings, between manholes, or as indicated otherwise on the Drawings. Slope uniformly from each manhole or from high point between manholes.

**j.** Conduit Bends and Elbows

**i.** Minimum bending radii of conduits and manufactured elbows shall be as follows:
**a.** Less than 3" - 30" radius
**b.** 3" or greater - 36" radius

**ii.** Use long sweep bends with 25" radius minimum for change in direction of more than 5 degrees. Maximum curve shall be 30 degrees.

**iii.** Use large radius, galvanized steel manufactured elbows or conduit bends for ground slab penetrations, pole risers, equipment risers or where conduits change direction in less than a 10 foot radius.

**k.** Make duct joint couplings watertight. Provide bell end fittings and make watertight duct connections at entrances to manholes and handholes.

**l.** Clean duct lines thoroughly by rodding or brushing. Pull no wire or cable until line is completely free of water or other foreign material.

**m.** Pull insulated ground conductor through duct line where shown on the Drawings.

**n.** Install bare grounding conductor integral to ductbank, route as shown on the Drawings.

**o.** Identification: Provide underground, warning tape 12" below grade level directly above duct or cable for entire length of run and use colored (red) concrete. Apply material with brush before concrete has set at the rate of 0.35 lbs./sq. ft. of surface. Refer to Buried Line Warning tape this SECTION for materials.

**p.** Mandrel each conduit. Cap spare ducts. Plug duct ends with removable plugs during and after installation to prevent water and debris from entering duct.

**q.** Provide 200 lb. test, pull cord or pull wire in empty conduits. Provide miminum of 12 inches of slack at each end. Provide identification tags. Secure at both ends. Cap ends of empty conduits.

**260543.1-3.2 Application.**

**a.** Rigid metal conduit (steel) shall be used for the following:

**i.** In concrete slabs on grade, below grade, concrete slabs and decks above grade.

**ii.** In areas where moisture may enter conduit system.

**iii.** In exposed areas where riser conduits turn up from a duct bank.

**b.** Rigid nonmetallic conduit shall be used for the following:

**i.** Underground direct buried or concrete encased.

**c.** Conduit bodies may be used in raceway systems as pulling fittings and access points.

**260543.1-3.3 Encased.**

**a.** Encase each duct with minimum of 3" concrete unless otherwise indicated on the Drawings. Maintain horizontal and vertical separation of 2" minimum between outside surfaces of adjacent conduits. Pour encasement in one continuous operation. Where more than one pour is necessary, terminate each pour in a vertical plane and install rebar dowels for joints. Partial pours shall not terminate in horizontal or angular planes.

**b.** Use monolithic construction with rectangular configuration.

**c.** At any point, top of concrete encasement shall be not less than 30" below finished grade or pavement. Slope top of encasement termination for drainage above grade.

**d.** Provide molded plastic spacers or separators. Place separators or spacing blocks no further apart than 4 feet on centers. Stagger conduit joints at least 6" vertically and horizontally between each line. Use holddown bars or other methods to lock ducts in place while pouring concrete.

**e.** Install and reinforce underground ducts passing under railroads, driveways, and road surfaces to minimum depth of 30" below grade. Reinforce duct passing over other conduits and pipe lines.

**f.** Underground Line Identification: Install continuous plastic line detectable marker, located directly above lines at 12 inches below finished grade before trench backfilling. Install single line marker where multiple lines are installed in common trench or concrete envelope, 16 inches or less.

**g.** Reinforcement

**i.** Single runs of rigid steel conduit may be concrete-encased without reinforcing.

**ii.** Encase multiple runs of conduit in concrete with reinforcing steel bars.

**iii.** Use rebar to tie between concrete-encased duct banks and manholes, handholes and building structure to prevent sheering stress.

**iv.** Install rods parallel to conduits with 1-1/2" minimum space between rods and edge of concrete.

**v.** Use #4 minimum size reinforcing steel bars as specified in SECTION 260001 - BASIC ELECTRICAL MATERIALS AND METHODS for lateral and tie reinforcement or as noted otherwise on the Drawings.

**vi.** Single runs of PVC conduit shall be concrete-encased with reinforcing steel bars.

**h.** Encase #4/0 bare copper ground cable with multiple conduit runs. Refer to ductbank details on the Drawings. Use exothermic welds for connections to ground rods, structural steel, underground connections and other inaccessible connections, except at test wells. Comply with manufacturer's written recommendations. Welds that are puffed up or that show convex surfaces, indicating improper cleaning, are not acceptable.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF SECTION 260543.1

# Item 260544 Sleeves and Sleeve Seals for Electrical Raceway

## DESCRIPTION

### 260544-1.1 Related Documents.

**a.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 260544-1.2 Summary.

**a.** Section Includes:
- **i.** Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
- **ii.** Sleeve-seal systems.
- **iii.** Sleeve-seal fittings.
- **iv.** Grout.
- **i.** Silicone sealants.

### 260544-1.3 Action Submittals.

**a.** Product Data: For each type of product.

## EQUIPMENT AND MATERIALS

### 260544-2.1 Sleeves.

**a.** Wall Sleeves:
- **i.** Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- **ii.** Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

**b.** Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

**c.** PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

**d.** Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

**e.** Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

### 260544-2.2 Sleeve-Seal Systems.

**a.** Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
  **i.** Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  **ii.** Pressure Plates: Carbon steel.
  **iii.** Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

**260544-2.3 Sleeve-Seal Fittings.**

**a.** Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

**260544-2.4 Grout.**

**a.** Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

**b.** Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

**c.** Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

**d.** Packaging: Premixed and factory packaged.

**260544-2.5 Silicone Sealants.**

**a.** Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  **i.** Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

**b.** Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## CONSTRUCTION METHODS

**260529-3.1 Sleeve Installation for Non-Fire-Rated Electrical Penetrations.**

**a.** Comply with NECA 1.

**b.** Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  **i.** Interior Penetrations of Non-Fire-Rated Walls and Floors:
    **a.** Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
    **b.** Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

**ii.** Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
**iii.** Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
**iv.** Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

**c.** Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

**i.** Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
**ii.** Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

**d.** Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 260544**

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# Item 260553 Identification for Electrical Systems

## DESCRIPTION

### 260553-1.1 Summary.

**a.** Section Includes:
- **i.** Identification for raceways.
- **ii.** Identification of power and control cables.
- **iii.** Identification for conductors.
- **iv.** Warning labels and signs.
- **v.** Instruction signs.
- **vi.** Equipment identification labels, including arc-flash warning labels.
- **vii.** Miscellaneous identification products.

### 260553-1.2 Action Submittals.

**a.** Product Data: For each type of product.
- **i.** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

**b.** Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

**c.** Delegated-Design Submittal: For arc-flash hazard study.

## EQUIPMENT AND MATERIALS

### 260553-2.1 Performance Requirements.

**a.** Comply with ASME A13.1.

**b.** Comply with NFPA 70.

**c.** Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

**d.** Comply with ANSI Z535.4 for safety signs and labels.

**e.** Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

**f.** Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
- **i.** Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

**260553-2.2 Legend Requirements.**

**a.** Warning labels and signs shall include, but are not limited to, the following legends:
- **i.** Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- **ii.** Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

**260553-2.3 Labels.**

**a.** Self-Adhesive Labels:
- **i.** Preprinted, 3-mil- (0.08-mm-) thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
  - **1.** Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the raceway diameter, such that the clear shield overlaps the entire printed legend.
- **ii.** Polyester or Vinyl, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
  - **1.** Nominal Size: 3.5-by-5-inch (76-by-127-mm).
- **iii.** Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

**260553-2.4 Signs.**

**a.** Baked-Enamel Signs:
- **i.** Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
- **ii.** 1/4-inch (6.4-mm) grommets in corners for mounting.
- **iii.** Nominal Size: 7 by 10 inches (180 by 250 mm).

**b.** Metal-Backed Butyrate Signs:
- **i.** Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch (1-mm) galvanized-steel backing and with colors, legend, and size required for application.
- **ii.** 1/4-inch (6.4-mm) grommets in corners for mounting.
- **iii.** Nominal Size: 10 by 14 inches (250 by 360 mm).

**260553-2.5 Cable Ties.**

**a.** General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
- **i.** Minimum Width: 3/16 inch (5 mm).
- **ii.** Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
- **iii.** Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

**iv.** Color: Black, except where used for color-coding.

**b.** UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

**i.** Minimum Width: 3/16 inch (5 mm).
**ii.** Tensile Strength at 73 deg F (23 deg C) according to ASTM D 638: 12,000 psi (82.7 MPa).
**iii.** Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
**iv.** Color: Black.

**260553-2.6 Miscellaneous Identification Products.**

**a.** Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

**b.** Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## CONSTRUCTION METHODS

**260553-3.1 Preparation.**

**a.** Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

**260553-3.2 Installation.**

**a.** Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

**b.** Verify identity of each item before installing identification products.

**c.** Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

**d.** Apply identification devices to surfaces that require finish after completing finish work.

**e.** Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

**f.** Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

**g.** Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
**i.** Outdoors: UV-stabilized nylon.

**h.** System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

**260553-3.3 Identification Schedule.**

**a.** Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
**i.** Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

**1.** Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
**2.** Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

**3.** Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

**4.** Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

**b.** Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, use self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.

**c.** Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.

**d.** Conductors To Be Extended in the Future: Attach write-on tags to conductors and list source.

**e.** Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
**i.** Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
**ii.** Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

**iii.** Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

**f.** Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
**i.** Comply with 29 CFR 1910.145.
**ii.** Identify system voltage with black letters on an orange background.
**iii.** Apply to exterior of door, cover, or other access.
**iv.** For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

**1.** Power-transfer switches.
**2.** Controls with external control power connections.

**g.** Arc Flash Warning Labeling: Self-adhesive thermal transfer vinyl labels.
**i.** Comply with NFPA 70E and ANSI Z535.4.
**ii.** Comply with Section 260574 "Overcurrent Protective Device Arc-Flash Study" requirements for arc-flash warning labels.

**h.** Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

**i.** Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

**j.** Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.
**i.** Labeling Instructions:

**1.** Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
**2.** Outdoor Equipment: Engraved, laminated acrylic or melamine label.
**3.** Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
**4.** Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

**ii.** Equipment To Be Labeled:

**1.** Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.

2. Enclosures and electrical cabinets.
3. Access doors and panels for concealed electrical items.
4. Switchgear.
5. Switchboards.
6. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
7. Emergency system boxes and enclosures.
8. Enclosed switches.
9. Enclosed circuit breakers.
10. Enclosed controllers.
11. Power-transfer equipment.
12. Contactors.
13. Remote-controlled switches, dimmer modules, and control devices.
14. Power-generating units.
15. Monitoring and control equipment.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 260553**

# Item 260573 Overcurrent Protective Device Coordination Study

## DESCRIPTION

### 260573-1.1 Summary.

**a.** Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

### 260573-1.2 Definitions.

**a.** Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

**b.** One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

**c.** Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

**d.** SCCR: Short-circuit current rating.

**e.** Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

### 260573-1.3 Action Submittals.

**a.** Product Data: For computer software program to be used for studies.

**b.** Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

**i.** Coordination-study input data, including completed computer program input data sheets.

**ii.** Study and equipment evaluation reports.

**iii.** Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

**1.** Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

**260573-1.4 Informational Submittals.**

**a.** Qualification Data: For Coordination Study Specialist.

**b.** Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

**260573-1.5 Closeout Submittals.**

**a.** Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals.
  **i.** Include the following:
    **1.** The following parts from the Protective Device Coordination Study Report:

      **1)** One-line diagram.
      **2)** Protective device coordination study.
      **3)** Time-current coordination curves.

    **2.** Power system data.

**260573-1.6 Quality Assurance.**

**a.** Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

**b.** Coordination Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  **i.** The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

**c.** Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

**d.** Field Adjusting Agency Qualifications: An independent agency, with the experience and capability to adjust overcurrent devices and to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

## EQUIPMENT AND MATERIALS

**260573-2.1 Computer Software Developers.**

**a.** Comply with IEEE 242 and IEEE 399.

**b.** Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

**c.** Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
- **i.** Optional Features:
  - **1.** Arcing faults.
  - **2.** Simultaneous faults.
  - **3.** Explicit negative sequence.
  - **4.** Mutual coupling in zero sequence.

**260573-2.2 Protective Device Coordination Study Report Contents.**

**a.** Executive summary.

**b.** Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

**c.** One-line diagram, showing the following:
- **i.** Protective device designations and ampere ratings.
- **ii.** Cable size and lengths.
- **iii.** Transformer kilovolt ampere (kVA) and voltage ratings.
- **iv.** Motor and generator designations and kVA ratings.
- **v.** Switchgear, switchboard, motor-control center, and panelboard designations.

**d.** Study Input Data: As described in "Power System Data" Article.

**e.** Protective Device Coordination Study:
- **i.** Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
  - **1.** Phase and Ground Relays:
    - **1)** Device tag.
    - **2)** Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
    - **3)** Recommendations on improved relaying systems, if applicable.
  - **2.** Circuit Breakers:

**4)** Adjustable pickups and time delays (long time, short time, ground).
**5)** Adjustable time-current characteristic.
**6)** Adjustable instantaneous pickup.
**7)** Recommendations on improved trip systems, if applicable.

**3.** Fuses: Show current rating, voltage, and class.

**f.** Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

**i.** Device tag and title, one-line diagram with legend identifying the portion of the system covered.

**ii.** Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

**iii.** Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

**iv.** Plot the following listed characteristic curves, as applicable:

**1.** Power utility's overcurrent protective device.
**2.** Medium-voltage equipment overcurrent relays.
**3.** Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
**4.** Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
**5.** Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
**6.** Cables and conductors damage curves.
**7.** Ground-fault protective devices.
**8.** Motor-starting characteristics and motor damage points.
**9.** Generator short-circuit decrement curve and generator damage point.
**10.** The largest feeder circuit breaker in each motor-control center and panelboard.

**v.** Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.

**vi.** Provide adequate time margins between device characteristics such that selective operation is achieved.

**vii.** Comments and recommendations for system improvements.

## CONSTRUCTION METHODS

### 260573-3.1 Examination.

**a.** Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

**i.** Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

**260573-3.2 Protective Device Coordination Study.**

**a.** Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

**b.** Comply with IEEE 399 for general study procedures.

**c.** The study shall be based on the device characteristics supplied by device manufacturer.

**d.** The extent of the electrical power system to be studied is indicated on Drawings.

**e.** Begin analysis at the service, extending down to the system overcurrent protective devices as follows:
- **i.** To normal system low-voltage load buses where fault current is 10 kA or less.
- **ii.** Exclude equipment rated 240-V ac or less when supplied by a single transformer rated less than 125 kVA.

**f.** Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

**g.** Transformer Primary Overcurrent Protective Devices:
- **i.** Device shall not operate in response to the following:
  - **1.** Inrush current when first energized.
  - **2.** Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
  - **3.** Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
- **ii.** Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

**h.** Motor Protection:
- **i.** Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
- **ii.** Select protection for motors served at voltages more than 600 V according to IEEE 620.

**i.** Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

**j.** Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.

**k.** The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
- **i.** For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

**l.** Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
- **i.** Electric utility's supply termination point.
- **ii.** Service Disconnect Switch.
- **iii.** Distribution Panelboards.
- **iv.** Standby generators and automatic transfer switches.
- **v.** Branch circuit panelboards.

**m.** Protective Device Evaluation:
- **i.** Evaluate equipment and protective devices and compare to short-circuit ratings.
- **ii.** Adequacy of switchgear, and panelboard bus bars to withstand short-circuit stresses.
- **iii.** Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

**260573-3.3 Power System Data.**

**a.** Obtain all data necessary for the conduct of the overcurrent protective device study.
- **i.** Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Engineer.
- **ii.** For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
- **iii.** For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.

**b.** Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
- **i.** Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
- **ii.** Electrical power utility impedance at the service.
- **iii.** Power sources and ties.
- **iv.** Short-circuit current at each system bus, three phase and line-to-ground.
- **v.** Full-load current of all loads.
- **vi.** Voltage level at each bus.
- **vii.** For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

**viii.** For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

**ix.** Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

**x.** Motor horsepower and NEMA MG 1 code letter designation.

**xi.** Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

**xii.** Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

**1.** Special load considerations, including starting inrush currents and frequent starting and stopping.

**2.** Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

**3.** Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

**4.** Generator thermal-damage curve.

**5.** Time-current-characteristic curves of devices indicated to be coordinated.

**6.** Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

**7.** Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

**8.** Panelboards, switchboards, motor-control center ampacity, and SCCR in amperes rms symmetrical.

**9.** Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

**260573-3.4 Field Adjusting.**

**a.** Adjust relay and protective device settings according to the recommended settings provided by the coordination study.

**b.** Make minor modifications to equipment as required to accomplish compliance with protective device coordination studies.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 260573**

# Item 260574 Overcurrent Protective Device Arc-Flash Study

## DESCRIPTION

### 260574-1.1 Summary.

**a.** Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

### 260574-1.2 Definitions.

**a.** Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

**b.** One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

**c.** Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

**d.** SCCR: Short-circuit current rating.

**e.** Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

### 260574-1.3 Action Submittals.

**a.** Product Data: For computer software program to be used for studies.

**b.** Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.

**i.** Arc-flash study input data, including completed computer program input data sheets.

**ii.** Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.

**1.** Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

### 260574-1.4 Informational Submittals.

**a.** Qualification Data: For Arc-Flash Study Specialist.

**b.** Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

**260574-1.5 Closeout Submittals.**

**a.** Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

**b.** Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

**260574-1.6 Quality Assurance.**

**a.** Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.

**b.** Arc-Flash Study Software Developer Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
**i.** The computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

**c.** Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

## EQUIPMENT AND MATERIALS

**260574-2.1 Computer Software Developers.**

**a.** Comply with IEEE 1584 and NFPA 70E.

**b.** Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

**260574-2.2 Arc-Flash Study Report Content**

**a.** Executive summary.

**b.** Study descriptions, purpose, basis and scope.

**c.** One-line diagram, showing the following:
**i.** Protective device designations and ampere ratings.

**ii.** Cable size and lengths.
**iii.** Transformer kilovolt ampere (kVA) and voltage ratings.
**iv.** Motor and generator designations and kVA ratings.
**v.** Switchgear, switchboard, motor-control center and panelboard designations.

**d.** Study Input Data: As described in "Power System Data" Article.

**e.** Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

**f.** Arc-Flash Study Output:
**i.** Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
**1.** Voltage.
**2.** Calculated symmetrical fault-current magnitude and angle.
**3.** Fault-point X/R ratio.
**4.** No AC Decrement (NACD) ratio.
**5.** Equivalent impedance.
**6.** Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
**7.** Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

**g.** Incident Energy and Flash Protection Boundary Calculations:
**i.** Arcing fault magnitude.
**ii.** Protective device clearing time.
**iii.** Duration of arc.
**iv.** Arc-flash boundary.
**v.** Working distance.
**vi.** Incident energy.
**vii.** Hazard risk category.
**viii.** Recommendations for arc-flash energy reduction.

**h.** Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

**260574-2.3 Arc-Flash Warning Labels.**

**a.** Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a 3.5-by-5-inch (76-by-127-mm) thermal transfer label of high-adhesion polyester for each work location included in the analysis.

**b.** The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
**i.** Location designation.
**ii.** Nominal voltage.
**iii.** Flash protection boundary.
**iv.** Hazard risk category.
**v.** Incident energy.

**vi.** Working distance.
**vii.** Engineering report number, revision number, and issue date.

**c.** Labels shall be machine printed, with no field-applied markings.

## CONSTRUCTION METHODS

### 260547-3.1 Examination.

**a.** Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

### 260574-2.2 Arc-Flash Hazard Analysis.

**a.** Comply with NFPA 70E and its Annex D for hazard analysis study.

**b.** Preparatory Studies:
**i.** Protective Device Coordination Study Report Contents: As specified in "Protective Device Coordination Study Report Contents" Article in Section 260573 "Overcurrent Protective Device Coordination Study."

**c.** Calculate maximum and minimum contributions of fault-current size.

**i.** The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
**ii.** The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

**d.** Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.

**e.** Include medium- and low-voltage equipment locations, except equipment rated 240-V ac or less fed from transformers less than 125 kVA.

**f.** Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.

**g.** Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

**i.** Fault contribution from induction motors should not be considered beyond three to five cycles.
**ii.** Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

**h.** Arc-flash computation shall include both line and load side of a circuit breaker as follows:

**i.** When the circuit breaker is in a separate enclosure.
**ii.** When the line terminals of the circuit breaker are separate from the work location.

**i.** Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

**260574-2.3 Power System Data.**

**a.** Obtain all data necessary for the conduct of the arc-flash hazard analysis.

**i.** Verify completeness of data supplied on the one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to the attention of Engineer.
**ii.** For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
**iii.** For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.

**b.** Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.

**i.** Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
**ii.** Obtain electrical power utility impedance at the service.
**iii.** Power sources and ties.
**iv.** Short-circuit current at each system bus, three phase and line-to-ground.
**v.** Full-load current of all loads.
**vi.** Voltage level at each bus.
**vii.** For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
**viii.** For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
**ix.** Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
**x.** Motor horsepower and NEMA MG 1 code letter designation.
**xi.** Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

**260574-2.4 Labeling.**

**a.** Apply one arc-flash label for 600-V ac, 480-V ac, and applicable 208-V ac panelboards and disconnects and for equipment.

**260574-2.5 Application of Warning Labels.**

**a.** Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

**260574-2.6 Demonstration.**

**a.** Engage the Arc-Flash Study Specialist to train Owner's maintenance personnel in the potential arc-flash hazards associated with working on energized equipment and the significance of the arc-flash warning labels.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 260574

# Item 262200 Low-Voltage Transformers

## DESCRIPTION

### 262200-1.1 Summary.

**a.** Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

### 262200-1.2 Action Submittals.

**a.** Product Data: For each type of product.
- **i.** Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
- **ii.** Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

**b.** Shop Drawings:
- **i.** Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- **i.** Include diagrams for power, signal, and control wiring.

### 262200-1.3 Closeout Submittals.

**a.** Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

### 262200-1.4 Delivery, Storage, and Handling.

**a.** Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## EQUIPMENT AND MATERIALS

### 262200-2.1 Manufacturers.

**a.** Source Limitations: Obtain each transformer type from single source from single manufacturer.

**262200-2.2 General Transformer Requirements.**

**a.** Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

**b.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**c.** Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

**d.** Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

**e.** Coils: Continuous windings without splices except for taps.
- **i.** Internal Coil Connections: Brazed or pressure type.
- **ii.** Coil Material: Copper.

**f.** Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

**g.** Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

**262200-2.3 Distribution Transformers.**

**a.** Comply with NFPA 70, and list and label as complying with UL 1561.

**b.** Provide transformers that are constructed to withstand seismic forces.

**c.** Cores: One leg per phase.

**d.** Enclosure: Ventilated.
- **i.** NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
- **ii.** KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

**e.** Transformer Enclosure Finish: Comply with NEMA 250.
- **i.** Finish Color: Gray.

**f.** Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

**g.** Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

**h.** Fungus Proofing: Permanent fungicidal treatment for coil and core.

**i.** Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
- **i.** 30 to 50 kVA: 50 dB.

**262200-2.4 Identification Devices.**

**a.** Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

**262200-2.5 Source Quality Control.**

**a.** Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
- **i.** Resistance measurements of all windings at the rated voltage connections and at all tap connections.
- **ii.** Ratio tests at the rated voltage connections and at all tap connections.
- **iii.** Phase relation and polarity tests at the rated voltage connections.
- **iv.** No load losses, and excitation current and rated voltage at the rated voltage connections.
- **v.** Impedance and load losses at rated current and rated frequency at the rated voltage connections.
- **vi.** Applied and induced tensile tests.
- **vii.** Regulation and efficiency at rated load and voltage.
- **viii.** Insulation Resistance Tests:
  - **1.** High-voltage to ground.
  - **2.** Low-voltage to ground.
  - **3.** High-voltage to low-voltage.
- **ix.** Temperature tests.

**b.** Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

## CONSTRUCTION METHODS

**262200-3.1 Examination.**

**a.** Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

**b.** Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

**c.** Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

**d.** Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

**e.** Environment: Enclosures shall be rated for the environment in which they are located.

**f.** Proceed with installation only after unsatisfactory conditions have been corrected.

**262200-3.2 Installation.**

**a.** Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

**b.** Construct concrete bases according to Item P-610 Structural Portland Cement Concrete and anchor floor-mounted transformers according to manufacturer's written instructions, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

**i.** Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

**c.** Secure transformer to concrete base according to manufacturer's written instructions.

**d.** Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

**e.** Remove shipping bolts, blocking, and wedges.

**262200-3.3 Connections.**

**a.** Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

**b.** Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**c.** Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

**d.** Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

**262200-3.4 Field Quality Control.**

**a.** Perform tests and inspections.

**b.** Tests and Inspections:

**i.** Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

**c.** Remove and replace units that do not pass tests or inspections and retest as specified above.

**d.** Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

**i.** Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

**ii.** Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.

**iii.** Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

**e.** Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

**262200-3.5 Adjusting.**

**a.** Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

**b.** Output Settings Report: Prepare a written report recording output voltages and tap settings.

**262200-3.6 Cleaning.**

**a.** Vacuum dirt and debris; do not use compressed air to assist in cleaning.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 262200

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# Item 262416 Panelboards

## DESCRIPTION

### 262416-1.1 Summary.

**a.** Section Includes:
- **i.** Distribution panelboards.
- **ii.** Lighting and appliance branch-circuit panelboards.

### 262416-1.2 Definitions.

**a.** ATS: Acceptance testing specification.

**b.** GFCI: Ground-fault circuit interrupter.

**c.** GFEP: Ground-fault equipment protection.

**d.** HID: High-intensity discharge.

**e.** MCCB: Molded-case circuit breaker.

**f.** SPD: Surge protective device.

**g.** VPR: Voltage protection rating.

### 262416-1.3 Action Submittals.

**a.** Product Data: For each type of panelboard.
- **i.** Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
- **ii.** Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

**b.** Shop Drawings: For each panelboard and related equipment.
- **i.** Include dimensioned plans, elevations, sections, and details.
- **ii.** Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
- **iii.** Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
- **iv.** Detail bus configuration, current, and voltage ratings.
- **v.** Short-circuit current rating of panelboards and overcurrent protective devices.
- **vi.** Include evidence of NRTL listing for series rating of installed devices.
- **vii.** Include evidence of NRTL listing for SPD as installed in panelboard.
- **viii.** Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- **ix.** Include wiring diagrams for power, signal, and control wiring.

**x.** Key interlock scheme drawing and sequence of operations.

**xi.** Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

**262416-1.4 Informational Submittals.**

**a.** Qualification Data: For testing agency.

**b.** Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

**262416-1.5 Closeout Submittals.**

**a.** Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

**i.** Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

**ii.** Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

**262416-1.6 Maintenance Material Submittals.**

**a.** Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

**i.** Keys: Two spares for each type of panelboard cabinet lock.

**ii.** Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

**iii.** Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

**262416-1.7 Quality Assurance.**

**a.** Manufacturer Qualifications: ISO 9001 or 9002 certified.

**262416-1.8 Delivery, Storage, and Handling.**

**a.** Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

**b.** Handle and prepare panelboards for installation according to NEMA PB 1.

**262416-1.9 Field Conditions.**

**a.** Environmental Limitations:

**i.** Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

**ii.** Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
2. Altitude: Not exceeding 6600 feet (2000 m).

**b.** Service Conditions: NEMA PB 1, usual service conditions, as follows:

**i.** Ambient temperatures within limits specified.

**ii.** Altitude not exceeding 6600 feet (2000 m).

### 262416-1.10 Warranty.

**a.** Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

**i.** Panelboard Warranty Period: 18 months from date of Substantial Completion.

**b.** Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

**i.** SPD Warranty Period: Five years from date of Substantial Completion.

## EQUIPMENT AND MATERIALS

### 262416-2.1 Panelboards and Load Centers Common Requirements.

**a.** Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

**b.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**c.** Comply with NEMA PB 1.

**d.** Comply with NFPA 70.

**e.** Enclosures: Surface-mounted, dead-front cabinets.

**i.** Rated for environmental conditions at installed location.

1. Indoor Dry and Clean Locations: NEMA 250, Type 1.

**ii.** Height: 84 inches (2.13 m) maximum.

**iii.** Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.

**iv.** Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

**v.** Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

**vi.** Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

**vii.** Finishes:

1. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
2. Back Boxes: Same finish as panels and trim.
3. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

**f.** Incoming Mains:

**i.** Location: Convertible between top and bottom.

**ii.** Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

**g.** Phase, Neutral, and Ground Buses:

**i.** Material: Hard-drawn copper, 98 percent conductivity.

1. Plating shall run entire length of bus.
2. Bus shall be fully rated the entire length.

**ii.** Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

**iii.** Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

**iv.** Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

**h.** Conductor Connectors: Suitable for use with conductor material and sizes.

**i.** Material: Hard-drawn copper, 98 percent conductivity.

**ii.** Terminations shall allow use of 75 deg C rated conductors without derating.

**iii.** Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

**iv.** Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.

**v.** Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

**vi.** Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

**vii.** Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

**viii.** Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

**i.** NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures,

wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

**j.** Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

**i.** Percentage of Future Space Capacity: 20 percent.

**k.** Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

**i.** Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
**ii.** Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

**262416-2.2 Performance Requirements.**

**a.** Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

**262416-2.3 Power Panelboards.**

**a.** Panelboards: NEMA PB 1, distribution type.

**b.** Doors: Secured with vault-type latch with tumbler lock; keyed alike.
**i.** For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

**c.** Mains: Circuit breaker.

**d.** Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

**e.** Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

**262416-2.4 Lighting and Appliance Branch-Circuit Panelboards.**

**a.** Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

**b.** Mains: Circuit breaker.

**c.** Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

**d.** Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door

shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

**262416-2.5 Disconnecting and Overcurrent Protective Devices.**

**a.** MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
- **i.** Thermal-Magnetic Circuit Breakers:
  1. Inverse time-current element for low-level overloads.
  2. Instantaneous magnetic trip element for short circuits.
  3. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- **ii.** Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- **iii.** Electronic Trip Circuit Breakers:
  1. RMS sensing.
  2. Field-replaceable rating plug or electronic trip.
  3. Digital display of settings, trip targets, and indicated metering displays.
  4. Multi-button keypad to access programmable functions and monitored data.
  5. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
  6. Integral test jack for connection to portable test set or laptop computer.
  7. Field-Adjustable Settings:
     1) Instantaneous trip.
     2) Long- and short-time pickup levels.
     3) Long and short time adjustments.
     4) Ground-fault pickup level, time delay, and I squared T response.
- **iv.** Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- **v.** GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- **vi.** GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- **vii.** Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- **viii.** Subfeed Circuit Breakers: Vertically mounted.
- **ix.** MCCB Features and Accessories:
  1. Standard frame sizes, trip ratings, and number of poles.
  2. Breaker handle indicates tripped status.
  3. UL listed for reverse connection without restrictive line or load ratings.
  4. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  5. Application Listing: Appropriate for application.
  6. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  7. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
  8. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
  9. Multipole units enclosed in a single housing with a single handle.

10. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

**b.** Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
**i.** Fuses: Comply with requirements specified in Section 262813 "Fuses."
**ii.** Fused Switch Features and Accessories:
1. Standard ampere ratings and number of poles.
2. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.

**262416-2.6 Identification.**

**a.** Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

**b.** Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

**c.** Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
**i.** Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

**262416-2.7 Accessory Components and Features.**

**a.** Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

**262416-3.2 Capacitor Bank**

**a.** Provide (1) wall mounted NEMA 1 (indoor) 480 volt, 3 phase, 100kVAR top entry, fixed power factor capacitor and harmonic filter. Current inputs shall be provided from the current transformers in MDP. Terminal blocks shall be furnished for these inputs.

**b.** Capacitor shall be 100kVAR with PCB free dielectric fluid, internal discharge resistors and be equipped with current limiting fuses. Inrush limiting reactors shall be provided if required to reduce the back to back switching inrush current to a level well below the momentary maximum rating of the capacitor fuses and switching devices.

**c.** The unit shall contain a minimum 1/4 x 2” ground bus and ground switch to ensure that stored energy has been discharged from the capacitors to provide maximum safety. One (1) #4/0 and three (3) #2/0 copper only crimp type compression lugs shall be provided.

**d.** The capacitor unit shall be provided with vent filters. Filters shall be replaceable and prevent dust build-up inside the enclosures. Rear access shall not be required.

**e.** Design basis is Schneider Electric 100KVAR AccuSine EVC+, part EVCP100D5W02 Capacitor Bank or approved equal. Include a quantity of three: 1200A Current Transformers, part #PCSPCTFCL120056 or approved equal

## CONSTRUCTION METHODS

### 262416-3.1 Examination.

**a.** Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

**b.** Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

**c.** Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

**d.** Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

**e.** Proceed with installation only after unsatisfactory conditions have been corrected.

### 262416-3.2 Installation.

**a.** Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**b.** Comply with NECA 1.

**c.** Install panelboards and accessories according to NEMA PB 1.1.

**d.** Equipment Mounting:
  **i.** Attach panelboard to the vertical finished or structural surface behind the panelboard.

**e.** Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

**f.** Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

**g.** Mount panelboard cabinet plumb and rigid without distortion of box.

**h.** Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch (32 mm) in depth. Orient steel slotted supports vertically.

**i.** Install overcurrent protective devices and controllers not already factory installed.
  **i.** Set field-adjustable, circuit-breaker trip ranges.

**ii.** Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

**j.** Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

**k.** Install filler plates in unused spaces.

**l.** Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

**262416-3.3 Identification.**

**a.** Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Item 260553 "Identification for Electrical Systems."

**b.** Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

**c.** Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Item 260553 "Identification for Electrical Systems."

**d.** Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Item 260553 "Identification for Electrical Systems."

**e.** Install warning signs complying with requirements in Item 260553 "Identification for Electrical Systems" identifying source of remote circuit.

**262416-3.4 Field Quality Control.**

**a.** Acceptance Testing Preparation:
- **i.** Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
- **ii.** Test continuity of each circuit.

**b.** Tests and Inspections:
- **i.** Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
- **ii.** Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- **iii.** Perform the following infrared scan tests and inspections and prepare reports:

1. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
2. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
3. Instruments and Equipment:

    1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

**c.** Panelboards will be considered defective if they do not pass tests and inspections.

**d.** Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**262416-3.5 Adjusting.**

**a.** Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

**b.** Set field-adjustable circuit-breaker trip ranges as specified in Item 260573 "Overcurrent Protective Device Coordination Study."

**c.** Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.

**i.** Measure loads during period of normal facility operations.

**ii.** Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Engineer. Avoid disrupting services to airfield lighting system. Coordinate all required outages with the Engineer.

**iii.** After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

**iv.** Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

**262416-3.6 Protection.**

**a.** Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 262416**

# Item 262726 Wiring Devices

## DESCRIPTION

### 262726-1.1 Related Documents.

**a.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 262726-1.2 Summary.

**a.** Section Includes:
- **i.** Straight-blade convenience.
- **ii.** GFCI receptacles.
- **iii.** Toggle switches.
- **iv.** Wall plates.

### 262726-1.3 Definitions.

**a.** Abbreviations of Manufacturers' Names:
- **i.** Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
- **ii.** Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
- **iii.** Leviton: Leviton Mfg. Company, Inc.
- **iv.** Pass & Seymour: Pass& Seymour/Legrand.

**b.** EMI: Electromagnetic interference.

**c.** GFCI: Ground-fault circuit interrupter.

**d.** Pigtail: Short lead used to connect a device to a branch-circuit conductor.

**e.** RFI: Radio-frequency interference.

**f.** SPD: Surge protective device.

**g.** UTP: Unshielded twisted pair.

### 262726-1.4 Action Submittals.

**a.** Product Data: For each type of product.

**b.** Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

**c.** Samples: One for each type of device and wall plate specified, in each color specified.

**262726-1.5 Informational Submittals.**

**a.** Field quality-control reports.

**262726-1.6 Closeout Submittals.**

**a.** Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

## EQUIPMENT AND MATERIALS

**262726-2.1 General Wiring - Device Requirements.**

**a.** Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** Comply with NFPA 70.

**c.** Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

**262726-2.2 Straight-Blade Receptacles.**

**a.** Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

**262726-2.3 GFCI Receptacles.**

**a.** General Description:
- **i.** 125 V, 20 A, straight blade, feed-through type.
- **ii.** Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
- **iii.** Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

**262726-2.4 Toggle Switches.**

**a.** Comply with NEMA WD 1, UL 20, and FS W-S-896.

**b.** Switches, 120/277 V, 20 A.

**262726-2.5 Wall Plates.**

**a.** Single and combination types shall match corresponding wiring devices.
- **i.** Plate-Securing Screws: Metal with head color to match plate finish.

**ii.** Material for Finished Spaces: 0.05-inch- (1.2-mm-) thick, anodized aluminum

**b.** Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

**262726-2.6 Finishes.**

**a.** Device Color:
**i.** Wiring Devices: Black, unless otherwise indicated or required by NFPA 70 or device listing.

## CONSTRUCTION METHODS

**262726-3.1 Installation.**

**a.** Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

**b.** Coordination with Other Trades:
**i.** Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
**ii.** Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
**iii.** Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
**iv.** Install wiring devices after all wall preparation, including painting, is complete.

**c.** Conductors:
**i.** Do not strip insulation from conductors until right before they are spliced or terminated on devices.
**ii.** Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
**iii.** The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
**iv.** Existing Conductors:
**1.** Cut back and pigtail, or replace all damaged conductors.
**2.** Straighten conductors that remain and remove corrosion and foreign matter.
**3.** Pigtailing existing conductors is permitted, provided the outlet box is large enough.

**d.** Device Installation:
**i.** Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
**ii.** Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
**iii.** Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

**iv.** Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.

**v.** When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

**vi.** Use a torque screwdriver when a torque is recommended or required by manufacturer.

**vii.** When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

**viii.** Tighten unused terminal screws on the device.

**ix.** When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

**e.** Receptacle Orientation:

**i.** Install ground pin of vertically mounted receptacles down.

**f.** Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

**262726-3.2 GFCI Receptacles.**

**a.** Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

**262726-3.3 Identification.**

**a.** Comply with Section 260553 "Identification for Electrical Systems."

**b.** Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

**262726-3.4 Field Quality Control.**

**a.** Perform the following tests and inspections:

**i.** Test Instruments: Use instruments that comply with UL 1436.

**b.** Tests for Convenience Receptacles:

**i.** Line Voltage: Acceptable range is 105 to 132 V.

**ii.** Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

**iii.** Ground Impedance: Values of up to 2 ohms are acceptable.

**iv.** GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

**v.** Using the test plug, verify that the device and its outlet box are securely mounted.

**vi.** Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

**c.** Wiring device will be considered defective if it does not pass tests and inspections.

**d.** Prepare test and inspection reports.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 262726**

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# Item 262813 Fuses

## DESCRIPTION

### 262813-1.1 Related Documents.

**a.** Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 262813-1.2 Summary.

**a.** Section Includes:
- **i.** Cartridge fuses rated 600 V ac and less for use in the following:
  - **1.** Control circuits.
  - **2.** Enclosed switches.

### 262813-1.3 Action Submittals.

**a.** Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
- **i.** Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
  - **1.** For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
  - **2.** Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- **ii.** Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
- **iii.** Current-limitation curves for fuses with current-limiting characteristics.
- **iv.** Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
- **i.** Coordination charts and tables and related data.

### 262813-1.4 Closeout Submittals.

**a.** Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. Include the following:
- **i.** Ambient temperature adjustment information.
- **v.** Current-limitation curves for fuses with current-limiting characteristics.
- **vi.** Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
- **vii.** Coordination charts and tables and related data.

**262813-1.5 Maintenance Material Submittals.**

**a.** Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   **i.** Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

**262813-1.6** FIELD CONDITIONS
   **ii.** Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

## EQUIPMENT AND MATERIALS

**262813-2.1 Manufacturers.**

**a.** Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

**262813-2.2 Cartridge Fuses.**

**a.** Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   **i.** Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

**b.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**c.** Comply with NEMA FU 1 for cartridge fuses.

**d.** Comply with NFPA 70.

**e.** Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

## CONSTRUCTION METHODS

**262813-3.1 Examination.**

**a.** Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

**b.** Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

**c.** Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

**d.** Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

**e.** Proceed with installation only after unsatisfactory conditions have been corrected.

**262813-3.2 Fuse Applications.**

**f.** Cartridge Fuses:
- **i.** Service Entrance: Class RK1, time delay.
- **ii.** Feeders: Class RK1, time delay.
- **iii.** Provide open-fuse indicator fuses or fuse covers with open fuse indication.

**262813-3.3 Installation.**

**g.** Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

**262813-3.4 Identification.**

**a.** Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 262813

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# Item 262816 Enclosed Switches and Circuit Breakers

## DESCRIPTION

### 262816-1.1 Summary.

**a.** Section Includes:
- **i.** Fusible switches.
- **ii.** Nonfusible switches.
- **iii.** Molded-case circuit breakers (MCCBs).
- **iv.** Enclosures.

### 262816-1.2 Definitions.

**a.** NC: Normally closed.

**b.** NO: Normally open.

**c.** SPDT: Single pole, double throw.

### 262816-1.3 Action Submittals.

**a.** Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- **i.** Enclosure types and details for types other than NEMA 250, Type 1.
- **ii.** Current and voltage ratings.
- **iii.** Short-circuit current ratings (interrupting and withstand, as appropriate).
- **iv.** Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
- **v.** Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- **vi.** Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

**d.** Shop Drawings: For enclosed switches and circuit breakers.
- **i.** Include plans, elevations, sections, details, and attachments to other work.
- **ii.** Include wiring diagrams for power, signal, and control wiring.

### 262816-1.4 Informational Submittals.

**a.** Qualification Data: For qualified testing agency.

**e.** Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.

**i.** Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
**ii.** Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
**iii.** Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

**f.** Field quality-control reports.

**262816-1.5 Closeout Submittals.**

**a.** Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

**i.** Include the following:

**1.** Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
**2.** Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

**262816-1.6 Maintenance Material Submittals.**

**a.** Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
**ii.** Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
**iii.** Fuse Pullers: Two for each size and type.

**262816-1.7 Quality Assurance.**

**a.** Testing Agency Qualifications: Accredited by NETA.
**iv.** Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

**262816-1.8 Field Conditions.**

**a.** Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
**v.** Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
**vi.** Altitude: Not exceeding 6600 feet (2010 m).

**262816-1.9 Warranty.**

**a.** Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
**vii.** Warranty Period: One year(s) from date of Substantial Completion.

## EQUIPMENT AND MATERIALS

**262816-2.1 Performance Requirements.**

**a.** Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE.
  **i.** The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

**262816-2.2 General Requirements.**

**a.** Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

**b.** Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

**c.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

**d.** Comply with NFPA 70.

**262816-2.3 Fusible Switches.**

**a.** Type HD, Heavy Duty:
  **i.** Single throw.
  **ii.** Three pole.
  **iii.** 600-V ac.
  **iv.** 1200 A and smaller.
  **v.** UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
  **vi.** Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

**b.** Accessories:
  **i.** Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  **ii.** Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  **iii.** Lugs: Mechanical type, suitable for number, size, and conductor material.
  **iv.** Service-Rated Switches: Labeled for use as service equipment.

**262816-2.4 Nonfusible Switches.**

**a.** Type HD, Heavy Duty, Three Pole, Single Throw, 240V ac and 600V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

**b.** Accessories:
- **i.** Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
- **ii.** Lugs: Mechanical type, suitable for number, size, and conductor material.

**262816-2.5 Molded-Case Circuit Breakers.**

**a.** Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

**b.** Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

**c.** The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.

**d.** MCCBs shall be equipped with a device for locking in the isolated position.

**e.** Lugs shall be suitable for 167 deg F (75 deg C) rated wire.

**f.** Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

**g.** Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

**h.** Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

**i.** Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
- **i.** Instantaneous trip.
- **ii.** Long- and short-time pickup levels.
- **iii.** Long- and short-time time adjustments.
- **iv.** Ground-fault pickup level, time delay, and I-squared t response.

**j.** Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

**k.** Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

**l.** Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

**m.** Features and Accessories:
- **i.** Standard frame sizes, trip ratings, and number of poles.
- **ii.** Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
- **iii.** Application Listing: Appropriate for application.
- **iv.** Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
- **v.** Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

**262816-2.6 Enclosures.**

**a.** Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

**b.** Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

**c.** Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

**d.** Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

## CONSTRUCTION METHODS

**262816-3.1 Examination.**

**a.** Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

**b.** Proceed with installation only after unsatisfactory conditions have been corrected.
- **i.** Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

**262816-3.2 Enclosure Environmental Rating Applications.**

**a.** Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
- **i.** Indoor, Dry and Clean Locations: NEMA 250, Type 1.
- **ii.** Outdoor Locations: NEMA 250, Type 4X.

**262816-3.3 Installation.**

**a.** Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**b.** Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

**c.** Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

**d.** Install fuses in fusible devices.

**e.** Comply with NFPA 70 and NECA 1.

**262816-3.4 Identification.**

**a.** Comply with requirements in Section 260553 "Identification for Electrical Systems."
- **i.** Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
- **ii.** Label each enclosure with engraved metal or laminated-plastic nameplate.

**262816-3.5 Field Quality Control.**

**a.** Perform tests and inspections.

**b.** Tests and Inspections for Switches:

**i.** Visual and Mechanical Inspection:
- **1.** Inspect physical and mechanical condition.
- **2.** Inspect anchorage, alignment, grounding, and clearances.
- **3.** Verify that the unit is clean.
- **4.** Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- **5.** Verify that fuse sizes and types match the Specifications and Drawings.
- **6.** Verify that each fuse has adequate mechanical support and contact integrity.
- **7.** Inspect bolted electrical connections for high resistance using one of the two following methods:
  - **1)** Use a low-resistance ohmmeter.
    - **a)** Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - **2)** Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
    - **a)** Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- **8.** Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- **9.** Verify correct phase barrier installation.

**10.** Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

**ii.** Electrical Tests:

**1.** Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
**2.** Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
**3.** Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
**4.** Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
**5.** Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

**c.** Tests and Inspections for Molded Case Circuit Breakers:

**i.** Visual and Mechanical Inspection:

**1.** Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
**2.** Inspect physical and mechanical condition.
**3.** Inspect anchorage, alignment, grounding, and clearances.
**4.** Verify that the unit is clean.
**5.** Operate the circuit breaker to ensure smooth operation.
**6.** Inspect bolted electrical connections for high resistance using one of the two following methods:

**1)** Use a low-resistance ohmmeter.

**a)** Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

**2)** Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

**a)** Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

**7.** Inspect operating mechanism, contacts, and chutes in unsealed units.
**8.** Perform adjustments for final protective device settings in accordance with the coordination study.

**ii.** Electrical Tests:

**1.** Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
**2.** Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
**3.** Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
**4.** Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
**5.** Determine the following by primary current injection:

**1)** Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
**2)** Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
**3)** Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
**4)** Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

**6.** Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
**7.** Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
**8.** Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
**9.** Verify operation of charging mechanism. Investigate units that do not function as designed.

**iii.** Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

**iv.** Perform the following infrared scan tests and inspections and prepare reports:

**1.** Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

**2.** Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

**3.** Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

**v.** Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

**d.** Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

**e.** Prepare test and inspection reports.

**i.** Test procedures used.

**ii.** Include identification of each enclosed switch and circuit breaker tested and describe test results.

**iii.** List deficiencies detected, remedial action taken, and observations after remedial action.

**262816-3.6 Adjusting.**

**a.** Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

**b.** Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 260529

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# Item 263213 Engine Generators

## DESCRIPTION

### 263213-1.1 Summary.

**a.** Section includes installation of the Owner-provided packaged engine-generator set for standby power supply with the following features:
- **i.** Diesel engine.
- **ii.** Unit-mounted cooling system.
- **iii.** Unit-mounted control and monitoring.
- **iv.** Fuel system.
- **v.** Load banks.
- **vi.** Retrieval of generator, and other owner-provided items outlined herein, from on-airport location and delivery to project site.

**b.** Section includes furnishing and installing all cable, conduit, underground ductbank, and all other associated items required for a complete generator installation.

**c.** Section includes salvage of the existing generator, ATS, and other equipment as noted in the drawings.
- **i.** Contractor shall coordinate with generator manufacturer for packaging of the existing generator and ATS prior to demolition.
- **ii.** Existing generator and ATS shall be packaged and relocated to another location on the airport. Coordinate location with RPR.

**d.** Related Requirements:
- **i.** Item 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
- **ii.** Item

### 263213-1.2 Definitions.

**a.** Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

**b.** EPS: Emergency power supply.

**c.** EPSS: Emergency power supply system.

### 263213-1.3 Informational Submittals.

**a.** Qualification Data: For Installer, manufacturer, and testing agency.

**b.** Field quality-control reports.

**263213-1.4 Closeout Submittals.**

**a.** Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
  **i.** Include the following:
    **1.** List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    **2.** Operating instructions laminated and mounted adjacent to generator location.
    **3.** Training plan.

**263213-1.5 QUALITY ASSURANCE**

**a.** Installer Qualifications: Manufacturer's authorized representative who is trained and approved by manufacturer.

**b.** Testing Agency Qualifications: Member company of NETA or an NRTL.
  **i.** Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## CONSTRUCTION METHODS

**263213-2.1 Examination.**

**a.** Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

**b.** Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

**c.** Proceed with installation only after unsatisfactory conditions have been corrected.

**263213-2.2 Installation.**

**a.** Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

**b.** Equipment Mounting:
  **i.** Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Item P-610 “Portland Structural Concrete Cement.”
  **ii.** Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

**c.** Install packaged engine-generator to provide access, without removing connections or accessories, for periodic maintenance.

**d.** Install packaged engine-generator with isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases.

**e.** Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
- **i.** Install flexible connectors and steel piping materials according to requirements in Item 232116 Hydronic Piping Specialties."
- **ii.** Insulate muffler/silencer and exhaust system components according to requirements in Item 230719 "HVAC Piping Insulation."
- **iii.** Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches (225 mm) clearance from combustibles.

**f.** Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints.

**g.** Installation requirements for piping materials and flexible connectors are specified in Item 232116 "Hydronic Piping Specialties." Copper and galvanized steel shall not be used in the fuel-oil piping system.

**h.** Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

**263213-2.3 Connections.**

**a.** Piping installation requirements are specified in other Items. Drawings indicate general arrangement of piping and specialties.

**b.** Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine-generator to allow service and maintenance.

**c.** Connect engine exhaust pipe to engine with flexible connector.

**d.** Connect fuel piping to engines with a gate valve and union and flexible connector.
- **i.** Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Item 231113 "Facility Fuel-Oil Piping."
- **ii.** Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.

**e.** Ground equipment according to Item 260526 "Grounding and Bonding for Electrical Systems."

**f.** Connect wiring according to Item L-108 “Underground Power Cable for Airports” Provide a minimum of one 90 degree bend in flexible conduit routed to the generator set from a stationary element.

**g.** Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

**263213-2.4 Identification.**

**a.** Identify system components according to Item 260553 "Identification for Electrical Systems."

**263213-2.5 Field Quality Control.**

**a.** Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

**b.** Tests and Inspections:

**i.** Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs as specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

**1.** Visual and Mechanical Inspection

**1)** Compare equipment nameplate data with drawings and specifications.
**2)** Inspect physical and mechanical condition.
**3)** Inspect anchorage, alignment, and grounding.
**4)** Verify the unit is clean.

**2.** Electrical and Mechanical Tests

**1)** Perform insulation-resistance tests in accordance with IEEE 43.

**a)** Machines larger than 200 horsepower (150 kilowatts). Test duration shall be 10 minutes. Calculate polarization index.
**b)** Machines 200 horsepower (150 kilowatts) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.

**2)** Test protective relay devices.
**3)** Verify phase rotation, phasing, and synchronized operation as required by the application.
**4)** Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
**5)** Conduct performance test in accordance with NFPA 110.
**6)** Verify correct functioning of the governor and regulator.

**ii.** NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

**iii.** Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

**1.** Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
**2.** Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
**3.** Verify acceptance of charge for each element of the battery after discharge.
**4.** Verify that measurements are within manufacturer's specifications.

**iv.** Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

**v.** System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

**vi.** Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

**vii.** Exhaust Emissions Test: Comply with applicable government test criteria.

**viii.** Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

**ix.** Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

**x.** Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

**c.** Coordinate tests with tests for transfer switches and run them concurrently.

**d.** Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

**e.** Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

**f.** Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

**g.** Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

**h.** Remove and replace malfunctioning units and retest as specified above.

**i.** Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

**j.** Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

**k.** Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

**i.** Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

**ii.** Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

**iii.** Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**263213-2.6 Airport Requirements**

**a.** The existing generator has an illuminated red light mounted on the roof of the ALV that is visible from the ATCT to provide visual confirmation the generator is running. The new generator will connect to this existing light to provide the same visual cue to tower personnel. In addition, the ALCMS will provide positive feedback when the generator is running.

**263213-2.7 Demonstration.**

**a.** Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment. Rather it shall be considered subsidiary to Item A-001-1 ‘Airfield Lighting Vault Expansion’.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 263213

# Item 263600 - Transfer Switches

## DESCRIPTION

### 263600-1.1 Summary.

**a.** Section includes automatic transfer switches rated 600 V and less, including the following:
  **i.** Bypass/isolation switches.

### 263600-1.2 Quality Assurance.

**a.** Testing Agency Qualifications:
  **i.** Member company of NETA.

    **1.** Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## CONSTRUCTION METHODS

### 260529-2.1 Installation.

**a.** Floor-Mounting Switch: Anchor to floor by bolting.
  **i.** Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Item P-610 “Portland Structural Concrete Cement”.
  **ii.** Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
  **iii.** Provide workspace and clearances required by NFPA 70.

**b.** Identify components according to Item 260553 "Identification for Electrical Systems."

**c.** Set field-adjustable intervals and delays, relays, and engine exerciser clock.

**d.** Comply with NECA 1.

### 260529-2.2 Connections.

**a.** Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

**b.** Wiring Method: Install cables in raceways except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
  **i.** Comply with requirements for raceways and boxes specified in Item 260533 "Raceways and Boxes for Electrical Systems."

**c.** Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

**d.** Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

**e.** Connect wiring according to Item 260519 "Low-Voltage Electrical Power Conductors and Cables"

**f.** Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

**260529-2.3 Field Quality Control.**

**a.** Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

**b.** Perform the following tests and inspections with the assistance of a factory-authorized service representative:

**i.** After installing equipment, test for compliance with requirements according to NETA ATS.

**ii.** Visual and Mechanical Inspection:

**1.** Compare equipment nameplate data with Drawings and Specifications.

**2.** Inspect physical and mechanical condition.

**3.** Inspect anchorage, alignment, grounding, and required clearances.

**4.** Verify that the unit is clean.

**5.** Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

**6.** Verify that manual transfer warnings are attached and visible.

**7.** Verify tightness of all control connections.

**8.** Inspect bolted electrical connections for high resistance using one of the following methods, or both:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

**9.** Perform manual transfer operation.

**10.** Verify positive mechanical interlocking between normal and alternate sources.

**11.** Perform visual and mechanical inspection of surge arresters.

**12.** Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.

3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

**iii.** Electrical Tests:

**1.** Perform insulation-resistance tests on all control wiring with respect to ground.
**2.** Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
**3.** Verify settings and operation of control devices.
**4.** Calibrate and set all relays and timers.
**5.** Verify phase rotation, phasing, and synchronized operation.
**6.** Perform automatic transfer tests.
**7.** Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

**iv.** Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
**1.** Check for electrical continuity of circuits and for short circuits.
**2.** Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
**3.** Verify that manual transfer warnings are properly placed.
**4.** Perform manual transfer operation.

**v.** After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
**1.** Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
**2.** Simulate loss of phase-to-ground voltage for each phase of normal source.
**3.** Verify time-delay settings.
**4.** Verify pickup and dropout voltages by data readout or inspection of control settings.
**5.** Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
**6.** Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
**7.** Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

**c.** Coordinate tests with tests of generator and run them concurrently.

**d.** Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

**e.** Transfer switches will be considered defective if they do not pass tests and inspections.

**f.** Remove and replace malfunctioning units and retest as specified above.

**g.** Prepare test and inspection reports.

**h.** Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

**i.** Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

**ii.** Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

**iii.** Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

**260529-2.4 Demonstration.**

**a.** Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

**b.** Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

**c.** Coordinate this training with that for generator equipment.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 263600

# Item 264113 Lightning Protection for Structures

## DESCRIPTION

### 264113-1.1 Summary.

**a.** Section includes lightning protection system for the following:
  **i.** Airfield lighting vault.

### 264113-1.2 Action Submittals.

**a.** Product Data: For each type of product.

**b.** Shop Drawings:
  **i.** Include layouts of the lightning protection system, with details of the components to be used in the installation.
  **ii.** Include raceway locations needed for the installation of conductors.
  **iii.** Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
  **iv.** Include roof attachment details, coordinated with roof installation.
  **v.** Calculations required by NFPA 780 for bonding of metal bodies.

### 264113-1.3 Informational Submittals.

**a.** Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  **i.** Lightning protection cabling attachments to roofing systems and accessories.
  **ii.** Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
  **iii.** Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

**b.** Qualification Data: For Installer.

**c.** Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

**d.** Field quality-control reports.

### 264113-1.4 Closeout Submittals.

**a.** Maintenance Data: For lightning protection system to include in maintenance manuals.
  **i.** Include the following:
    **1.** A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

**b.** Completion Certificate:
**i.** UL Master Label Certificate**.**

**264113-1.5 Quality Assurance.**

**a.** Installer Qualifications: UL-listed installer, category OWAY.

## EQUIPMENT AND MATERIALS

**264113-2.1 Performance Requirements.**

**a.** NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

**b.** UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

**c.** Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

**264113-2.2 Materials.**

**a.** Air Terminals:
**i.** Copper unless otherwise indicated.
**ii.** 1/2-inch (12.7-mm) diameter by 24 inches (610 mm) long.
**iii.** Pointed tip.
**iv.** Threaded base support.

**b.** Class 1 Main Conductors:
**i.** Stranded Copper: 115,000 circular mils in diameter.

**c.** Secondary Conductors:
**i.** Stranded Copper: 26,240 circular mils in diameter.

**d.** Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

## CONSTRUCTION METHODS

**264113-3.1 Installation.**

**a.** Install lightning protection components and systems according to NFPA 780.

**b.** Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches (203 mm) in radius and narrow loops.

**264113-3.2 Connections.**

**a.** Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: exothermic weld.

**b.** Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
- **i.** Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
- **ii.** Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

**264113-3.3 Corrosion Protection.**

**a.** Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

**b.** Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

**264113-3.4 Field Quality Control.**

**a.** Special Inspections: Engage a qualified special inspector to perform the following special inspections:
- **i.** Perform inspections as required to obtain a UL Master Label for system.
- **ii.** Perform inspections to obtain an LPI certification.

**b.** Prepare test and inspection reports and certificates.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 264113

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# Item 265119 LED Interior Lighting

## DESCRIPTION

### 265119-1.1 Summary.

**a.** Section Includes:
  **i.** Interior solid-state luminaires that use LED technology.

### 265119-1.2 Definitions.

**a.** CCT: Correlated color temperature.

**b.** CRI: Color Rendering Index.

**c.** Fixture: See "Luminaire."

**d.** IP: International Protection or Ingress Protection Rating.

**e.** LED: Light-emitting diode.

**f.** Lumen: Measured output of lamp and luminaire, or both.

**g.** Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 265119-1.3 Action Submittals.

**a.** Product Data: For each type of product.
  **i.** Include data on features, accessories, and finishes.
  **ii.** Include physical description and dimensions of luminaires.
  **iii.** Include emergency lighting units, including batteries and chargers.
  **iv.** Include life, output (lumens, CCT, and CRI), and energy efficiency data.

### 265119-1.4 Informational Submittals.

**a.** Qualification Data: For testing laboratory providing photometric data for luminaires.

**b.** Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
  **i.** Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  **ii.** Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

**c.** Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

**d.** Product Certificates: For each type of luminaire.

**e.** Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

**f.** Sample warranty.

**265119-1.5 Closeout Submittals.**

**a.** Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
**i.** Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

**265119-1.6 Quality Assurance.**

**a.** Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

**b.** Provide luminaires from a single manufacturer for each luminaire type.

**c.** Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

**265119-1.7 Delivery, Storage, and Handling.**

**a.** Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

**265119-1.8 Warranty.**

**a.** Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

**b.** Warranty Period: Five year(s) from date of Substantial Completion.

## EQUIPMENT AND MATERIALS

**265119-2.1 Performance Requirements.**

**a.** Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE.

**b.** Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

**i.** The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

**265119-2.2 Luminaire Requirements.**

**a.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

**c.** CRI of minimum 70. CCT of 4,000K.

**d.** Rated lamp life of 100,000 hours.

**e.** Lamps dimmable from 100 percent to 0 percent of maximum light output.

**f.** Internal driver.

**g.** Nominal Operating Voltage: Universal (120-277 V ac)
- **i.** Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

**h.** Housings:
- **i.** Steel housing and extruded aluminum heat sink.
- **ii.** Powder-coat finish.

**265119-2.3 Surface Mount, Linear**

**a.** Minimum 4000 lumens. Minimum allowable efficacy of 110 lumens per watt.

**b.** Integral junction box with conduit fittings.

**265119-2.4 Materials.**

**a.** Metal Parts:
- **i.** Free of burrs and sharp corners and edges.
- **ii.** Sheet metal components shall be steel unless otherwise indicated.
- **iii.** Form and support to prevent warping and sagging.

**b.** Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

**c.** Diffusers and Globes:
- **i.** Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- **ii.** Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

**d.** Housings:
- **i.** Steel housing and extruded aluminum heat sink.
- **ii.** Powder-coat finish.

**e.** Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  **i.** Label shall include the following lamp characteristics:
    **1.** "USE ONLY" and include specific lamp type.
    **2.** Lamp diameter, shape, size, wattage, and coating.
    **3.** CCT and CRI for all luminaires.

**265119-2.5 Luminaire Fixture Support Components.**

**a.** Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## CONSTRUCTION METHODS

**265119-3.1 Examination.**

**a.** Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

**b.** Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

**265119-3.2 Temporary Lighting.**

**a.** If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

**265119-3.3 Installation.**

**b.** Comply with NECA 1.

**c.** Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

**d.** Install lamps in each luminaire.

**e.** Supports:
  **i.** Sized and rated for luminaire weight.
  **ii.** Able to maintain luminaire position after cleaning and relamping.
  **iii.** Provide support for luminaire without causing deflection of ceiling or wall.
  **iv.** Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

**f.** Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

**265119-3.4 Identification.**

**a.** Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**265119-3.5 Field Quality Control**

**a.** Perform the following tests and inspections:
  **i.** Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  **ii.** Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

**b.** Luminaire will be considered defective if it does not pass operation tests and inspections.

**c.** Prepare test and inspection reports.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 265119

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# Item 265619 LED Exterior Lighting

## DESCRIPTION

### 265619-1.1 Summary.

- **a.** Section Includes:
  - **i.** Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

### 265619-1.2 Definitions.

- **a.** CCT: Correlated color temperature.
- **b.** CRI: Color rendering index.
- **c.** Fixture: See "Luminaire."
- **d.** IP: International Protection or Ingress Protection Rating.
- **e.** Lumen: Measured output of lamp and luminaire, or both.
- **f.** Luminaire: Complete lighting unit, including lamp, reflector, and housing.

### 265619-1.3 Action Submittals.

- **a.** Product Data: For each type of luminaire.
  - **i.** Arrange in order of luminaire designation.
  - **ii.** Include data on features, accessories, and finishes.
  - **iii.** Include physical description and dimensions of luminaire.
  - **iv.** Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
  - **v.** Wiring diagrams for power, control, and signal wiring.
  - **vi.** Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

### 265619-1.4 Closeout Submittals.

- **a.** Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.
  - **i.** Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

### 265619-1.5 Quality Assurance.

- **a.** Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

**b.** Provide luminaires from a single manufacturer for each luminaire type.

**c.** Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

**265619-1.6 Delivery, Storage, and Handling.**

**a.** Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

**265619-1.7 Warranty.**

**a.** Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- **i.** Failures include, but are not limited to, the following:
  - **1.** Structural failures, including luminaire support components.
  - **2.** Faulty operation of luminaires and accessories.
  - **3.** Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- **ii.** Warranty Period: 2 year(s) from date of Substantial Completion.

## EQUIPMENT AND MATERIALS

**265619-2.1 Performance Requirements.**

**a.** Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE.

**b.** Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

- **i.** The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

**265619-2.2 Luminaire Requirements.**

**a.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**b.** UL Compliance: Comply with UL 1598 and listed for wet location.

**c.** CRI of 70. CCT of 5000 K.

**d.** L70 lamp life of 50,000 hours.

**e.** Internal driver.

**f.** Nominal Operating Voltage: Universal (120-277V ac).

**g.** Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

**h.** Source Limitations: Obtain luminaires from single source from a single manufacturer.

**265619-2.3 Materials.**

**a.** Metal Parts: Free of burrs and sharp corners and edges.

**b.** Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

**c.** Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

**d.** Diffusers and Globes:
- **i.** Glass: Annealed crystal glass unless otherwise indicated.
- **ii.** Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

**e.** Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

**f.** Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
- **i.** White Surfaces: 85 percent.
- **ii.** Specular Surfaces: 83 percent.
- **iii.** Diffusing Specular Surfaces: 75 percent.

**g.** Housings:
- **i.** Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
- **ii.** Provide filter/breather for enclosed luminaires.

**h.** Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
- **i.** Label shall include the following lamp characteristics:
  - **1.** "USE ONLY" and include specific lamp type.
  - **2.** Lamp diameter, shape, size, wattage and coating.
  - **3.** CCT and CRI for all luminaires.

**265619-2.4 Finishes.**

**a.** Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**b.** Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

**265619-2.5 Luminaire Support Components.**

**c.** Comply with requirements in Item 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

## CONSTRUCTION METHODS

**265619-3.1 Examination.**

**a.** Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

**b.** Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

**c.** Examine walls for suitable conditions where luminaires will be installed.

**d.** Proceed with installation only after unsatisfactory conditions have been corrected.

**265619-3.2 General Installation Requirements.**

**a.** Comply with NECA 1.

**b.** Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

**c.** Install lamps in each luminaire.

**d.** Fasten luminaire to structural support.

**e.** Supports:
- **i.** Sized and rated for luminaire weight.
- **ii.** Able to maintain luminaire position after cleaning and relamping.
- **iii.** Support luminaires without causing deflection of finished surface.
- **iv.** Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

**f.** Wiring Method: Install cables in raceways. Conceal raceways and cables.

**g.** Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

**h.** Coordinate layout and installation of luminaires with other construction.

**i.** Adjust luminaires that require field adjustment or aiming.

**j.** Comply with requirements in Item 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

**265619-3.3 Corrosion Prevention.**

**a.** Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

**265619-3.4 Identification.**

**a.** Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**265619-3.5 Field Quality Control.**

**a.** Inspect each installed luminaire for damage. Replace damaged luminaires and components.

**b.** Perform the following tests and inspections:
- **i.** Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

**c.** Illumination Tests:
- **i.** Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
  - **1.** IES LM-5.
  - **2.** IES LM-50.
  - **3.** IES LM-52.
  - **4.** IES LM-64.
  - **5.** IES LM-72.
- **ii.** Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

**d.** Luminaire will be considered defective if it does not pass tests and inspections.

**e.** Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**265619-3.6 Demonstration.**

**a.** Train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

**265619-3.7** ADJUSTING

**a.** Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  **i.** During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  **ii.** Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  **iii.** Adjust the aim of luminaires in the presence of the Architect.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

## END OF ITEM 265619

# Item 280513 Conductors and Cables for Electronic Safety and Security

## DESCRIPTION

### 280513-1.1 Summary.

**a.** Section Includes:
- **i.** Fire alarm wire and cable.
- **ii.** Security wire and cable
- **iii.** Identification products.

### 280513-1.2 Definitions.

**a.** EMI: Electromagnetic interference.

**b.** IDC: Insulation displacement connector.

**c.** Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

**d.** Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

### 280513-1.3 Action Submittals.

**a.** Product Data: For each type of product.

### 280513-1.4 Informational Submittals.

**a.** Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

**b.** Source quality-control reports.

**c.** Field quality-control reports.

## EQUIPMENT AND MATERIALS

### 280513-2.1 Performance Requirements.

**a.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

**280513-2.2 Fire Alarm Wire and Cable.**

**a.** General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

**b.** Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG size as recommended by system manufacturer.
- **i.** Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

**c.** Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
- **i.** Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
- **ii.** Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.

**280513-3.2 Security Wire and Cable**

**a.** Minimum Specifications:
- **i.** All wire and cable shall be UL approved, meet all national, state and local codes, and manufacturers' recommendations for connected components for its intended application.
- **ii.** Plenum rated cable shall be used in all return air plenum spaces and where required by code.
- **iii.** Insulation shall be rated for a minimum of 300 volts.
- **iv.** Conductors shall be 100% copper.
- **v.** Cable shall be shielded where required by equipment manufacturer.
- **vi.** Category 6 data cabling (to Security Panel) by Telecom Contractor

**280513-2.3 Identification Products.**

**a.** Comply with requirements in Section 260553 "Identification for Electrical Systems."

## CONSTRUCTION METHODS

**280513-3.1 Wiring Method.**

**a.** Install wiring in metal pathways and wireways.
- **i.** Minimum conduit size shall be 3/4 inch (21 mm)

**280513-3.2 Installation of Conductors and Cables.**

**a.** Comply with NECA 1 and NFPA 70.

**b.** Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

**c.** Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

**280513-3.3 Fire Alarm Wiring Installation.**

**a.** Comply with NECA 1 and NFPA 72.

**b.** Wiring Method: Install wiring in metal pathway according to Section 280528 "Pathways for Electronic Safety and Security."

**i.** Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

**c.** Wiring Method:

**i.** Cables and pathways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

**ii.** Fire-Rated Cables: Use of two-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.

**iii.** Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

**d.** Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

**e.** Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

**f.** Color Coding: Color code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and another for supervisory circuits. Color code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

**g.** Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

**280513-3.4 Connections.**

**a.** Comply with requirements in Item 283112 "Zoned (DC Loop) Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

**280513-3.5 Identification.**

**a.** Comply with requirements for identification specified in Item 260553 "Identification for Electrical Systems."

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 280513**

# SECTION 281500

# INTEGRATED ACCESS CONTROL HARDWARE DEVICES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Integrated credential readers and entry management.
2. Access control credentials.
3. Electrified locking devices and accessories.
4. Egress management devices.
5. Access control remote devices.
6. Electronic key management systems.

B. Related Requirements:

1. Section 280513 " Conductors and Cables for Electronic Safety and Security".

### 1.2 DEFINITIONS

A. BMS: Building management system.

B. NFC: Near Field Communications.

C. PoE: Power over Ethernet.

### 1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings:

1. Project general notes.
2. Device layout.
3. Block diagram and cable/conduit routing.
4. System communications details.
5. System mounting details.
6. Secondary power calculations.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Installation instructions for integrated credential readers and entry management devices.
2. Manufacturer's recommended tests and inspections for integrated credential readers and entry management devices.
3. Printing, programming, and handling instructions for access control credentials.
4. Installation instructions for electrified locking devices and accessories.
5. Manufacturer's recommended tests and inspections for electrified locking devices and accessories.
6. Installation instructions for egress management devices.
7. Manufacturer's recommended tests and inspections for egress management devices.
8. Installation instructions for access control remote devices.
9. Manufacturer's recommended tests and inspections for access control remote devices.
10. Installation instructions for electronic key management systems.
11. Manufacturer's recommended tests and inspections for electronic key management systems.

B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Contracts:

1. Software and firmware service agreements.

B. Warranty documentation.

1.6 REGULATORY AGENCY APPROVALS FOR EGRESS MANAGEMENT DEVICES

A. Submittals for egress management devices requiring approval by authorities having jurisdiction must be signed and sealed by qualified life safety professional engineer responsible for their preparation. Submit for action by Architect prior to submitting for approval by authorities having jurisdiction.

B. Submittals for egress management devices require action by Architect prior to submitting for approval by authorities having jurisdiction.

1.7 QUALIFICATIONS

A. Security Design Professional: Design professional with active Physical Security Professional (PSP) certification issued by American Society for Industrial Security (ASIS) and with documented experience managing installation of security systems in similar size and complexity.

B. Security Testing and Inspecting Agency: Entity possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1.8 WARRANTY

A. Integrated Credential Readers and Entry Management Devices Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed integrated credential readers and entry management devices perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Electrified Locking Devices and Accessories Warranty:

1. Special Installer Extended Warranty: Installer warrants that fabricated and installed electrified locking devices and accessories perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.

a. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 Manufacturers and products may include, but are not limited to, the following. Alternate equipment may be proposed by the Contractor. Approvals are subject to review by the Owner and the access control integrator for specification conformance and compatibility with the existing Airport access control system.

**Required Specific Equipment list**
Software House iStar Ultra G2 controller
Altronix AL600ULXB with Batteries (POWER SUPPLY)
Altronix ACM8 (ACCESS POWER CONTROLLER)
Altronix PD8UL (POWER DISTRIBUTION MODULE)
HID Proximity ProxPro 5355
Axis P3827-PVE 180-degree outdoor camera

**Additional Non-Specific Equipment List**
Electronic Door Strikes
Door Sensing Modules
Magnetic Locks
Request to Exit Button

**Door #1- Basement Door- Single Walk Through**
HID Proximity Card Reader
Door Sensing Module
Request to Exit Button
Electric Door Strike

**Door #2- Old Storage Room Door- Single Walk Through**
HID Proximity Card Reader
Door Sensing Module
Request to Exit Button
Electric Door Strike

**Door #3- Old Regulator Room Door- Double Walk through**
HID Proximity Card Reader
Door Sensing Module
Request to Exit Button
Magnetic Lock (2 Single Mags or 1 Dual Mag)

**Door #4- Old Generator Room Door- Double Walk through**
HID Proximity Card Reader
Door Sensing Module
Request to Exit Button
Magnetic Lock (2 Single Mags or 1 Dual Mag)

**Door #5- New Regulator Room Door- Single Walk Through**
HID Proximity Card Reader
Door Sensing Module
Request to Exit Button
Electric Door Strike

**Door #6- New Regulator Room Door- Overhead Door**
HID Proximity Card Reader x2 (inside and outside)
Door Sensing Module

## PART 3 - EXECUTION

### 3.1 DEPLOYMENT OF CREDENTIALS

A. Comply with manufacturer's published instructions.

B. Third-Party Issuing of Access Control Credentials:

1. Printing of New Credentials: Contractor must be capable of programming and issuing credentials compatible with Owner's access control system.

    a. Initial Issuance: Provide spreadsheet or form for collecting data for generation of credentials. Owner will submit completed form containing data for personnel to be issued credentials. Print and provide initial run, printed and programmed credentials in specified format within four weeks of request.
    b. Ongoing Issuance: Produce additional credentials upon Owner request. Owner will submit completed form containing data for personnel to be issued credentials. Print and program credentials in specified format within two weeks of request.

## 3.2 INSTALLATION OF INTEGRATED ACCESS CONTROL HARDWARE DEVICES

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Cable Type: Unshielded.
2. Analog Maximum Cable Length: 1000 ft (300 m).
3. Digital Maximum Cable Length: 300 ft (100 m).

C. Interfaces with Other Work:

1. Coordinate access control credentials with integrated credential readers and access control system architecture.

## 3.3 FIELD QUALITY CONTROL

A. Administrant for Security Tests and Inspections:

1. Owner will engage qualified security testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified security testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Field tests and inspections must be witnessed by the authorities having jurisdiction.

C. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

D. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.4 PROTECTION

A. After installation, protect integrated access control hardware devices from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 MAINTENANCE

A. Software and Firmware Service Agreement:

1. Technical Support: Beginning at Substantial Completion, verify that software and firmware service agreement includes software and firmware support for two years.
2. Upgrade Service: At Substantial Completion, update software and firmware to latest version. Install and program software and firmware upgrades that become available within two years from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

    a. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF SECTION 281500**

# Item 283112 Zoned (DC Loop) Fire-Alarm System

## DESCRIPTION

### 283112-1.1 Summary.

**a.** Section Includes:
- **i.** Fire-alarm control unit.
- **ii.** Manual fire-alarm boxes.
- **iii.** Heat detectors.
- **iv.** Smoke detector.
- **v.** Notification appliances.
- **vi.** Digital alarm communicator transmitter.
- **vii.** Radio alarm transmitter.

**b.** Related Requirements:

- **i.** Item 280513 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

### 283112-1.2 Definitions.

**a.** EMT: Electrical Metallic Tubing.

**b.** FACP: Fire Alarm Control Panel.

**c.** NICET: National Institute for Certification in Engineering Technologies.

### 283112-1.3 Action Submittals.

**a.** Product Data: For each type of product, including furnished options and accessories.
- **i.** Include construction details, material descriptions, dimensions, and profiles and finishes.
- **ii.** Include rated capacities, operating characteristics, and electrical characteristics.

**b.** Shop Drawings: For fire-alarm system.
- **i.** Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
- **ii.** Include plans, elevations, sections, details, and attachments to other work.
- **iii.** Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
- **iv.** Detail assembly and support requirements.
- **v.** Include voltage drop calculations for notification-appliance circuits.
- **vi.** Include battery size calculations.
- **vii.** Include input/output matrix.

**viii.** Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

**ix.** Include performance parameters and installation details for each detector.

**x.** Include floor plans to indicate final outlet locations showing zone designation of each device. Show size and route of cable and conduits and point-to-point wiring diagrams.

**c.** General Submittal Requirements:

**i.** Submittals shall be approved by authorities having jurisdiction prior to submitting them to Engineer.

**ii.** Shop Drawings shall be prepared by persons with the following qualifications:

**1.** Trained and certified by manufacturer in fire-alarm system design.

**2.** NICET-certified fire-alarm technician; Level III minimum.

**3.** Licensed or certified by authorities having jurisdiction.

**d.** Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

**i.** Drawings showing the location of each heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

**ii.** Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

**iii.** Indicate audible appliances required to produce square wave signal per NFPA 72.

**283112-1.4 Informational Submittals.**

**a.** Qualification Data: For Installer.

**b.** Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

**i.** Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

**ii.** Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

**iii.** Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

**c.** Field quality-control reports.

**d.** Sample Warranty: For special warranty.

**283112-1.5 Closeout Submittals.**

**a.** Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

**i.** Include the following and deliver copies to authorities having jurisdiction:

1. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Provide the "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
3. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
4. Riser diagram.
5. Provide the "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
   1.) Equipment tested.
   2.) Frequency of testing of installed components.
   3.) Frequency of inspection of installed components.
   4.) Requirements and recommendations related to results of maintenance.
   5.) Manufacturer's user training manuals.
6. Manufacturer's required maintenance related to system warranty requirements.
7. Abbreviated operating instructions for mounting at fire-alarm control unit.

**283112-1.6 Maintenance Material Submittals.**

**a.** Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   **i.** Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   **ii.** Keys and Tools: One extra set for access to locked or tamperproofed components.
   **iii.** Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

**283112-1.7 Quality Assurance.**

**a.** Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

**b.** NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

**283112-1.8 Project Conditions.**

**a.** Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

**283112-1.9 Warranty.**

**a.** Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

**i.** Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
**ii.** Warranty Period: Five years from date of Substantial Completion.

## EQUIPMENT AND MATERIALS

### 283112-2.1 System Description.

**a.** Source Limitations for Fire-Alarm System and Components: Components shall be compatible with and operate as an extension of existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

**b.** Noncoded system dedicated to fire-alarm service only.

**c.** All components provided shall be listed for use with the selected system.

**d.** Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### 283112-2.2 Systems Operational Description.

**a.** Fire-alarm signal initiation shall be by one or more of the following devices:
**i.** Manual stations.
**ii.** Heat detectors.
**iii.** Smoke detector.

**b.** Fire-alarm signal shall initiate the following actions:
**i.** Continuously operate alarm notification appliances.
**ii.** Identify alarm zone at fire-alarm control unit.
**iii.** Transmit an alarm signal to the remote alarm receiving station.

**c.** System trouble signal initiation shall be by one or more of the following devices and actions:
**i.** Open circuits, shorts, and grounds in designated circuits.
**ii.** Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
**iii.** Loss of primary power at fire-alarm control unit.
**iv.** Ground or a single break in internal circuits of fire-alarm control unit.
**v.** Abnormal ac voltage at fire-alarm control unit.
**vi.** Break in standby battery circuitry.
**vii.** Failure of battery charging.
**viii.** Abnormal position of any switch at fire-alarm control unit.

**d.** System Trouble and Supervisory Signal Actions:
**i.** Annunciate at fire-alarm control unit.
**ii.** Record the event on system printer.
**iii.** After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

**283112-2.3 Performance Requirements.**

**a.** Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE.

**i.** The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

**283112-2.4 Fire-Alarm Control Unit.**

**a.** General Requirements for Fire-Alarm Control Unit:
**i.** Modular, power-limited design with electronic modules, UL 864 listed.
**1.** Include a real-time clock for time annotation of events.
**2.** The FACP shall be listed for connection to a central-station signaling system service.

**b.** Circuits:
**i.** No Fewer Than Two Initiating-Device Circuits:
**1.** Two circuits, NFPA 72, Class B.

**ii.** No Fewer Than One Notification-Appliance Circuits: NFPA 72, Class B.
**iii.** Pathway Survivability: Level 0.
**iv.** Serial Interfaces:
**1.** One RS 232 port for personal computer configuration.

**c.** Smoke-Alarm Verification:
**i.** Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
**ii.** Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
**iii.** Sound general alarm if the alarm is verified.
**iv.** Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

**d.** Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

**e.** Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by the 24-V dc source.
**i.** Alarm current draw of the entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

**f.** Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
**i.** Batteries: Sealed, valve-regulated, recombinant lead acid

**g.** Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe

appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

**283112-2.5 Manual Fire-Alarm Boxes.**

**a.** General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on manufacturer's surface back box.
  **i.** Single-action mechanism, pull-lever type.
  **ii.** Station Reset: Key- or wrench-operated switch.

**283112-2.6 Heat Detectors.**

**a.** General Requirements for Heat Detectors: Comply with UL 521.

**b.** Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
  **i.** Mounting: Adapter plate for outlet box mounting.

**283112-2.7 Notification Appliances.**

**a.** General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  **i.** Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

**b.** Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

**c.** Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
  **i.** Rated Light Output: as shown on plans.
  **ii.** Mounting: Wall mounted unless otherwise indicated.
  **iii.** For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  **iv.** Flashing shall be in a temporal pattern, synchronized with other units.
  **v.** Strobe Leads: Factory connected to screw terminals.
  **vi.** Mounting Faceplate: Factory finished, red.

**283112-2.8 Radio Alarm Transmitter.**

**a.** Transmitter shall comply with NFPA 1221 and 47 CFR 90.

**b.** Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.
- **i.** Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
- **ii.** Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station. Coordinate requirements with Main Fire protection Systems.
- **iii.** Normal Power Input: 120-V ac.
- **iv.** Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
- **v.** Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

**c.** Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
- **i.** Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
- **ii.** System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
- **iii.** Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
- **iv.** Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
- **v.** Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
- **vi.** Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

## CONSTRUCTION METHODS

### 283112-3.1 Examination.

**a.** Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
- **i.** Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

**b.** Examine roughing-in for electrical connections to verify actual locations of connections before installation.

**c.** Proceed with installation only after unsatisfactory conditions have been corrected.

**283112-3.2 Equipment Installation.**

**a.** Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

**b.** Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

**c.** Manual Fire-Alarm Boxes:
- **i.** Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
- **ii.** Mount manual fire-alarm box on a background of a contrasting color.
- **iii.** The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

**d.** Smoke- or Heat-Detector Spacing:
- **i.** Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
- **ii.** Smooth ceiling spacing shall not exceed 30 feet (9 m).
- **iii.** Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
- **iv.** Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

**e.** Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place, except during system testing. Remove cover prior to system turnover.

**f.** Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

**g.** Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

**283112-3.3 Pathways.**

**a.** Pathways shall be installed in EMT.

**283112-3.4 Identification.**

**a.** Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Item 260553 "Identification for Electrical Systems."

**b.** Install framed instructions in a location visible from fire-alarm control unit.

**283112-3.5 Grounding.**

**a.** Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

**b.** Ground shielded cables at the control panel location only. Insulate shield at device location.

**283112-3.6 Field Quality Control.**

**a.** Field tests shall be witnessed by Engineer.

**b.** Perform the following tests and inspections:
- **i.** Visual Inspection: Conduct the visual inspection prior to testing.
  - **1.** Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  - **2.** Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
- **ii.** System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing, and Maintenance" chapter in NFPA 72.
- **iii.** Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
- **iv.** Test visible appliances for the public operating mode according to manufacturer's written instructions.
- **v.** Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

**c.** Fire-alarm system will be considered defective if it does not pass tests and inspections.

**d.** Prepare test and inspection reports.

**283112-3.7 Demonstration.**

**a.** Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

## METHOD OF MEASUREMENT

This work shall not be measured separately for payment.

## BASIS OF PAYMENT

No separate payment will be made for items described in this specification. All costs for this work shall be considered incidental to those items requiring the various work items delineated in this Specification.

**END OF ITEM 283112**

# Item 330000 Electrical Utility Services

## DESCRIPTION

### 330000-1.1 General.

Work under this section is subject to the requirements of the Contract Documents.

Work under this section includes work by Eversource to install new pad mounted utility transformers, primary cables and connections, associated with extension of the existing three-phase primary utility service adjacent to the roadway extension, utilizing new duct bank infrastructure and equipment pads and foundations installed by the contractor. This also includes work by Eversource to coordinate and perform inspections of the installation work performed by the contractor.

Installation by the contractor of duct banks, equipment pads and foundations associated with this work are described in Item 260526 “Grounding and Bonding for Electrical Systems” and Item 260543 “Underground Ducts and Raceways for Electrical Systems.

### 330000-1.2 Utility Coordination.

A. Eversource: Contact Amanda Stone at (603) 570-8192 or amanda.stone@eversource.com for Eversource installation requirements and to coordinate all electrical utility company work.

### 330000-1.3 Quality Assurance.

A. Perform electrical utility work in accordance with Eversource written requirements including Eversource Standard “Requirements for Electric Service Connections – Information and Requirements for Electric Supply – NH 2021 Edition.”

B. Maintain one copy of each document on site.

### 330000-1.4 Special Requirements.

A. Coordinate all work with Eversource.

B. All underground conduit and ductbank infrastructure installed to support the new utility services shall be coordinated with Eversource for inspection prior to backfill.

## EQUIPMENT AND MATERIALS

**330000-2.1** Refer to Item 260526 “Grounding and Bonding for Electrical Systems” and Item 260543.1 “Underground Duct” for requirements.

## CONSTRUCTION METHODS

**330000-3.1 Work By Eversource.**

A. Eversource shall be enlisted by the contractor to perform the following services to facilitate the extension of primary three-phase electrical service adjacent to the roadway extension:

a. Install new pad-mounted utility transformers.
b. Install primary cables and make primary connections.
c. Perform necessary coordination and inspections of contractor electrical utility work.

B. All costs incurred by Eversource shall be borne by the contractor and shall be included under the Electrical Utility Service pay item. Contractor shall invoice the project for services performed by Eversource. Coordinate with Eversource as soon as NTP is given to schedule construction dates for above mentioned services.

C. Eversource may elect to delay installation of equipment and cables until after substantial completion of the contractor's work. In this instance, the contractor shall only be responsible for coordination with Eversource for the necessary inspections and approvals of the contractor's portion of the work. The contractor shall utilize the allowance pay item under this section for pre-payment to Eversource for the portion of Eversource's work which will be completed in the future.

## METHOD OF MEASUREMENT

**330000-4.1** Work performed by Eversource to complete "Electrical Utility Service" shall be measured as part of the Contract Allowance for this item.

**330000-4.2** Installation of duct bank, equipment pads and foundations, and other incidentals by the contractor shall not be measured for payment under this item but shall be paid for under other items of these specifications.

## BASIS OF PAYMENT

**330000-5.1** Payment for "Electrical Utility Service" will be paid from the Contract Allowance for the completed and accepted electrical utility service extension installed, in place and approved by the RPR and Eversource or for the agreed up future installation of electrical utility cables and equipment by Eversource. The cost paid to the contractor shall be the direct cost invoiced to the contractor by Eversource without markup. This price shall be full compensation for furnishing all materials and for preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item 330000-1 Electrical Utility Service – per Allowance

## END OF ITEM 330000

SECTION 024100

DEMOLITION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included:

1. Demolition and removal of selected portions of buildings and structures and as required for new work. Refer to the Drawings for additional requirements.
2. Demolition and removal of selected site elements and as required for new work. Refer to the Drawings for additional requirements.
3. Salvage of existing items to be reused or turned over to the facility.
4. Removal and legal disposal of demolished materials off site. Except those items specifically designated to be relocated, reused, or turned over to the facility, all existing removed materials, items, trash and debris shall become property of the Contractor and shall be completely removed from the site and legally disposed of at their expense. Salvage value belongs to the Contractor. On-site sale of materials is not permitted.
5. Demolition and removal work shall properly prepare for alteration work and new construction to be provided under the Contract.
6. Scheduling and sequencing operations without interruption to utilities serving occupied areas. If interruption is required, obtain written permission from the utility company and the Owner.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Division 21 - FIRE PROTECTION:

a. Disconnecting, capping and otherwise making inactive existing fire protection services in areas where demolition and removal work is required.

b. Disconnect and reinstallation of fire protection equipment temporarily interrupted during construction.

2. Division 22 - PLUMBING:

a. Disconnecting, capping and otherwise making inactive existing plumbing services in areas where demolition and removal work is required.
b. Disconnection and reinstallation of plumbing equipment temporarily interrupted during construction.

3. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING:

a. Disconnecting, capping and otherwise making inactive existing HVAC services in areas where demolition and removal work is required.
b. Disconnect and reinstallation of HVAC equipment temporarily interrupted during construction.

4. Division 26 - ELECTRICAL WORK:

a. Disconnecting, capping and otherwise making inactive existing electrical services in areas where demolition and removal work is required.
b. Disconnect and reinstallation of electrical equipment temporarily interrupted during construction.

5. Section 311000 – SITE CLEARING:

a. Excavating and removal of existing pavement, sub-surface building and utility structures and lines, appurtenances, and other elements indicated on the Drawings.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Detach items from existing construction and deliver them to the Owner ready for reuse, at a location designated by the Owner. Protect from weather until accepted by Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated. Protect from weather until reinstallation.

D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with early and late starting and finishing dates for each activity. Ensure Owner's on-site operations are uninterrupted if applicable.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other occupants affected by selective demolition operations.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner’s partial occupancy of completed Work.
6. Means of protection for items to remain and items in path of waste removal from building.

B. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged, and turned over the Owner.

C. Predemolition Video and Pictures: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01 requirements. Submit before Work begins.

1.5 QUALITY ASSURANCE

A. Examination of Existing Conditions: The Contractor shall examine the Contract Drawings for demolition and removal requirements and provisions for new work. Verify all existing conditions and dimensions before commencing work. The Contractor shall visit the site and examine the existing conditions as he finds them and shall inform herself/himself of the character, extent and type of demolition and removal work to be performed. Submit any questions regarding the extent and character of the demolition and removal work in the manner and within the time period established for receipt of such questions during the bidding period.

B. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

C. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Standards: Comply with ANSI A10.6 and NFPA 241.

E. Predemolition Conference: Conduct conference at Project site to comply with requirements in Section 011000 - GENERAL REQUIREMENTS, Project Meetings. Review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 SALVAGING

A. Salvaged for Reinstallation: Materials indicated on the Drawings to be salvaged and reinstalled shall be carefully removed and stored at a location acceptable to the Architect and Owner.

B. Salvaged for Storage: Materials indicated on the Drawings or designated in the field by the Owner to be salvaged and stored shall be carefully removed and delivered to the Owner at locations determined by Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Engage a professional engineer registered in New Hampshire to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction videotapes.

1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

G. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities with utility companies and Owner.
2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.
4. Prior to commencing cutting work in existing surfaces, take all precautionary measures to assure that mechanical and electrical services to the particular area have been made inactive. Coordinate with Fire Suppression, Plumbing, HVAC, and Electrical subcontractors. Only licensed tradesmen of that particular trade shall disconnect and cap existing mechanical and electrical items that are to be removed, abandoned and/or relocated.
5. If, during the process of cutting work, existing utility lines are encountered which are not indicated on the Drawings, regardless of their condition, immediately report such items to the Architect. Do not proceed with work in such areas until instructions are issued by the Architect. Continue work in other areas.

## 3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 011000 - GENERAL REQUIREMENTS, Temporary Facilities and Controls.
2. Maintain adequate passage to and from all exits at all times. Before any work is done which significantly alters access or egress patterns, consult with the Architect and obtain approval of code required egress. Under no condition block or interfere with the free flow of people at legally required exits, or in any way alter the required condition of such exits.

B. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.
2. Remove temporary shoring, bracing and structural supports when no longer required.
3. Post warning signs and place barricades as applicable during placement and removal of temporary shoring.

C. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area(s).

1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction. Provide temporary barricades as required to limit access to demolition areas.
2. Protect existing site improvements, appurtenances, and landscaping to remain.

## 3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Maintain clear unimpeded passage through the work area for safety and emergency egress.
10. Saw cut overruns in concrete and masonry for new door, window and other finish openings is not permitted. Core drill corners and finish square to match required opening.
11. Dispose of demolished items and materials promptly.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.

4. Transport items to storage area designated by the Owner.
5. Protect items from damage during transport and storage.

C. Removed Items for Reinstallation by the Respective Trade.

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area designated by the Owner.
5. Protect items from damage during transport and storage.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

E. Items for Re-use and Preservation of Existing Surfaces to Remain:

1. The Contractor shall inspect closely each item specifically designated to be relocated, re-used, or turned over to the Owner prior to its removal, and immediately report damages and defects to the Architect and the Owner. The Contractor shall be responsible for any subsequent damage to the same other than latent defects not readily apparent from close inspection, and shall bear responsibility for its repair or same replacement as directed by the Architect, to the satisfaction of the Owner.
2. Unless special surface preparation is specified under other Specification Sections, leave existing surfaces that are to remain in a condition suitable to receive new materials and/or finishes.

## 3.5 PROTECTION OF PUBLIC AND PROPERTY

A. Provide all measures required by federal, state and municipal laws, regulations, and ordinances for the protection of surrounding property, the public, workmen, and Owner’s employees during all demolition and removal operations. Measures are to be taken, but not limited to installation of sidewalks, sheds, barricades, fences, warning lights and signs, trash chutes and temporary lighting.

B. Protect all walks, roads, streets, curbs, pavements, trees and plantings, on and off premises, and bear all costs for correcting such damage as directed by the Architect, and to the satisfaction of the Owner.

C. Demolition shall be performed in such a manner that will insure the safety of adjacent property. Protect adjacent property from damage and protect persons occupying adjacent property from

injuries which might occur from falling debris or other cause and so as not to cause interference with the use of other portions of the building, of adjacent buildings or the free access and safe passage to and from the same.

D. Every precaution shall be taken to protect against movement or settlement of the building, of adjacent buildings, sidewalks, roads, streets, curbs and pavements. Provide and place at the Contractor's own expense, all necessary bracing and shoring in connection with demolition and removal work.

E. Remove portions of structures with care by using tools and methods that will not transfer heavy shocks to existing and adjacent building structures, both internal and external of the particular work area.

F. Provide and maintain in proper condition, suitable fire resistive dust barriers around areas where interior demolition and removal work is in progress. Dust barriers shall prevent the dust migration to adjacent areas. Remove dust barriers upon completion of major demolition and removal in the particular work area.

## 3.6 DISCOVERY OF HAZARDOUS MATERIALS

A. If hazardous materials, such as chemicals, asbestos-containing materials, or other hazardous materials are discovered during the course of the work, cease work in affected area only and immediately notify the Architect and the Owner of such discovery. Do not proceed with work in such areas until instructions are issued by the Architect. Continue work in other areas.

B. If unmarked containers are discovered during the course of the work, cease work in the affected area only and immediately notify the Architect and the Owner of such discovery. Do not proceed with work in such areas until instructions are issued by the Architect. Take immediate precautions to prohibit endangering the containers integrity. Continue work in other areas.

## 3.7 CUTTING

A. Perform all cutting of existing surfaces in a manner which will ensure a minimal difference between the cut area and new materials when patched. Use extreme care when cutting existing surfaces containing concealed utility lines which are indicated to remain and bear full responsibility for repairing or replacement of all such utilities that are accidentally damaged.

B. Provide a flush saw cut edge where pavement, curb and concrete removals abut new construction work or existing surfaces to remain undisturbed.

C. All slurry and water shall be contained and managed to avoid damage to existing conditions when using a wet saw or wet core driller.

D. Obtain and pay for a hot work permit and arrange to have on-site a Fire Watch when using a cutting torch or similar item.

## 3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. General:

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

## 3.9 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Premises shall be left in a clean condition and ready to accept alteration work and new construction.

END OF SECTION

# SECTION 042000

# UNIT MASONRY

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Ground face concrete masonry units matching existing.
2. Concrete masonry units.
3. Embedded flashing.
4. Mortar and grout.
5. Reinforcing steel, masonry joint reinforcement, ties and anchors.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 072100 - THERMAL INSULATION for cavity wall insulation.
2. Section 072700 - AIR BARRIERS for membrane air barrier.
3. Section 078440 - FIRE-RESISTIVE JOINT SYSTEMS for fire-resistive joint systems openings in masonry walls and at heads of masonry walls.
4. Section 079200 - JOINT SEALANTS for sealing control and expansion joints in unit masonry.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

C. Samples for Verification: For each type and color of the following:

1. Exposed concrete masonry units.
2. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
3. Weep holes/vents.
4. Accessories embedded in masonry.

D. Qualification Data: For testing agency.

E. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units:

a. Include material test reports substantiating compliance with requirements.
b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

F. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780 for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019 for grout mixes required to comply with compressive strength requirement.

G. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

## 1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Preconstruction Testing Service: The Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Payment for these services will be made by the Owner. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

1. Prism Test: For each type of construction required, per ASTM C 1314.

E. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

F. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 01 for mockups.

1. Build sample panels for typical exterior and interior walls in sizes approximately 48 inches long by 48 inches high by full thickness.
2. Clean one-half of exposed faces of panels with masonry cleaner indicated.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

G. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not uses units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01. Agenda shall include protection of air barrier membrane during construction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

A. Protection of Air Barrier Membrane: During construction, protect air barrier membrane from penetrations which allow air to pass through air barrier assemblies. Engage original installer to repair damage promptly using identical materials and methods of installation, and to the satisfaction of the Architect.

B. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day’s work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

C. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

D. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

E. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

F. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## PART 2 - PRODUCTS

### 2.1 CONCRETE MASONRY UNITS (CMUS)

A. Concrete Masonry Units: ASTM C 90, normal weight unless indicated otherwise manufactured to dimensions 3/8 inch less than nominal dimensions.

B. Shapes: Provide standard shapes indicated and as required for building configuration. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

C. Decorative Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi
2. Weight Classification: Normal weight.
3. Size (Width): Manufactured to dimensions specified in "Concrete Masonry Units" Paragraph above.
4. Pattern and Texture:

    a. Standard pattern, ground finish. Match existing.

5. Colors: As selected by Architect from manufacturer's full range.
6. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.
7. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A Jandris & Sons
    b. Trenwyth Industries.
    c. Westbrook Concrete Block Co.

D. Integral Water Repellent: Provide units made with integral water repellent for exterior exposed units.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E 514, with test period extended to 24 hours, show no visible water or leaks on the back of test specimen. Available products include:

    a. ACM Chemistries: RainBlock
    b. Addiment Incorporated, a Div. of Grace Construction Products; Block Plus W-10.
    c. GCP Applied Technologies (formerly W.R. Grace); Dry-Block.
    d. BASF Construction Chemicals; Masterpel.

## 2.2 MORTAR AND GROUT MATERIALS

A. Regional Materials: Provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Available Products:

a. LanXess; Bayferrox Iron Oxide Pigments.
b. Davis Colors; True Tone Mortar Colors.
c. Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.

E. Aggregate for Mortar: ASTM C 144. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

F. Aggregate for Grout: ASTM C 404.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer. Available products include:

1. Addiment Incorporated, a Div. of Grace Construction Products; Mortar Tite.
2. GCP Applied Technologies (formerly W.R. Grace); Dry-Block Mortar Admixture.
3. BASF Construction Chemicals; MasterPel Mortar Admixture.

H. Water: Potable.

## 2.3 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Mill-galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size and Spacing: As required by Code.

4. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod at each wythe of masonry 4 inches or less in width.

2.4 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with subparagraphs below, unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 316.
3. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
5. Stainless Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

B. Partition Top Anchors: 0.097-inch-thick metal plate with 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

C. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, with structural performance capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
2. Screw-Attached, Masonry-Veneer Anchors: Units equal to HB-213 Adjustable Veneer Anchor by Hohmann & Barnard, Inc., consisting of a wire tie and a metal anchor section.

a. Anchor Section: Rib-stiffened, sheet metal plate with 9/32 inch diameter screw holes top and bottom, 2-3/4 inches wide by 3 inches high; with projecting tabs having slotted holes with 1-1/4 inch maximum allowable eccentricity, sized to prevent in-and-out movement beyond allowable tolerances, for inserting vertical legs of wire tie specially formed to fit anchor section.
b. Wire Ties: Rectangular-shaped wire ties fabricated from 0.188-inch-diameter, hot-dip galvanized steel wire.

## 2.5 MISCELLANEOUS ANCHORS

A. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

## 2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with Section 076200 - SHEET METAL FLASHING AND TRIM and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
2. Configuration: Provide continuous flashing including preformed outside, inside corners, and end dams with smooth uninterrupted soldered seams and hemmed edges to maintain continuity. See drawings for profiles required.

B. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 – SHEET METAL FLASHING AND TRIM.

C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates. Verify compatibility between flashing materials and substrates.

D. Transition Strips: Provide long-term compatible 6" wide transition strips to seal embedded flashing terminations to air barrier membrane.

E. Drip Edge: Provide type 316, 0.016 inch (0.40 mm) thick stainless steel drip edge plates with factory applied adhesive strip for all through-wall flashing conditions. Provide preformed outside and inside corner drip plate corners with smooth uninterrupted soldered seams and hemmed drip edges to maintain continuity. Custom sizes will be required see drawings for profiles required.

## 2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Provide strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings or equivalent. Available products:

1. Advanced Building Products Inc.; Mortar Break II.
2. Archovations, Inc.; CavClear Masonry Mat.
3. Hohmann & Barnard; MortarTrap.
4. Mortar Net USA, Ltd.; Mortar Net.

## 2.8 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Available Manufacturers:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

## 2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement and lime.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

C. Pigmented Mortar: Use colored cement product. Pigments shall not exceed 10 percent of portland cement by weight.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed. Do not use units cut to less than one-half size.

E. Do not install concrete masonry units with more than 5 percent damage to the face. Do not install brick units which will show defects after installation.

F. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

G. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

H. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

## 3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs. Prior to installation review bond pattern with Architect.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

E. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

F. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

G. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c., unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078440 – FIRE-RESISTIVE JOINT SYSTEMS.

## 3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

## 3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
2. Masonry Veneer Anchors: Comply with requirements for anchoring masonry veneers.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

D. Coordinate and allow access for air and vapor barrier membrane installed in cavity under Section 072700 - AIR BARRIERS.

## 3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches. Space reinforcement not more than 16 inches o.c.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

## 3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

## 3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through insulation and sheathing to wall framing and to concrete and masonry backup as applicable with metal fasteners of type indicated.
2. Embed tie sections in masonry joints. Provide air space indicated on the Drawings between back of masonry veneer and face of insulation.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as required by Code.

## 3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of concrete masonry units on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick made from clay or shale as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
2. Build flanges of factory-fabricated, expansion-joint units into masonry.
3. Build in compressible joint fillers where indicated.
4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 - JOINT SEALANTS.

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 - JOINT SEALANTS but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

## 3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

## 3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge covered with elastomeric membrane, lapping at least 4 inches.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
5. Install air barrier transition strips to seal embedded flashings in masonry to air barrier membrane in accordance with Section 072700 – AIR BARRIERS.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install metal drip edge plate in accordance with architectural details and manufacturer’s requirements.

E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches o.c., unless otherwise indicated.

F. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 “Miscellaneous Masonry Accessories” Article.

G. Install vents in head joints in exterior wythes at spacing indicated.

## 3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

## 3.13 FIELD QUALITY CONTROL

A. Inspectors: Owner will engage qualified independent inspectors to perform inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports. Retesting of materials failing to comply with specified requirements shall be done at Contractor’s expense.

C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof. Test types as determined by the independent testing and inspection agency.

## 3.14 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent

construction, to provide a neat, uniform appearance. Prepare joints for sealant application, around penetrations and where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

## 3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 - EARTHWORK.
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off the Site.

END OF SECTION 042000

# SECTION 055000

# METAL FABRICATIONS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following. Requirements for materials, hot-dip galvanizing, and shop-applied primers are included with each item as applicable.

1. Galvanized steel lintels at exterior and interior locations.
2. Steel lintels with shop-applied zinc-rich primer at interior locations.
3. Galvanized steel framing and supports for sectional doors.
4. Galvanized steel ladder and cross-over at coping at exterior.
5. Galvanized steel ladder at interior.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 033000 - CAST-IN-PLACE CONCRETE for lintels, sleeves, anchors, inserts, plates and similar items.
2. Section 042000 - UNIT MASONRY for lintels, miscellaneous metal and iron sleeves, anchors, inserts and plates to be built into masonry walls.
3. Section 055100 - METAL STAIRS AND RAILINGS for steel stairs, handrails, and guardrails.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal fabrications and supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

C. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 1.4 SUBMITTALS

A. Product Data: For each product.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. Where fabrications are to receive sprayed-on fireproofing, include statement that primer is compatible with fireproofing proposed for use.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Qualification Data: For professional engineer.

## 1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in New Hampshire and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal fabrications that are similar to those indicated for this Project in material, design, and extent.

C. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

D. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Slotted Channel Framing: Cold-formed metal channels with continuous slot complying with MFMA-4.

1. Basis of Design: Unistrut Corp.

## 2.2 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Anchor Bolts: ASTM F 1554, Grade 36. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

C. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

D. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency. Anchors shall have an ICC-ES report with approval for use in cracked concrete.

1. Acceptable Manufacturers: Kwik-Bolt TZ by Hilti, Inc., TruBolt Wedge Anchor by ITW Red Head, Power-Stud+ by Powers Fasteners, or Strong Bolt by Simpson.

## 2.3 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content (95% by weight) paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

1. Available Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Duncan Galvanizing; ZiRP.

b. ZRC Worldwide; Galvilite Galvanizing Repair, low VOC type.

2. VOC Content: 250 g/L or less.

C. Isolation Coating (Bituminous Paint): ASTM D 1187, cold-applied asphalt emulsion, VOC compliant, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

## 2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

## 2.5 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches, unless otherwise indicated.

## 2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts if units are installed after concrete is placed.

## 2.7 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, unless otherwise indicated.
2. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.
3. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.

## 2.8 HOT-DIP GALVANIZING

A. Hot-Dip Galvanizing: For steel exposed to the elements, weather or corrosive environments and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process.

1. Basis-of-Design: Duragalv by Duncan Galvanizing.
2. Comply with ASTM A 123 for fabricated products and ASTM A 153 for hardware.
3. Provide thickness of galvanizing specified in referenced standards.
4. Galvanizing bath shall contain special high grade zinc and other earthly materials.
5. Fill vent holes after galvanizing, if applicable, and grind smooth.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of steel that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of isolation coating.

## 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

## 3.3 ADJUSTING AND CLEANING

A. Touch-Up and Repair for Galvanized Surfaces: For damaged and field-welded metal coated surfaces, clean welds, bolted connections and abraded areas.

1. For galvanized surfaces, apply organic zinc repair paint complying with requirements of ASTM A 780, modified to 95 percent zinc in dry film. Thickness of applied galvanizing repair paint shall be not less than coating thickness required by ASTM A 123 or A 153 as applicable. Touch-up of galvanized surfaces with silver paint, brite paint, or aluminum paints is not acceptable.
2. For factory-applied finish coatings, field-touch-up shall be performed by factory approved personnel. Touch-up shall be such that repair is not visible from a distance of 6 feet.
3. A touch-up repair kit or touchup instructions shall be provided to the Owner for each type of factory-applied finish.

END OF SECTION

SECTION 055100

METAL STAIRS AND RAILINGS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Galvanized steel stairs with steel grating treads and railings.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 033000 - CAST-IN-PLACE CONCRETE for sleeves, anchors, inserts, plates and similar items.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design stairs and railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Provide metal stairs capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load and Concentrated Loads: As required by Code.
2. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less.

C. Structural Performance of Railings: Provide railings capable of withstanding the effects of gravity loads and Code required loads and stresses within limits and under conditions indicated.

1.4 SUBMITTALS

A. Product Data: For each product.

1. Manufacturer's product lines of railings assembled from standard components.
2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Provide templates for anchors and bolts specified for installation under other Sections.
2. Shop drawings shall be signed and sealed by a professional engineer currently licensed in New Hampshire.

C. Delegated-Design Submittal: For stairs and railings indicated to comply with performance requirements and design criteria, including structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs and railings that are similar to those indicated for this Project in material, design, and extent.

C. Installer Qualifications: Fabricator of products.

D. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Industrial Type Stairs: Industrial class.

E. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.6 COORDINATION

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513, Type 5 (mandrel drawn).

C. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

D. Wire Rod for Grating Crossbars: ASTM A 510.

E. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

F. Galvanized Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.

## 2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

## 2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

1. Provide interior, field-applied primer with a VOC content of 250 g/L or less.

C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

## 2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding, unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously, unless otherwise indicated.
5. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Comply with “Guideline 1: Joint Finishes”, by National Ornamental & Miscellaneous Metals Association (NOMMA), as follows:

1. Service Stair Railing: Type 3 or better, unless otherwise indicated.

I. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

## 2.6 STEEL-FRAMED STAIRS

A. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 1/2 inch in least dimension.
2. Surface: Serrated.
3. Finish: Galvanized.
4. Fabricate grating treads with rolled-steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
5. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

## 2.7 STEEL RAILINGS

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

C. Form changes in direction of railings as detailed on the Drawings.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect posts to stair framing by direct welding, unless otherwise indicated.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.

H. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

## 2.8 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

## 2.9 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A 123/A 123M, for galvanizing steel and iron products.
2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
3. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
4. Handrails: Galvanizing shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of the railings.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

## 3.2 INSTALLING STEEL RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

## 3.3 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

# SECTION 061000

# ROUGH CARPENTRY

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Wood blocking, cants, and nailers.
2. Plywood backing panels.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 042000 - UNIT MASONRY for wood nailers and blocking built into masonry.

### 1.3 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product.

1. Indicate component materials and dimensions and include construction and application details.
2. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
3. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.

4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels; place spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of lumber grading agencies certified by the American Lumber Standards Committee Board of Review.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.
4. Provide dry lumber with 15 percent maximum moisture content at time of dressing for 2-inch nominal thickness or less, unless otherwise indicated.

B. Plywood Panels:

1. Plywood: Either DOC PS 1 or DOC PS 2, unless otherwise indicated.
2. Thickness: As needed to comply with requirements specified but not less than thickness indicated.
3. Factory mark panels according to indicated standard.

## 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.

a. Use Borate or Copper Azole treatments. Product shall not contain creosote, arsenic or pentachlorophenol.

2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry material after treatment to a maximum moisture content of 19 percent for lumber and 18 percent for plywood. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete in exterior walls.

E. Available Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hoover Treated Wood Products; PyroGuard.
2. Koppers Performance Chemicals; LifeWood MicroPro Treatment.
3. Sustainable Northwest Wood; Pressure Treated Wood with Copper Azule.

## 2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: For all interior use materials, and where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having

jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841.
5. Product shall not contain creosote, arsenic or pentachlorophenol.

C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent. Kiln-dry plywood after treatment to maximum moisture content of 15 percent.

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Available Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Technologies Boralife Inc.; Boraflame.

## 2.4 MISCELLANEOUS LUMBER

A. General: Provide FRTW lumber for support or attachment of other construction, including, but not limited to, the following: Rooftop equipment bases and support curbs, blocking, cants, nailers, furring and grounds.

B. For items of dimension lumber size, provide Construction, Stud, or No. 2 grade lumber with 15 percent moisture content.

## 2.5 PANEL PRODUCTS

A. Miscellaneous Concealed Plywood: Exposure 1 sheathing, span rating to suit framing in each location, and thickness as indicated but not less than 1/2 inch.

B. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch thick.

## 2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Bolts: Steel bolts complying with ASTM A 307, Grade A with ASTM A 563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5; except provide stainless steel complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2, where in contact with pressure-preservative treated wood or when exposed to exterior conditions.

## 2.7 MISCELLANEOUS MATERIALS

A. Adhesive, Including Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

1. Available Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Henkel Corp.; Loctite PL Premium Polyurethane Construction Adhesive.
b. Henkel Corp.; OSI SF450 Heavy Duty Subfloor Construction Adhesive.

2. Low-Emitting Materials: Provide adhesives in compliance with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
3. VOC Content: 70 g/L or less.
4. Do not use adhesives that contain urea formaldehyde.
5. Methylene chloride and perchloroethylene may not be intentionally added to adhesives.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

C. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber and plywood.

D. Countersink fastener heads on exposed carpentry work and fill holes with wood filler.

E. Use fasteners of appropriate type and length. Predrill members when necessary to avoid splitting wood.

## 3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install as required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

END OF SECTION

SECTION 071416

COLD FLUID-APPLIED WATERPROOFING

PART 1 - GENERALA

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Cold fluid-applied waterproofing at foundation walls.
2. Drainage board.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 076200 - SHEET METAL FLASHING AND TRIM
2. Section 079200 - JOINT SEALANTS for joint-sealant materials and installation.
3.

1.3 SUBMITTALS

A. Product Data: Include manufacturer’s installation instructions and general recommendations. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

B. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.

1. Shop drawings shall include relationship to and integration with adjacent and surrounding construction. For complex situations, provide isometric details.

C. Samples: 12-by-12-inch square of waterproofing and reinforcing strip.

D. Installer Certificates: Signed by manufacturers certifying that installers comply with requirements.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is acceptable to waterproofing manufacturer to install manufacturer's products, with at least five years project experience and at least three

projects with size and complexity similar to the Project completed with the last five years using the proposed system.

B. Source Limitations: Obtain waterproofing materials through one source from a single manufacturer.

C. First-Installation Mockups: Build mockups to verify selections made under sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, terminations, membrane lapping, crack and joint treatment, corner treatment, and protection.

a. Size: 100 sq. foot area.
b. Description: Each type of membrane installation.
c. Include at least one inside corner and one outside corner within the mockup.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site after submittals and shop drawings have been reviewed by Architect, and at least 10 business days before ordering materials or starting work, including preparation, to comply with requirements in Division 01. Review requirements for waterproofing, including shop drawings, project specific detailing, surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, mockups and protection and repairs.

1. Meet with the Owner, Owner’s representative, Architect, waterproofing Installer, waterproofing system manufacturer's technical representative, and installers whose work interfaces with or affects waterproofing work under this Section.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Application of waterproofing system shall not commence until all issues raised during the conference have been resolved.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original packages with seals unbroken, labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by waterproofing manufacturer. Protect stored materials from direct sunlight.

C. Remove, replace, or dispose of damaged materials, and liquid materials that cannot be applied within their stated shelf life at no cost to the Owner.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, or when temperature is below 0 deg F.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace waterproofing and sheet flashings that do not comply with requirements or that fail to remain watertight within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Installer's Warranty: Signed by Installer, covering Work of this Section, for warranty period of two years.

PART 2 - PRODUCTS

2.1 POLYURETHANE WATERPROOFING

A. Two-Component Membrane: Two-component, cold fluid-applied reinforced polyurethane waterproofing membrane with two layers of 360 degree needle punched non-woven 165 g/m2 polyester reinforcing fleece, for a finished dry film membrane thickness of .070 inch nominal per ply. Provide products manufactured and supplied by the following:

1. Kemper System’s Kemperol 2K-PUR resin for use in an adhered waterproofing system or approved equal by Sika or GCPAT.

2.2 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended by manufacturer to be compatible with one another and with waterproofing, as demonstrated by waterproofing manufacturer, based on testing and field experience.

B. Membrane Flashings: A composite of the same resin material as field membrane with 165 g/m2 fleece reinforcement.

C. Substrate Joint Filler: Compatible with membrane, typically Tremco Dymeric 240FC or equal.

D. Epoxy Primer: Two-component, solvent-free epoxy resin for use in improving adhesion of membrane to cementitious/masonry substrate surfaces, as provided by the following manufacturer:

1. Kemper System’s Kempertec EP/EP5 primer.

E. Topcoat: Provide Kemperdur EP-FR finish, high-performance, solvent-free, impact and abrasion-resistant coating.

F. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Manufactured composite subsurface drainage panels consisting of a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to 1 side and a polymeric film bonded to the other side of a 3-dimensional, nonbiodegradable, molded-plastic-sheet drainage core, with a vertical flow rate of 9 to 24 gpm per ft.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

### 3.3 JOINTS, CRACKS, AND TERMINATIONS

A. Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

### 3.4 INSTALLATION

A. Install in strict accordance with manufacturer’s recommendations, approved submittals and in proper relationship with adjacent construction.

1. Prepare and cure waterproofing membrane per the manufacturer’s instructions prior to applying topcoat material and aggregate.
2. Apply topcoat and aggregate per manufacturer’s instructions.

### 3.5 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate according to manufacturer's written instructions. Use methods that do not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

## 3.6 CLEANING AND PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

# SECTION 072100

# THERMAL INSULATION

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Insulation under slabs-on-grade, extruded polystyrene board,
2. Perimeter foundation wall insulation, extruded polystyrene board.
3. Continuous insulation in cavity wall, faced polyisocyanurate.
4. Sprayed-foam insulation at gaps and voids in exterior assemblies.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 072600 - UNDERSLAB VAPOR RETARDERS for underslab vapor barrier.
2. Section 071416 - COLD FLUID-APPLIED WATERPROOFING.
3. Section 072700 - AIR BARRIERS for air and vapor barrier membrane.
4. Section 075400 - THERMOPLASTIC MEMBRANE ROOFING for roofing insulation.
5. Division 22 - PLUMBING for plumbing insulation.
6. Division 23 - HEATING, VENTILATING, AND AIR CONDITIONING for mechanical insulation.

### 1.3 SUBMITTALS

A. Product Data: Manufacturer installation instructions, performance criteria, and product limitations for each type of product indicated.

B. Qualification Data: For Installer of spray-applied products and Testing Agency.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Installer Qualifications: A qualified installer who has been trained by and is acceptable to spray polyurethane foam insulation manufacturer to install manufacturer's products.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

D. Thermal Performance: Target U values and Psi values are included on the Drawings. Manufacturers are responsible for providing materials that will meet these values. Clear wall U values must be derated for cladding support system. Psi values will require collaboration with adjacent trades at interfaces. For conditions that occur within the opaque wall system (corners, slab edges), this section should require calculations supporting U and Psi values.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store in a dry and secure location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic and spray polyurethane foam insulation as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver materials to Project site before installation time.
3. Complete installation and concealment of materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 PERIMETER FOUNDATION WALL AND UNDER SLAB RIGID INSULATION

A. Available Manufacturers, Low Global Warming Potential: Blowing Agent, Honeywell Solstice Liquid Blowing Agent, low global warming potential (GWP) hydrofluoro-olefin (HFO), or approved equal. Other insulation manufacturers may be considered, if they have adopted the

HFO blowing agents by start of construction. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. DuPont (formerly Dow Chemical); Reduced GWP Styrofoam series (gray color).
2. Kingspan; Greenguard XPS LG series.
3. Owens Corning; Foamular NGX (Next Generation Extruded) series.

B. Extruded-Polystyrene (XPS) Board Insulation: ASTM C 578, square edged of type, density, and compressive strength indicated below. Thermal Resistivity (R-value): 5.0 per inch.

1. For vertical applications, Type IV, 1.6-lb/cu. ft. minimum density and 25-psi minimum compressive strength.
2. For horizontal applications, pedestrian traffic, Type VII, 2.2-lb/cu. ft. minimum density and 60-psi minimum compressive strength.
3. For horizontal applications, vehicular traffic, façade maintenance traffic, heavyladscape items including planters and benches, Type V, 3-lb/cu. ft. minimum density and 100-psi minimum compressive strength.

C. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

1. Methylene chloride and perchloroethylene may not be intentionally added to adhesives.
2. Do not use adhesives that contain urea formaldehyde.

## 2.2 CONTINUOUS INSULATION OUTBOARD OF EXTERIOR SHEATHING

A. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, felt or glass-fiber mat facer on both major surfaces. R-value at 2 inches, 12.0. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Carlisle SynTec Incorporated.
2. Firestone Building Products Company.
3. GAF Materials Corp.
4. Johns Manville International Inc.

B. Attachment to Substrate: Tape joints. Attach as recommended by manufacturer.

## 2.3 SPRAYED-FOAM INSULATION, AT GAPS AND VOIDS

A. Sprayed Polyurethane Foam Insulation to Fill Gaps at Penetrations and Openings: Single component, foamed-in-place, polyurethane foam sealant specifically approved for use in filling cracks and annular spaces without a thermal barrier, containing no urea-formaldehyde and no CFCs.

1. Fire Resistance: UL 723, flame spread index of 25 or less and smoke developed index of less than 50 when tested in accordance with ASTM E84 and tested in accordance with ASTM E814 (modified) to establish that the integrity of the fireblocking is maintained when the fireblocking is penetrated.
2. Provide primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.
3. Provide low expansion foam complying with AAMA 812. Installation must be per manufacturer's instructions and ICC-ESR-1961 or ESR-2717.
4. VOC Emissions: GreenGuard Gold certification
5. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Chemical; GreatStuff Pro.
    b. ICP Adhesives and Sealants (formerly Fomo Products): Handi-Foam products.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

## 3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

## 3.4 INSTALLATION OF BELOW-GRADE INSULATION

A. On vertical surfaces, set rigid insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

1. If not otherwise indicated, extend insulation a minimum of 48 inches below exterior grade line, except 10'-0" minimum at locations which have conditioned spaces in the building.

B. On horizontal surfaces, loosely lay rigid insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

## 3.5 INSTALLATION OF CONTINUOUS INSULATION IN CAVITY WALL

A. Install mineral fiber board cavity insulation per manufacturer’s instructions. Fit insulation with edges butted tightly in both directions. Do not compress insulation. Maintain cavity width of dimension indicated between insulation and cladding material.

1. Provide insulation attachments at the minimum number required by the insulation manufacturer.
2. Coordinate installation with air barrier and cladding support systems.
3. Coordinate installation to completely cover all surfaces required with tightly fitting joints tight to substrate with no gaps.

## 3.6 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation

is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

# SECTION 072600

# UNDERSLAB VAPOR RETARDERS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Vapor retarders under slabs-on-grade.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 033000 - CAST-IN-PLACE CONCRETE.

### 1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

### 1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

## PART 2 - PRODUCTS

### 2.1 VAPOR RETARDER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Stego Wrap Vapor Retarder by Stego Industries LLC.
2. Perminator by W.R. Meadows.
3. Viper VaporCheck II 15 mil by ISI Building Products.

B. Vapor retarder shall have the following qualities:

1. Permeance of less than 0.01 perms per ASTM F 1249 or ASTM E 96.
2. ASTM E 1745 Class A, with the permeance requirement modified to not exceed 0.01 perms both before and after conditioning.
3. Thickness: 15 mils.

C. Accessories:

1. Seam Tape: Permeance less than 0.3 perms per ASTM F 1249 or ASTM E 96.
2. Vapor Proofing Mastic: Permeance less than 0.3 perms per ASTM F 1249 or ASTM E 96.
3. Pipe Boots: Construct pipe boots from vapor retarder material, pressure sensitive tape and/or mastic per manufacturer’s instructions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Clean substrates of substances harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.3 INSTALLATION, GENERAL

A. Comply with manufacturer's written instructions.

3.4 PROTECTION

A. Protect installed vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes.

END OF SECTION

SECTION 072700

AIR BARRIERS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Fluid-applied, vapor-retarding membrane air barrier.
2. Transition strips to adjacent and penetrating materials.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 042000 - UNIT MASONRY for substrate for air and vapor barrier system.
2. Section 075400 - THERMOPLASTIC MEMBRANE ROOFING for roof air and vapor barrier.
3. Section 079200 - JOINT SEALANTS for joint sealant requirements.

1.3 DEFINITIONS

A. Air Barrier Assembly: The collection of air barrier materials and auxiliary materials applied to an opaque wall or soffit, including joints and junctions to abutting construction, to control air movement through the wall.

1.4 PERFORMANCE REQUIREMENTS

A. General: Air barrier shall be capable of performing as a continuous vapor-retarding air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate

movement and of sealing substrate expansion and control joints, construction material changes, penetrations, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

B. Air Barrier Assembly Air Leakage: Not to exceed 0.03 cfm/sq. ft. of surface area at 1.57 lbf/sq. ft., ASTM E 2357.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.

B. Shop Drawings: Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.

1. Include details of interfaces with other materials that form part of air barrier.

C. Product Certificates: For air barriers, certifying compatibility of air barrier and accessory materials with Project materials that connect to or that come in contact with air barrier; signed by product manufacturer.

D. Qualification Data: For Applicator.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Preinstallation Conference: Conduct conference at Project site.

1. Include installers of other construction connecting to air barrier, such as roofing, waterproofing, architectural precast concrete, masonry, joint sealants, windows, glazed curtain walls, and door frames.

2. Review air barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store liquid materials in their original undamaged packages in a clean, dry, protected location and within temperature range required by air barrier manufacturer.

B. Remove and replace liquid materials that cannot be applied within their stated shelf life.

C. Store rolls according to manufacturer's written instructions.

D. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 FLUID-APPLIED MEMBRANE AIR BARRIERS

A. Fluid-Applied, Vapor-Retarding Membrane Air Barrier: Elastomeric, modified bituminous, or synthetic polymer membrane.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing; Fire Resist Barritech NP.
b. GCP Applied Technologies (formerly W.R. Grace); Perm-A-Barrier NPL 10.
c. Henry Co.; Air Bloc 16MR or 17MR.
d. Tremco; ExoAir 130.
e. W.R. Meadows; Air-Shield LSR.

2. Physical and Performance Properties:

a. Vapor Permeance: Not more than 0.1 perm, ASTM E 96, Water Method.
b. Air Permeance: Not to exceed 0.004 cfm/sq. ft. of surface area at 1.57-lbf/sq. ft. pressure difference; ASTM E 2178.
c. Fastener Sealability: No water leaking through fastener penetration after 24 hours; ASTM D 1970.
d. Fire Test Performance: Passes NFPA 285, Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.

## 2.2 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by air barrier manufacturer for intended use and compatible with air barrier. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne or solvent-borne primer recommended for substrate by manufacturer of air barrier material.

C. Counterflashing Strip: Modified bituminous 40-mil-thick, self-adhering sheet consisting of 32 mils of rubberized asphalt laminated to an 8-mil-thick, crosslaminated polyethylene film with release liner backing.

D. Butyl Strip at Termination with EPDM or TPO Roofing Membrane: Vapor-retarding, 30- to 40-mil-thick, self-adhering; polyethylene-film-reinforced top surface laminated to layer of butyl adhesive, with release liner backing.

E. Modified Bituminous Strip To Cover Cracks and Joints and Terminate Air Barrier to Compatible Roofing Membrane: Vapor-retarding, 40-mil-thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil- polyethylene film with release liner backing.

F. Termination Mastic: Cold fluid-applied elastomeric liquid; trowel grade.

G. Substrate Patching Membrane: Manufacturer's standard trowel-grade substrate filler.

H. Adhesive and Tape: Air barrier manufacturer's standard adhesive and pressure-sensitive adhesive tape.

I. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, 0.0187 inch thick, and Series 300 stainless-steel fasteners.

J. Sprayed Polyurethane Foam Sealant to Fill Gaps at Penetrations and Openings: one- or two-component, foamed-in-place, polyurethane foam sealant, 1.5 to 2.0 lb/cu. ft. density; flame spread index of 25 or less according to ASTM E 162; with primer and noncorrosive substrate cleaner recommended by foam sealant manufacturer.

K. Modified Bituminous Transition Strip to Seal Air Barrier Terminations with Glazing Systems: Vapor-retarding, 40-mil-thick, smooth-surfaced, self-adhering; consisting of 36 mils of rubberized asphalt laminated to a 4-mil-thick polyethylene or aluminum film with release liner backing.

L. Preformed Silicone-Sealant Extrusion to Seal Air Barrier Terminations with Glazing Systems: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding extrusions to substrates.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Corning Corporation; 123 Silicone Seal.
b. Elbex Corp: Transition Silicone Sheeting.
c. GE Silicone; UltraSpan US1100.
d. Tremco; approved equal.

M. Joint Sealant: ASTM C 920, single-component, neutral-curing silicone; Class 100/50 (low-modulus), Grade NS, Use NT related to exposure, and, as applicable to joint substrates indicated, Use O. Comply with Section 079200 - JOINT SEALANTS.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance.

1. Verify that substrates are sound and free of oil, grease, dirt, excess mortar, or other contaminants.
2. Verify that concrete has cured and aged for minimum time period recommended by air barrier manufacturer.
3. Verify that concrete is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
4. Verify that masonry joints are flush and completely filled with mortar.

5. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 SURFACE PREPARATION

A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.

B. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate-patching membrane.

E. Remove excess mortar from masonry ties, shelf angles, and other obstructions.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Install modified bituminous strips and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch.

G. Bridge and cover isolation joints expansion joints and discontinuous deck-to-wall and deck-to-deck joints with overlapping modified bituminous strips.

H. At changes in substrate plane, apply sealant or termination mastic beads at sharp corners and edges to form a smooth transition from one plane to another.

I. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

## 3.3 JOINT TREATMENT IN PREPARATION FOR INSTALLATION OF FLUID-APPLIED MEMBRANE

A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.

1. Prime substrate and apply a single thickness of preparation coat strip extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of air barrier membrane and embed a joint reinforcing strip in preparation coat.

B. Gypsum Sheathing: Fill joints greater than 1/4 inch with sealant according to ASTM C 1193 and with air barrier manufacturer's written instructions. Apply first layer of fluid air barrier membrane at joints. Tape joints with joint reinforcing strip after first layer is dry. Apply a second layer of fluid air barrier membrane over joint reinforcing strip.

## 3.4 TRANSITION STRIP INSTALLATION

A. Install strips, transition strips, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.

1. Coordinate the installation of air barrier with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
2. Install butyl or modified bituminous strip on roofing membrane or base flashing so that a minimum of 3 inches of coverage is achieved over both substrates.

B. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

C. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.

D. At end of each working day, seal top edge of strips and transition strips to substrate with termination mastic.

E. Apply joint sealants forming part of air barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip so that a minimum of 3 inches of coverage is achieved over both substrates. Maintain 3 inches of full contact over firm bearing to perimeter frames with not less than 1 inch of full contact.

1. Transition Strip: Roll firmly to enhance adhesion.
2. Elastomeric Flashing Sheet: Apply adhesive to wall, frame, and flashing sheet. Install flashing sheet and termination bars, fastened at 6 inches o.c. Apply lap sealant over exposed edges and on cavity side of flashing sheet.
3. Preformed Silicone-Sealant Extrusion: Set in full bed of silicone sealant applied to walls, frame, and membrane.

G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.

H. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

I. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, modified bituminous strip.

J. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.

K. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

## 3.5 INSTALLATION OF FLUID-APPLIED MEMBRANE AIR BARRIER

A. Apply air barrier membrane to form a seal with strips and transition strips and to achieve a continuous air barrier according to air barrier manufacturer's written instructions.

B. Apply air barrier membrane within manufacturer's recommended application temperature ranges.

C. Apply primer to substrates at required rate and allow to dry. Limit priming to areas that will be covered by air barrier sheet in same day. Reprime areas exposed for more than 24 hours.

1. Prime glass-fiber-surfaced gypsum sheathing with number of prime coats needed to achieve required bond, with adequate drying time between coats.

D. Apply a continuous unbroken air barrier to substrates according to the following minimum thickness. Apply membrane in full contact around protrusions such as masonry ties.

1. Vapor-Retarding Membrane Air Barrier: 60-mil dry film thickness.

E. Apply strip and transition strip a minimum of 1 inch onto cured air membrane or strip and transition strip over cured air membrane overlapping 3 inches onto each surface according to air barrier manufacturer's written instructions.

F. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

G. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

## 3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:

1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes.
2. Continuous structural support of air barrier system has been provided.
3. Masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions, and mortar droppings.
4. Site conditions for application temperature and dryness of substrates have been maintained.
5. Maximum exposure time of materials to UV deterioration has not been exceeded.
6. Surfaces have been primed.
7. Laps in sheet materials have complied with the minimum requirements and have been shingled in the correct direction (or mastic applied on exposed edges), with no fishmouths.
8. Termination mastic has been applied on cut edges.
9. Air barrier has been firmly adhered to substrate.
10. Compatible materials have been used.
11. Transitions at changes in direction and structural support at gaps have been provided.
12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation, and priming of surfaces, structural support, integrity, and continuity of seal.
13. All penetrations have been sealed.

C. Tests:

1. Qualitative Testing: Air barrier assemblies will be tested for evidence of air leakage according to ASTM E 1186.

2. Quantitative Air Leakage Testing: Testing not to exceed the test pressure differential, positive and negative, indicated in "Performance Requirements" Article for air barrier assembly air leakage according to ASTM E 783.

D. Remove and replace deficient air barrier components and retest as specified above.

## 3.7 CLEANING AND PROTECTION

A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.

1. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace air barrier exposed to these conditions for more than 30 days.
2. Protect air barrier from contact with creosote, uncured coal-tar products, TPO, EPDM, flexible PVC membranes, and sealants not approved by air barrier manufacturer.

B. Clean spills, stains, and soiling from adjacent construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

SECTION 072800

# LIQUID-APPLIED INSULATIVE COATING

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Section Includes: Spray-applied insulative coating at exterior lintel including primer, insulative coating and topcoat.

1. Aerogel filled thermal break tape including primer coating at locations where spray or roller applied coating is not practical (Contractor's option).

### 1.3 SUBMITTALS

A. Product Data: Submit product data including manufacturers technical data indicating product performance characteristics, performance and limitation criteria.

B. Shop Drawings: Submit shop drawings with plans, elevations, and details showing all locations where this system will be applied.

1. Include details of interfaces with other materials that form part of air barrier.
2. Include details of mockups.
3. Include relationship with adjacent materials (roof membrane, air barrier flashing membranes, and similar items), indication of sequence of installation for coordination during construction, and materials and methods for sealing connections and penetrations.

C. Manufacturer’s Instructions: Submit manufacturer written installation instructions.

D. Applicator Qualifications: Submit applicators current certification as a manufacturer trained applicator.

E. Performance Documentation: Submit published design listings for insulation value ratings and product thickness. Include evidence that thel liquid thermal break testing was sponsored by the manufacturer and that the material tested was produced at the manufacturers facility under the supervision of technical personnel.

## 1.4 QUALITY ASSURANCE

A. Manufacturer:

1. Company specializing in manufacturing product in this section with a minimum of 2 years documented experience in manufacturing insulative technology.
2. Applicator: Company specializing in applying the work of this section with documented experience and certified / trained by the manufacturer.
3. Liquid applied thermal break acrylic system shall be the complete system from a sole source consisting of primer, acrylic thermal break material and topcoat.

B. Mock-up:

1. Minimum thirty days prior to application in any area, provide mock-up samples of thermal break materials in accordance with the following requirements:

   a. Provide minimum two square feet on all representative substrates and conditions, where directed by the Engineer, for each different desired R Values and finish of required for the work.
   b. Provide mock-up areas that comply with thickness, density application, finish texture, and color.
   c. Inspect mock-up areas within one hour of application for variance due to shrinkage, temperature, and humidity.
      Where shrinkage and cracking are evident, adjust mixture and method of application as necessary to meet required installation, R Value, finish, and color requirements.
   d. Continue to provide mock-up areas at the Contractor's expense until acceptable areas are produced.
   e. Acceptable areas shall constitute standard of acceptance for method of application, thickness, finish texture, and color requirements, for Liquid applied thermal break material applications.

## 1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials in manufacturers’ original, sealed, undamaged container with identification label intact. Packaged materials shall bear the appropriate labels, seals.

B. Storage: Materials shall be stored in strict accordance with manufacturers documented instructions.

C. Documentation: All batch number, product identification and quantities shall be recorded on appropriate QC documents. A copy of the transport document and manufacturers conformance certificate shall be attached to the material delivery on site.

1.6 PROJECT/SITE CONDITIONS

A. Project Environmental Requirements: Substrate and air temperature shall be in accordance with the manufacturers' requirements including the following:

1. Protect work area from windblown dust and rain. Protect adjacent areas from over spray of material.
2. Provide ventilation in areas to receive work of this section during application and minimum 24 hours after application.

B. Temperature and Humidity Requirements: Maintain air temperature and relative humidity in areas where products will be applied for a time period before during and after application as recommended by manufacturer.

1. Do not apply coatings when temperature of substrate and/or surrounding ambient air temperature is below 45 degrees F. Temporary protection and heat shall be maintained at this minimum temperature for 24 hours before, during and 24 hours after material application.
2. Steel substrate temperature shall be a minimum of 5 degrees F (3 degrees C) above the dew point of the surrounding air for a period of 24 hours prior and during the application of the material.
3. If necessary for job schedule, the General Contractor shall provide enclosures and heat to maintain proper temperatures and humidity levels in the application areas.
4. The relative humidity of the application area shall not exceed a maximum of 85 percent 24 hours prior, during and 24 hours after the application of the material. The relative humidity shall not exceed 75 percent throughout the application and drying of the decorative top coat finish.

1.7 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard 5-year material warranty.

PART 2 - PRODUCTS

2.1 LIQUID-APPLIED INSULATIVE COATING

A. Basis-of-Design: Tnemec Aerolon Series 971 Coating System by Tnemec, Kansas City, MO, as represented by The Righter Group, ww.rightergroup.com, Tel. 800-533-3003.

1. Steel: Surface Preparation and Primer for Coating Steel, Shop or Site Applied:

a. Preparation: Abrasive blast clean, SSPC SP-6 surface profile 2-3 mils. Remove weld splatter and grind defects smooth. Steel substrate temperature shall be a minimum of 5 degrees F above the dew point of the surrounding air for a period of 24 hours prior and during the application of the material.
b. Primer: Tnemec Series 1224T with less than 11 grams VOC, surface tolerant inorganic epoxy coating, at 6-8 mils DFT; or Tnemec Series 394 PerimePrimer Mio / Zinc Primer at 2.5-3.5 mils DFT.

2. Galvanized Steel: Surface Preparation and Primer for Coating Steel, Shop or Site Applied:

a. Preparation: SSPC SP16.
b. Primer: Tnemec 135 Chembuild at 5-7 mils DFT; or Tnemec Series 1225 Epoxy; or Tnemec Series 115 at 3-4 mils DFT.

3. Insulative Coating: Coating Tnemec Series 971 Aerolon liquid-applied thermal break coating.

a. Solids by Volume: 76 percent.
b. Coating Type: Water based thermal acrylic, spray applied.
c. Fire Performance: ASTM E 84, Class A.
d. VOC Content: 0.01 lbs./Gallon (1.0 grams /liter).
e. Thinned: 0.01 lbs./ gallon (1.0 grams /liter).
f. HAPS: 0 lbs. per gallon solids.
g. Curing Time: 75 degrees F, 4 hours to touch 16 hours to recoat.
h. Thermal Transmission: ASTM C 518, no more than 50 mW/ mK.
i. Net Weight per Gallon: 4.66 lbs. per gallon
j. Storage Temperature: 40-110 degrees F.
k. Number of Components: One component part powder not liquid
l. Pot Life: 2 hours.
m. Spray Life: 2 hours.
n. Prohesion: ASTM D 5894, 4,00 hours.
o. Salt Fog: ASTM B 117m 4,000 hours.
p. Immersion: ASTM D 870 – 4,000 hours.

q. Humidity: ASTM D 4585 – 4,000 hours
r. Water Immersion: ASTM D 870 Method B, 2,000 hours at 140 degrees.
s. Taber Abrasion Resistance: ASTM D 4060 (CS-17 Wheel, 1,000g load), no more than 50 mg loss after 1,000 cycles.
t. Required Thermal Resistance, W Sections, 60 mils (approx 1/8 inch): 0.25 R-value.
u. Required Thermal Resistance, HSS Sections, 120 mils (approx 1/16 inch): 0.50 R-value.

4. Topcoat: Tnemec Series 1028 Enduratone or Tnemec at 2-3 mils DFT for non-immersion services. Apply Tnemec Series 22 at 16-40 miles DFT depending on application for areas where immersion is required.

a. Color for Exposed Applications: As selected by Architect.

## 2.2 AEROGEL FILLED THERMAL BREAK TAPE

A. Basis-of-Design: Tnemec Aerolon Series 945 Peel & Stick by Tnemec, Kansas City, as represented by The Righter Group, ww.rightergroup.com, Tel. 800-533-3003.

1. Primer Coating For Steel or Concrete to Receive Thermal Break Tape: Tnemec Series 90-97, 394, 530V ( Concrete ) or 1224 VOC, surface tolerant inorganic epoxy conforming to the following requirements. Galvanized metal must be clean dry and abraded.

a. Bond Strength: ASTM D4541 1320 psi
b. Abrasion Resistance: ASTM 4060 181 mg
c. Cathodic Disbondment: ASTM D G8- No disbondment 3000 Hrs.
d. Water Vapor Transmission: ASTM D 1653 4.68 g/m2 /24hrs/<0.22 prms.

2. Tnemec Series 945 Aerogel Filled thermal break tape, 76% solids, conforming to the following requirements: Material may be shop or field applied.

a. Solids by Volume: 76% Water based thermal insulative acrylic tape.
b. Recommended Film Thickness: 60 mil thick Aerolon Tape applied in multiple applications to specified R Value.
c. VOC Content: 0.01 lbs./Gallon (1.0 grams /liter).
d. Thinned: 0.01 lbs./ gallon (1.0 grams /liter).
e. HAPS: 0 lbs. per gallon solids.
f. Curing Time at 75 degrees F: 4 hours to touch , 16 hours to recoat.
g. Thermal Transmission: Must meet ASTM C 518 - No more than 49.8mW/ mK.
h. Net Weight per Gallon: 4.66 lbs. per gallon.
i. Storage Temperature 40 degrees F Maximum 110 degrees F
j. Number of Components: ne component.

k. Primer Required: As recommended by manufacturer.
l. Topcoat Required: Refer to Section 2.0 and 3.0.
m. Pot Life: 2 hours.
n. Spray Life: 2 hours.

3. Thermal Resistance of Thermal Break Tape: Thermal Conductivity (ASTM C518 at 77°F): 49.7 W/m-°K or 0.3446 BTU-in/ft²-hr-°F (R value at one inch equals 2.9) Tnemec 945 is to be applied in 60 mil ( 1.5mm ) lifts to desired R value established by Architect. Performance Data:

a. ASTM E 84 – Class A.
b. ASTM D 5894 – 4,000 hrs Prohesion.
c. ASTM B 117 – 4,000 hrs Salt Fog.
d. ASTM D 870 – 4,000 hrs. Immersion.
e. ASTM D 4585 – 4,000 hrs. Humidity.
f. 18 Months Roof Exposure.
g. Compatible with DOW 790 Sealant.

4. Application Thickness:

a. W Sections: One 60 mils layer.
b. HSS Sections: Two 60 mils layers.
c. Concrete: Minimum two 60 mil layers; confirm with manufacturer based on site conditions.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Application shall not commence until the Contractor, Installer and Architect have examined the surfaces to receive the primer and determined the surfaces are acceptable to receive the coatings and that the interface to adjacent air barrier materials has been reviewed and approved by all manufacturers. Commencement of application means acceptance of substrate.

B. Verify that substrate and workspace temperature and humidity conditions are in accordance with manufacturers recommendations.

### 3.2 PREPARATION

A. Provide masking, drop cloths or other suitable coverings to prevent overspray onto surfaces not intended to be coated.

B. Clean, dry and free of oil, grease, loose mill scale, dirt, dust or other foreign substances which would impair bond of the material to the substrate.

C. Primer shall not be applied to prepared substrate until the area has been adequately vented to remove all airborne dust. Prior to the application of any coating material, the blast products, dust and debris, shall be removed by vacuuming.

## 3.3 APPLICATION OF INSULATIVE COATING

A. Equipment and application procedures shall conform to the manufacturer's application instructions. Materials shall be applied at the required dry film thickness per the appropriate thicknesses specified.

B. Apply primer at thickness recommended by manufacturer. Apply insulative coating 60 mils for W Shapes, 120 mils for HSS sections per wet film thickness (DFT) per lift. Measure final DFT with a dry film thickness gauge. Apply topcoat at thickness recommended by the manufacturer.

C. Do not apply coatings to steel deck unless otherwise indicated.

D. Follow all manufacturer recommendations regarding adhesion and compatibility requirements for materials that come in contact with the liquid-applied insulative coating.

## 3.4 APPLICATION OF THERMAL BREAK TAPE

A. Equipment and application procedures shall conform to the manufacturer's application instructions. When the use of Tnemec Series 971 or 961 Aerolon Acrylic are used in concert with Tnemec 945 , apply 945 First and spray 971 or 961 onto the Aerolon 945 Tape.

B. Apply Tnemec Series 945 Aerolon, Aerogel Filled Thermal Break Tape at thicknesses / layer noted above mils per layer. Subsequent layers may be applied immediately after each other, using heat gun to activate adhesive more quickly as required in low temperature applications until final DFT is achieved for required. Work bubbles out of film with wallpaper or other rollers making 945 intimately bonded to substrate with no air gaps.

## 3.5 FIELD QUALITY CONTROL

A. The Owner will engage an independent testing laboratory inspect and verify the application of material in accordance with the provisions Tnemec Company.

1. Material inspection and testing shall be performed 24 hours after completion of final application coat.

2. The results of the above tests shall be made available to all parties at the completion of each pre-designated area and approval.
3. In-place material not in compliance with desired R Values the specification requirements shall be corrected prior to final acceptance.

B. The dry film thickness (DFT) of the applied material shall be measured with a non¬destructive coating thickness gage after material has completely cured. All measurements shall be documented in writing and furnished to the Owner.

## 3.6 CLEAN UP AND REPAIR

A. Upon completion of installation, excess material, overspray and debris shall be cleared and removed from the job site. Remove overspray materials from surfaces not required to be thermally protected.

B. Patching and repair to material, due to damage by other trades, shall be performed under this Section and paid for by the trade responsible for the damage. Patching shall be performed by applicators certified by the manufacturer and applied in accordance with the manufacturer application instructions.

END OF SECTION

# SECTION 075400

# THERMOPLASTIC MEMBRANE ROOFING

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Adhered TPO membrane-roofing system.
2. Cover board over insulation.
3. Roof insulation.
4. Self-adhering vapor retarder membrane.
5. Membrane clad metal flashing.
6. Flashing for equipment mounted on roofing and roofing penetrations.
7. Walkway pads.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 061000 - ROUGH CARPENTRY for wood nailers, curbs, and blocking.
2. Section 076200 - SHEET METAL FLASHING AND TRIM for metal roof penetration flashings, flashings, and counterflashings.
3. Section 072700 - AIR BARRIERS.
4. Section 079200 - JOINT SEALANTS for sealants.
5. Division 22 - PLUMBING for roof drains.
6. Division 23 - HEATING, VENTILATING, AND AIR CONDITIONING for roof curbs for HVAC equipment.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide assemblies capable of withstanding the effects of gravity loads and wind loads and stresses within limits and under conditions indicated without permanent deformation of components, metal fatigue, or permanent damage to fasteners and anchors; based on testing according to ASTM E 1592 and ASTM E 330 as applicable.

1. Wind Loads: As indicated on the Structural Drawings.

B. Delegated Design: Engineer roofing systems, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

D. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

E. Roofing System Design: Roofing system shall be designed and tested to withstand loads indicated on the Structural Drawings.

F. Flashings: Provide base flashings, perimeter flashings, detail flashings and component materials that comply with requirements and recommendations in FMG 1-49 Loss Prevention Data Sheet for Perimeter Flashings; FMG 1-29 Loss Prevention Data Sheet for Above Deck Roof Components; NRCA Roofing and Waterproofing Manual (Fourth Edition) for Construction Details and SMACNA Architectural Sheet Metal Manual (Fifth Edition) for Construction Details, as applicable.

G. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

H. Thermal Performance: Provide roof continuous layers of insulation. Submit data showing proposed assembly meets minimum R-value requirements.

## 1.5 SUBMITTALS

A. Product Data: Product data sheets, applicable test reports, and manufacturer installation instructions for each type of product indicated, specified or required for installation.

B. Delegated-Design Submittal: For roofing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Shop Drawings: For locations and extent of each roofing system and level. Include plans, elevations, sections, details, and attachments to other Work. Include manufacturer's reviewed and approved details that are Project-specific and include dimensions, scaled layouts, assembly profiles, etc. Manufacturer generic details will not be accepted. At a minimum, include the following:

1. Base flashings and membrane terminations.
2. Transitions to air barrier membrane, and other systems and materials.
3. Tapered insulation, including slopes.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations and note zone dimensions on shop drawing plans.
5. Requirments for meeting specified uplift requirements.
6. Tapered insulation layout, including amount and direction of slopes and drain sumps.
7. Walkway pad plan and detail, as required.
8. Proposed temporary, watertight, tie-off details for each substrate type.
9. Substrate joints, cracks, flashing penetrations, expansion joints, and inside / outside corners as needed.
10. Include full-size isometric details for all corners, transitions with complicated detailing.
11. Shop drawings to cross-reference to other trades and shop drawings for all interface details. General Contractor to identify which trade(s) will install other work. Use of term "By Others" is not acceptable.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Qualification Data: For Installer and manufacturer stating that the roof installer is authorized to install the specified system.

F. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of complying with performance requirements.

G. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

H. Manufacturer's Technical Repesentative Reports: Submit manufacturer's technical representative's written report for each site visit. Submit within 48 hours after each site visit. Include at least the following information:

1. Date on site.
2. Arrival and departure times.
3. Itemized list of all installation actiivites underway during visit.
4. Summary of directions and recommendations made to Installers.
5. Copies of recommended details and other information given to installers.
6. Clear statement that work observed complied with manufatuer's recommendations; or an itemized list with dimensioned lcoations of wll work observed which did not comply with manufacturer's recomments.

I. Manufacturer's Techincal Representtive's Final Certification: Submit final inspection certification for fully installed roof stating roof system was installed in compliance with roof system manufacturer's requirements and is eligile for manufacturer's warranty.

J. Maintenance Data: For roofing system to include in maintenance manuals.

K. Sample warranties: For manufacturer’s special warranties.

L. Closeout Submittals: Following completion of Work, submit roofing system manufacturer’s inspection report of completed roofing installation and completed warranty; submit Installer’s completed warranty.

1.6 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in New Hampshire and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of roofing systems that are similar to those indicated for this Project in material, design, and extent.

C. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer.

1. Provide written verification from each manufacturer indicated material compatibility and if warranty will be affected.

D. Manufacturer Qualifications: A qualified manufacturer shall have minimum of ten (10) years of experience in manufacturing of thermal polyolefin membrane.

E. Installer Qualifications: A qualified firm with at least five years project experience and at least three projects with size and complexity similar to the Project completed with the last five years using the proposed system, and that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

F. NRCA/SPRI Quality Assurance Guidelines for Thermoplastic Roofing Systems and Manufacturer’s Installation Instructions for Workmanship Standards.

G. Roofing Inspector: Owner may engage a full-time roofing inspector during installation of the deck, insulation assembly, membrane, flashing and other appurtenances, and when a survey of the roof and roof drains is conducted. Cooperate with Owner’s roofing inspector and allow unlimited access to roofing during construction.

H. Preinstallation Conference: Conduct conference at Project site after submittals and shop drawings have been reviewed by Architect, and at least 10 business days before ordering materials or starting work, including preparation. Comply with requirements in Division 01. Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with the Owner, Architect, Owner’s insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, roof system air barrier interface with wall air barrier systems, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.

9. Review roof observation and repair procedures after roofing installation.
10. Application of roofing system shall not commence until all issues raised during the conference have been resolved.

I. Use only roofing components that are manufactured, produced, or approved by roofing membrane manufacturer, and are acceptable for inclusion in the roofing warranty.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

1. Comply with manufacturer's written instructions for proper material storage for all materials including temperature and exposure limits.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect all roof materials, including but not limited to membrane, insulation, thermal barriers, cover boards and accessory materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location and on an elevated platform. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

1. Cover roof insulation with breathable tarps at all times prior to installation.
2. Roof insulation shall not be stored unprotected in plastic shrink wrap packaging alone, regardless of manufacturer’s approval. Unprotected insulation exposed to moisture (rain, snow, etc.) will be rejected and not allowed to be incorporated into finished roofing and must be removed from the project site.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1. Repair all areas damaged by improper storage and loading, including rework, engineering and other trades at no cost to the Owner.

## 1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

B. Verify existing dimensions and details prior to installation of materials. Notify Architect of conditions found to be different than those indicated in the Contract Documents. Architect will review situation and inform Contractor and Installer of changes.

C. Install materials in strict accordance with safety requirements required by roofing manufacturer, Material Safety Data Sheets, and local, state, and federal rules and regulations.

## 1.9 WARRANTY

A. Roofing Contractor’s Warranty: The roofing subcontractor shall supply Owner with a minimum two-year workmanship warranty for each roof. In the event any work related to the roofing, flashing, or metalwork is found to be defective within two years of substantial completion, the roofing contractor shall remove and replace such at no additional cost to the Owner. The roofing subcontractor’s warranty obligation shall run directly to the Owner, and a copy of the roofing signed warranty shall be sent to the roofing system’s manufacturer.

1. The duration of the Roofing Contractor’s two-year warranty shall run concurrent with the roofing system’s manufacturer’s 20-year warranty.
2. Warranty includes removing and reinstalling all components including pavers.

B. Roofing Systems Manufacturer’s Warranty: The roofing manufacturer shall guarantee roof areas to be in a watertight condition, for a period of 20 years, from the date of final acceptance of the roofing system. The warranty shall be a 20-year no dollar limit (NDL), non-prorated total system labor and material warranty, for wind speed as required by Code or as indicated on the Drawings. Total system warranty shall include all roofing materials, related components and accessories including, but not limited to the thermal-barrier board, vapor retarder, insulation board, underlayment board, roofing membrane, membrane flashings, fasteners, adhesives, metal roof copings, metal roof edges and termination metals and roof drain assemblies. The manufacturer shall repair defects in materials and workmanship as promptly after observation as weather and site conditions permit.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE

A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: Uniform, flexible sheet conforming to ASTM D 6878 and formed from a thermoplastic polyolefin, internally fabric or scrim reinforced, and as follows:

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle SynTec Incorporated; Sure-Weld TPO.
b. Holcim Building Envelope Elevate (formerly Firestone Building Products Company); Ultraply TPO.
c. Johns Manville; TPO.
d. Versico Inc.; VersaWeld TPO.

2. Thickness: 60 mils (1.5 mm) nominal typical, 80 mils at cooling towers and high traffic areas as indicated on Drawings.
3. Exposed Face Color: Gray.
4. Physical Properties:

a. Breaking Strength: 225 lbf; ASTM D 751, grab method.
b. Elongation at Break: 15 percent; ASTM D 751.
c. Tearing Strength: 55 lbf minimum; ASTM D 751, Procedure B.
d. Water Absorption: Less than 4 percent mass change after 166 hours' immersion at 158 deg F; ASTM D 471.

B. TPO-Clad Metal Roof Flashing: Heat-weldable flashing designed to serve as gravel stop and fascia at perimeter of thermoplastic membrane roofing.

1. Composition: 24 gauge steel with G90 galvanized coating, with 0.035 in. TPO membrane laminated to the outside face. Provide unsupported width of membrane along edge to be welded to roofing membrane.

2. Profile: As shown on Drawings.

3. Product: Sure-Weld TPO Coated Metal by Carlisle

4. Exposed Face Color: Match membrane.

## 2.2 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane.

C. Bonding Adhesive: Manufacturer's recommended bonding adhesive. Adhesive shall be water-based and compatible with insulation.

D. Metal Termination Bars: Manufacturer's standard predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

E. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

F. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.

G. Liquid Flashing: As recommended by manufacturer.

H. Prefabricated Penetration Housings: At locations where minimal space is provided between adjacent pipe penetrations and they cannot be flashed with roofing membrane, provide prefabricated penetration housings. Provide Roof Vault by Roof Penetration Housings or similar. Alternately, build doghouse out of compatible wood products.

## 2.3 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated and that comply with the MA Stretch Energy Code. Roofing insulation shall be mechanically fastened to roof deck.

B. Polyisocyanurate Board Insulation: With glass-mat facers, ISO95+ GL Insulation by Firestone Building Products, complying with ASTM C1289, Type II, Class I, minimum 25 psi (basis of

design). Use 60 psi at pedestal pavers and higher strength boards as required by planters and other heavy concentrated loads such as heavy wheeled traffic and at 80 mil membrane.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated. Provide slope of 1/2 inch per foot for tapered insulation at crickets.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

## 2.4 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Cover Board over Insulation: Provide one of the following, as required by roofing manufacturer to comply with performance requirements and provide specified warranty.

1. Underlayment Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 or 5/8 inch thick, factory primed unless greater thickness is required to meet uplift requirements.
2. Cover board to be mechanically fastened to roof deck.

D. Self-Adhering Sheet Vapor Retarder Under Insulation: ASTM D 1970, minimum 40-mil- thick film laminated to layer of rubberized asphalt adhesive; maximum permeance rating of 1/10 or less than that of the roof membrane; cold-applied, with slip-resisting surface and release paper backing. Provide primer by vapor-retarder manufacturer. Provide single source manufacturer with roofing membrane.

## 2.5 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured vinyl walkway pads or rolls approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck comply with requirements in Section 053100 - STEEL DECKING.
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
6. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed. Confirm adhesion between the roof vapor retarder self-adhering membrane to the concrete and substrate sheathing boards to verify adequate membrane adhesion and surface preparation techniques.
7. Confirm that roofing penetrations and structural steel are installed and placed so that flashing can extend a minimum of 8 in. above the top of the roofing membrane surface.
8. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Installer and roofing system manufacturer’s technical representative shall examine substrate to ensure that it is properly prepared and ready to receive roofing system. Roofing system manufacturer’s representative shall report in writing to Installer and Architect conditions which will adversely affect roofing system installation or performance. Do not proceed with roofing system installation until these conditions have been corrected and reviewed by Architect.

### 3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Close off roof drains and other penetrations to prevent materials from entering and clogging drains and conductors, and from spilling or migrating onto adjacent surfaces. Remove drain plugs when no work is taking place or when rain is forecast.

E. Perform testing according to ANSI/SPRI FX-1 to verify that fastener pull-out values meet or exceed those required to meet the wind uplift requirements for the Project.

## 3.3 VAPOR-RETARDER INSTALLATION

A. Self-Adhering Sheet Vapor Retarder: Prime substrate. Install self-adhering sheet vapor retarder over area to receive vapor retarder, side, and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively. Seal laps by rolling.

B. Completely seal vapor retarder at side laps, end laps, terminations, obstructions, and penetrations to prevent air movement into roofing system.

C. Tie vapor retarder to wall air barrier. Coordinate construction sequence to ensure air barrier continuity at roof to wall interfaces.

D. If vapor barrier serves as a temporary roof, rapair all damage prior to installation of roof assembly. Provide manufacturer's letter of acceptance for vapor barrier.

## 3.4 INSULATION AND UNDERLAYMENT BOARD INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday. Prevent construction traffic on the insulation during installation.

B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install minimum two layers of insulation, maximum 2 in. thick insulation boards, under area of roofing to achieve required thickness unless manufacturer recommends more than two layers. Install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation.

1. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
2. For insulation applied in multiple layers, loose-lay first layer and mechanically fasten top layer.

H. Mechanically Fastened Cover Boards: Install cover board over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction. Loosely butt underlayment boards together and mechanically fasten to roof deck.

1. Mechanically fasten underlayment boards, unless otherwise indicated.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
3. Adhere cover board in areas scheduled to receive pedestal pavers

## 3.5 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.

1. Do not permit construction materials or equipment to be stored directly on roofing membrane, including work completed by other trades.

B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply solvent-based bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

E. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

F. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Hot air weld to seal cut edges of roofing membrane.
2. Verify field strength of seams with test cuts at the installed weld a minimum of twice daily and repair seam sample areas. Roofing contractor is to take seam test cuts from the installed roofing seams; cut an approx. 1 in. wide seam sample. Pull the seam sample apart. A passing seam will include a cohesive failure (a seam where the membrane tears within the membrane and reinforcing itself and not at the weld interface). An adhesive failure will be considered a failing test. In the event of a failed seam sample, the roofer should cut additional seam samples from the same seam. If additional failures are observed, strip in the seam with an additional patch of membrane across the length of the seam. Hot air weld a patch of roof membrane flashing over seam test cut in roofing membrane; extend flashing 6 in. in either direction of cut
3. Repair tears, voids, and lapped seams in roofing membrane that does not meet requirements.

H. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

I. T-Laps: Install an additional ply of membrane at T-lap seam locations.

J. Do not install roofing membrane in adverse weather conditions.

K. Only install as much new roofing as can be made weather tight each day, including all flashing and detail work. All seams shall be heat welded before leaving the site. Provide temporary protection over roof edge at end of each working day and seal the protection to the structural deck.

L. Contractor is responsible for the integrity of the overnight seal. If water is allowed to bypass temporary edge seals, the extents of water intrusion under new roofing must be determined before progressing with new roof installation. Remove affected insulation as required until water is no longer observed beneath roof insulation or new roof membrane before continuing with new roof installation.

M. Remove temporary edge protection and cut back roof membrane as required from seal to structural deck to facilitate continued insulation and roof installation.

## 3.6 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing. Use manufacturer’s preformed accessories where possible.

D. Clean seam areas, overlap, and firmly roll sheet flashings and mechanically anchor to substrate through termination bars or as shown on approved shop drawings.

E. Terminate and seal top of sheet flashings 8 in. minimum above finished roof level. Provide counterflashing that overlaps the flashing 4 in. minimum.

F. Fully support flashings. Voids under flashings are not acceptable.

## 3.7 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

1. Clean the deck membrane in areas to be welded. Hot-air weld the entire perimeters of the walkway to the roofing deck sheet.
2. Provide gaps in walkway pads where necessary to allow water to freely flow to the roof drains.

## 3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

1. Cooperate with the Commissioning Authority engaged by the Owner for field quality control activities for the work of this Section.

2. Refer to Section 019115 - BUILDING EXTERIOR ENVELOPE COMMISSIONING for locations, type and frequency of testing.

B. Testing of Corner: Prepare a mock-up of typical roof system corner and perform bonded uplift resistance testing and fastener pull-out test, and provide testing results. Provide additional fasteners as required to meet performance requirements.

C. Conduct moisture testing of concrete decks in accordance with ASTM D 4263, plastic sheet method. Comply with manufacturer's requirements for testing concrete decks prior to installation of roof assembly materials.

1. Provide one test for each 500 sq. ft.
2. If failure occurs, then do not proceed with the roof system installation until a passing test is achieved.

D. Perform infrared scan by a qualified thermographer after completion of roof membrane installation; submit written report of results indicating test procedures.

E. Perform roof self-adhering sheet applied vapor retarder qualitative testing to the concrete/gypsum sheathing to confirm adequate adhesion. If the membrane does not adhere to the concrete/gypsum sheathing, then do not proceed with the roof system installation until a passing test is achieved.

F. Manufacturer's Technical Representative: Engage a qualified manufacturer's technical representative to perform roof tests and inspections and to prepare test reports. At a minimum provide the following:

1. Drain ponding tests.
2. Adhesion tests.
3. Fastener pull-out resistance tests.
4. Probing of 100% of welded roofing seams.

G. Roof Inspections: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation at the following intervals:

1. Start of the Work.
2. During roof installation at intervals recommended by roof system manufacturer.
3. 25 percent completion.
4. 50 percent completion.
5. Final Roof Inspection: Engage roofing system manufacturer's technical personnel to inspect roofing installation and probe 100 percent of roofing seams on completion and submit report to Architect.

6. Notify Architect and the Owner 48 hours in advance of date and time of inspection.

## 3.9 MEMBRANE REPAIRS

A. Repair a puncture in the membrane per manufacturer's requirements, and with like material. The repair must extend a minimum of 2 in. beyond the boundary of the affected area in all directions. Round all corners of the repair piece. A pinhole will require a minimum 4 in. x 4 in. patch.

B. Newly installed membrane shall be cleaned as described above for standard seaming details.

C. When repairing a membrane that has been in place for some time or has been subjected to dirt or contamination, it is necessary to remove accumulated field dirt. Proper membrane preparation is made by scrubbing the membrane with a scrub brush and warm soapy water, and then rinsing with clear water and drying with clean cotton cloths. For membrane with a significant accumulation of dirt, cleaning with acetone and a clean cotton cloth may be required. cleaner may then be used.

D. Heat-weld the repair as described above for standard seaming details.

## 3.10 STANDING WATER LIMITATIONS

A. The installed roof assembly is required to slope to drain and be free of standing water.

B. There shall be no standing water or puddles anywhere on the roof 48 hours after rain or intentional wetting.

C. Remove and replace roof system as required to eliminate standing water.

## 3.11 PROTECTING AND CLEANING

A. Do not allow standing water of any depth at any time on roofing systems.

B. Membrane wrinkles impeding water drainage are not acceptable.

C. Protect membrane-roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and the Owner.

D. Correct deficiencies in or remove membrane-roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane-roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements at no cost to the Owner.

E. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

# SECTION 076100

# SHEET METAL ROOFING

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Standing seam galvanized steel roofing.
2. Gutters and downspouts.
3. Snow guards.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 061000 - ROUGH CARPENTRY for wood nailers, curbs, and blocking.
2. Section 076200 - SHEET METAL FLASHING AND TRIM for fasciae, copings, and flashings that are not part of sheet metal roofing.
3. Section 079200 - JOINT SEALANTS for field-applied sheet metal roofing sealants.

### 1.3 PERFORMANCE REQUIREMENTS

A. General: Provide complete sheet metal roofing system, including, but not limited to, custom-fabricated metal roof pans, cleats, clips, anchors and fasteners, sheet metal flashing and drainage components related to sheet metal roofing, fascia panels, trim, underlayment, and accessories as indicated and as required for a weathertight installation.

B. Fabricate and install roofing capable of resisting forces required by Code according to recommendations in FMG Loss Prevention Data Sheet 1-49.

C. Thermal Movements: Provide sheet metal roofing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal roofing thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Water Infiltration: Provide sheet metal roofing that does not allow water infiltration to building interior, with metal flashing and connections of sheet metal roofing lapped to allow moisture to run over and off the material.

## 1.4 SUBMITTALS

A. Product Data: For each product indicated. Include details of construction relative to materials, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation layouts of sheet metal roofing, including plans, elevations, and keyed references to termination points. Distinguish between shop- and field-assembled work. Include the following:

1. Details for forming sheet metal roofing, including seams and dimensions.
2. Details for joining and securing sheet metal roofing, including layout of fasteners, clips, and other attachments. Include pattern of seams.
3. Details of termination points and assemblies, including fixed points.
4. Details of expansion joints, including showing direction of expansion and contraction.
5. Details of roof penetrations.
6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counter flashings.
7. Details of special conditions.
8. Details of connections to adjoining work.
9. Details of the following accessory items, at a scale of not less than 1-1/2 inches per 12 inches:

    a. Flashing and trim.
    b. Roof curbs.
    c. Snow guards.
    d. Gutters and downspouts.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Roofing: 12 inches long by actual pan width, including finished seam. Include fasteners, cleats, closures, and other attachments.
2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: 12-inch-long Samples for each type of accessory.

    a. Snow Guards: Full-size Sample.

D. Qualification Data: For Installer and manufacturer.

E. Maintenance Data: For roofing system to include in maintenance manuals.

F. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain components for roofing system from or approved by roofing system manufacturer.

B. Sheet Metal Roofing Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.

C. Copper Roofing Standard: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 01. Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with the Architect; Architect, Owner's insurer if applicable; testing and inspecting agency representative; roofing Installer; roofing system manufacturer's representative; deck Installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.

7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal roofing pans, components, and other sheet metal roofing materials so as not to be damaged or deformed. Package sheet metal roofing materials for protection during transportation and handling.

B. Unload, store, and erect sheet metal roofing materials in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Store sheet metal roofing materials to ensure dryness. Do not store sheet metal roofing materials in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on sheet metal roofing from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal roofing installation.

## 1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

## 1.8 WARRANTY

A. Special Warranty on Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace sheet metal roofing that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 ROOFING SHEET METALS

A. Metallic-Coated Steel Sheet, Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2. Surface: Smooth, flat finish.
3. Thickness: 0.0276 inch, unless otherwise indicated.
4. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings: Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil; complying with AAMA 2605. Color as selected by Architect from manufacturer’s full range, including metallics.

### 2.2 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: 30 to 40 mils thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
2. Low Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
3. Available Products:

    a. Carlisle Coatings & Waterproofing, Div. of Carlisle Companies Inc.; Dri-Start "HR" High Performance Roofing Underlayment.
    b. Grace, W. R. & Co.; Vycor Ultra.
    c. Henry Company; Perma-Seal PE.
    d. TC MiraDRI; WIP 300HT.

B. Slip Sheet: Building paper, minimum 5 lb/100 sq. ft., rosin sized.

## 2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.

B. Fasteners: Self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Exposed Fasteners: Heads matching color of sheet metal roofing by means of plastic caps or factory-applied coating.
2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
3. Blind Fasteners: Stainless steel rivets.

C. Solder:

1. For Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
2. For Zinc-Tin Alloy-Coated Copper: ASTM B 32, 100 percent tin.

D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

E. Elastomeric Joint Sealant: ASTM C 920, of base polymer, type, grade, class, and use classifications required to produce joints in sheet metal roofing that will remain weathertight and as recommended by roll-formed sheet metal roofing manufacturer for installation indicated.

F. Expansion-Joint Sealant: For hooked-type expansion joints, which must be free to move, provide nonsetting, nonhardening, nonmigrating, heavy-bodied polyisobutylene sealant.

G. Bituminous Coating: Cold-applied asphalt mastic, ASTM D 1187, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

## 2.4 ACCESSORIES

A. Sheet Metal Roofing Accessories: Provide components required for a complete sheet metal roofing assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of sheet metal roofing, unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as sheet metal roofing.
2. Clips: Minimum 0.0625-inch-thick, stainless steel panel clips designed to withstand negative-load requirements.
3. Cleats: For mechanically seaming into joints and formed from the following materials:

    a. Metallic-Coated Steel and Aluminum Roofing: 0.0250-inch- thick stainless steel.
    b. Copper and Zinc-Tin Alloy-Coated Copper Roofing: 16-oz./sq. ft. copper sheet.

4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.

B. Flashing and Trim: Formed from same material and with same finish as sheet metal roofing, minimum 0.0179-inch-thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers.

1. Pipe and Penetration Flashing: Premolded, flashing sleeve or pipe collar with flexible metal ring bonded to sloped base. Intended to provide weatherproof seal and to isolate pipe movement from vibration and expansion/contraction.

C. Roof Curbs: Fabricated from same material and finish as sheet metal roofing, minimum thickness matching the sheet metal roofing; with bottom of skirt profiled to match roof panel profiles; with weatherproof top box and integral full-length cricket. Fabricate curb sub framing of nominal 0.062-inch- thick, angle-, C-, or Z-shaped galvanized steel or stainless steel sheet. Fabricate curb and sub framing to withstand indicated loads of size and height indicated. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1. Factory insulate curbs with 1-inch- thick, rigid insulation.
2. Factory install wood nailers at tops of curbs.
3. Fabricate curb units with water diverter or cricket and with height tapered to match slope to level tops of units.

D. Snow Guards: Prefabricated, noncorrosive units designed to be installed without penetrating sheet metal roofing, and complete with predrilled holes, clamps, or hooks for anchoring.

1. Seam-Mounted, Bar-Type Snow Guards: Aluminum rods or bars held in place by stainless-steel clamps attached to vertical ribs of standing-seam sheet metal roofing.

    a. Aluminum Finish: Match roofing.
    b. Available Products:

1) Alpine Snow Guards, Div. of Vermont Slate & Copper Services, Inc.; Model No. 05-98.
2) LMCurbs; S-5! SnoFence.
3) Snow Management Systems, a division of Contek, Inc.; Vermont Snowguard.

E. Hanging Gutters: Fabricate to cross-section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.

1. Gutter Style: As indicated on Drawings.
2. Expansion Joints: Lap type.
3. Gutters with Girth up to 20 Inches: Fabricate from the following materials:

a. Galvanized Steel: 0.028 inch thick.
b. Aluminum: 0.040 inch thick.
c. Copper: 16 oz./sq. ft.
d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft.

4. Gutters with Girth greater than 20 Inches: Fabricate from materials and minimum thicknesses recommended by SMACNA.

F. Downspouts: Fabricate downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Downspout Shape: As indicated on Drawings.
2. Hanger Style: As indicated on Drawings.
3. Downspouts: Fabricate from the following materials:

a. Galvanized Steel: 0.022 inch thick.
b. Aluminum: 0.032 inch thick.
c. Copper: 16 oz./sq. ft.
d. Zinc-Tin Alloy-Coated Copper: 16 oz./sq. ft.

G. Splash Blocks: Provide precast concrete splash blocks.

## 2.5 FABRICATION

A. General: Custom fabricate sheet metal roofing to comply with details shown and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design,

dimensions (pan width and seam height), geometry, metal thickness, and other characteristics of installation indicated. Fabricate sheet metal roofing and accessories at the shop to greatest extent possible.

1. Standing-Seam Roofing: Form standing-seam pans with finished seam height of 1 inch

B. General: Fabricate roll-formed sheet metal roofing panels to comply with details shown and roll-formed sheet metal roofing manufacturer's written instructions.

C. Fabricate sheet metal roofing to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks, true to line and levels indicated, and with exposed edges folded back to form hems.

1. Lay out sheet metal roofing so cross seams, when required, are made in direction of flow with higher pans overlapping lower pans. Stagger cross seams.
2. Fold and cleat eaves and transverse seams in the shop.
3. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown and as required for leakproof construction.

D. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant (concealed within joints).

E. Sealant Joints: Where movable, nonexpansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.

F. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturers of dissimilar metals or by fabricator.

G. Sheet Metal Accessories: Custom fabricate flashings and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

2. Seams: Fabricate nonmoving seams with flat-lock seams.
3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.6 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, sheet metal roofing supports, and other conditions affecting performance of work.

1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored, and that provision has been made for flashings, and penetrations through sheet metal roofing.
3. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

B. Examine roughing-in for components and systems penetrating sheet metal roofing to verify actual locations of penetrations relative to seam locations of sheet metal roofing before sheet metal roofing installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Install flashings and other sheet metal to comply with requirements specified in Section 076200 - SHEET METAL FLASHING AND TRIM.

## 3.3 UNDERLAYMENT INSTALLATION

A. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free, on roof sheathing under sheet metal roofing. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply over entire roof in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

B. Install flashings to cover underlayment to comply with requirements specified in Section 076200 - SHEET METAL FLASHING AND TRIM.

C. Apply slip-sheet over underlayment before installing sheet metal roofing.

## 3.4 INSTALLATION, GENERAL

A. General: Install sheet metal roofing perpendicular to purlins or supports. Anchor sheet metal roofing and other components of the Work securely in place, with provisions for thermal and structural movement. Install fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for a complete roofing system and as recommended by fabricator for sheet metal roofing.

1. Field cutting of sheet metal roofing by torch is not permitted.
2. Rigidly fasten eave end of sheet metal roofing and allow ridge end free movement due to thermal expansion and contraction. Predrill roofing.
3. Provide metal closures at each side of ridge caps.
4. Flash and seal sheet metal roofing with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws.
5. Locate and space fastenings in uniform vertical and horizontal alignment.
6. Install ridge caps as sheet metal roofing work proceeds.

7. Locate roofing splices over, but not attached to, structural supports. Stagger roofing splices and end laps to avoid a four-panel lap splice condition.
8. Lap metal flashing over sheet metal roofing to allow moisture to run over and off the material.

B. Fasteners: Use fasteners of sizes that will not penetrate completely through substrate.

1. Steel Roofing: Use stainless-steel fasteners.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by fabricator of sheet metal roofing or manufacturers of dissimilar metals.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Fascia: Align bottom of sheet metal roofing and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal sheet metal roofing with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

## 3.5 CUSTOM-FABRICATED SHEET METAL ROOFING INSTALLATION

A. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form a hem on concealed side of exposed edges, unless otherwise indicated.

1. Install cleats to hold sheet metal panels in position. Attach each cleat with two fasteners to prevent rotation.
2. Nail cleats not more than 12 inches o.c. Bend tabs over nails.

B. Seal joints as shown and as required for leakproof construction. Provide low-slope transverse seams using cleats where backup of moisture may occur.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for

installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 - Joint Sealants.

C. Provide expansion cleats in roof panels that exceed 30 feet in length.

D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches, except reduce pre-tinning where pre-tinned surface would show in completed Work.

1. Do not solder metallic-coated steel or aluminum sheet.
2. Do not pre-tin zinc-tin alloy-coated copper.
3. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.
4. Copper Roofing: Tin edges of uncoated copper sheets, using solder for copper.

E. Standing-Seam Roofing: Attach standing-seam metal pans to substrate with cleats, double-nailed at 12 inches o.c. Install pans reaching from eave to ridge before moving to adjacent pans. Lock each pan to pan below with transverse seam. Before pans are locked, apply continuous bead of sealant to top flange of lower pan. Crimp standing seams by folding over twice so cleat and pan edges are completely engaged.

1. Loose-lock pans at eave edges to continuous cleats and flanges on back edges of gutters.
2. Fold over seams after crimping at ridges and hips.

## 3.6 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete sheet metal roofing assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to

form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

C. Pipe and Penetration Flashing: Form flashing around pipe penetration and sheet metal roofing. Fasten and seal to sheet metal roofing as recommended by SMACNA.

D. Bar-Type Snow Guards: Attach bar supports to vertical ribs of standing-seam sheet metal roofing with clamps or setscrews. Do not use fasteners that will penetrate sheet metal roofing.

## 3.7 ROOF-EDGE DRAINAGE INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored gutter brackets or straps spaced not more than 36 inches apart. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Fasten gutter spacers to front and back of gutter.
2. Loosely lock straps to front gutter bead and anchor to roof deck.
3. Anchor and loosely lock back edge of gutter to continuous cleat.
4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches apart.
5. Anchor gutter with spikes and ferrules spaced not more than 24 inches apart.
6. Install gutter with expansion joints at locations indicated, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts: Join sections with 1-1/2-inch telescoping joints.

1. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches o.c. in between.
2. Connect downspouts to underground drainage system indicated.

D. Splash Blocks: Install where downspouts discharge onto low-slope roofs and where indicated. Set in cement or sealant compatible with roofing membrane.

## 3.8 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal roofing within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

## 3.9 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

1. Steel and Aluminum Materials: Clean off excess sealants.
2. Copper Materials: Clean and neutralize flux materials. Clean off excess solder and sealants.

B. Remove temporary protective coverings and strippable films, if any, as sheet metal roofing is installed. On completion of sheet metal roofing installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

C. Replace panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

# SECTION 076200

# SHEET METAL FLASHING AND TRIM

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Sheet metal flashing and trim for the following applications:

    a. Through-wall flashing.
    b. Formed wall flashing and trim.
    c. Formed low-slope roof flashing and trim.
    d. Gutters, downspouts, conductor heads and splash blocks.
    e. Scuppers.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 061000 - ROUGH CARPENTRY for wood nailers, curbs, and blocking.
2. Section 075400 - THERMOPLASTIC MEMBRANE ROOFING for installing sheet metal flashing and trim integral with roofing membrane.
3. Section 076100 – SHEET METAL ROOFING.
4. Section 079200 - JOINT SEALANTS for field-applied sheet metal flashing and trim sealants.

## 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide assemblies capable of withstanding the effects of gravity loads and wind loads and stresses within limits and under conditions indicated without permanent deformation of components, metal fatigue, or permanent damage to fasteners and anchors; based on testing according to ASTM E 1592 and ASTM E 330 as applicable.

1. Wind Loads: As indicated on the Structural Drawings.

B. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

C. Provide permanently watertight flashing and sheet metal installations which will not deteriorate in excess of manufacturer’s published limitations.

D. Fabricate and install roof edge flashing and copings capable of resisting Wind Zone forces required by Code according to recommendations in FMG Loss Prevention Data Sheet 1-49.

E. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F material surfaces.

F. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

G. Interface with Other Systems:

1. Do not proceed with installation of flashing and sheet metal until completion of curb and substrate construction, cants, blocking, reglets and other construction required to receive flashing.

2. Coordinate flashing with other Work for correct sequencing of items comprising entire membrane or system of roofing or waterproofing and rain drainage.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:

1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion-joint covers, including showing direction of expansion and contraction.

C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim: 12 inches long. Include fasteners and other exposed accessories.
3. Accessories: Full-size Sample.
4. Solder joints in stainless steel flashing to allow review of detailing and workmanship quality. Alternatively, review these items in the field or during the mockup phase.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1. Meet with the Owner, Architect and Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

C. Sealant Compatibility and Adhesion Testing: Use sealant manufacturer's standard test methods to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates and adjacent sealants and materials.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

## 1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

# PART 2 - PRODUCTS

## 2.1 SHEET METALS

A. Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005. Thickness as specified in this Section. Temper suitable for forming and structural performance required, but not less than H14.

B. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304 for abovegrade, Type 316 for buried conditions, with No. 2D dull, cold-rolled finish. Thickness as specified in this Section.

2.2 UNDERLAYMENT MATERIALS

A. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

B. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft.

C. High-temperature resistant self-adhering membrane where installed directly below exposed metal flashing, such as Grace Ice and Water Shield.

2.3 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

C. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

E. EPDM flashing membrane (For Transverse Metal Flashing Expansion Joints): 0.060 in. thick pressure-sensitive, uncured EPDM membrane with manufacturer's recommended cleaners and primers. Carlisle CCW Pressure Sensitive Elastoform or approved equal. Use manufacturer's recommended primers, adhesives, sealants, and solvent cleaners.

F. Release Tape: 0.060 in. thick polyethylene, adhesive backed on one side, widths as required.

G. Elastomeric Sealant: ASTM C 920, silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight. Match sealant selected under Section 079200 to avoid risk of incompatible contact between adjacent sealants.

H. Isolation Coating: ASTM D 1187, cold-applied asphalt emulsion, VOC compliant, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15 mil (0.4 mm) dry film thickness per coat.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with silicone sealant. Rivet joints for additional strength. Provide 2 in. min. end dams at terminations (riveted and sealed watertight).
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

3. For soldered seams (Stainless steel) require prefabricated inside and outside corners and 2 in. min. end dams at terminations (riveted and soldered watertight).

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Expansion Provisions: Form expansion joints (overlap adjacent sheet metal 2 inches), install a 1 in. wide polyethylene tape (bond breaker), and cover the joint with a 6 in. wide strip of uncured EPDM membrane and an 8 in. wide metal cover plate) at 20 ft. o.c. and within 2 ft. of corners and terminations. All other flashing joints to be riveted and soldered. Provide laps, joints, and seams that are watertight and weatherproof.

1. Provide laps, joints and seams that are watertight and weatherproof.

F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

H. Gutters: Manufactured in uniform section lengths not exceeding 12 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.

1. Fabricate from the following exposed metal:

a. Aluminum: 0.050 inch (1.27 mm) thick.

2. Gutter Profile: As indicated according to SMACNA's "Architectural Sheet Metal Manual."
3. Corners: Factory mitered and soldered.
4. Gutter Supports: As indicated with finish matching the gutters.
5. Gutter Accessories: Bronze wire ball downspout strainer,

I. Downspouts: Plain round complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Aluminum: 0.040 inch (1.02 mm) thick.

J. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout.

1. Fabricate from the following exposed metal:

a. Aluminum: 0.040 inch (1.02 mm) thick.

## 2.5 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Copings: Fabricate in minimum 96-inch-long, but not exceeding 10-foot-long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and drill elongated holes for fasteners on interior leg. Miter corners, seal, and solder or weld watertight.

1. Joint Style: Butt, with 12-inch-wide concealed backup plate.
2. Fabricate copings from the following material:

a. Aluminum: 0.050 inch (1.27 mm) thick.

B. Roof and Roof to Wall Transition Expansion-Joint Cover, Base Flashing, Counterflashing, Roof Penetration Flashing: Fabricate from the following material:

1. Stainless Steel: 0.025 inch (0.64 mm) thick.

## 2.6 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing, Typical: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12 foot long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings. Form with 2-inch-high end dams. Fabricate from the following material:

1. Stainless Steel: 0.016 inch (0.40 mm) thick.

## 2.7 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system. Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer installation instructions, and SMACNA “Architectural Sheet Metal Manual”. Anchor units work of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.

1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Coat side of stainless-steel sheet metal flashing and trim with isolation coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip-sheet or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

1. Space cleats not more than 12 inches apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Form expansion joints (gap the metal 1/8 in., install a 1 in. wide min. release polyethylene tape (bond breaker), and cover the joint with a 6 in. wide strip of uncured EPDM membrane, and an 8 in. wide metal cover plate) at 20 ft. o.c. and within 2 ft. of corners and terminations. All other flashing joints to be riveted and soldered. Provide laps, joints, and seams that are watertight and weatherproof.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

1. Aluminum: Use aluminum or stainless steel fasteners.
2. Stainless Steel: Use stainless-steel fasteners.

H. Seal joints with elastomeric sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 - JOINT SEALANTS.

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.

1. Do not solder aluminum sheet.
2. Stainless-Steel Soldering: Pretin edges of uncoated sheets to be soldered using solder recommended for stainless steel and phosphoric acid flux. Promptly wash off acid flux residue from metal after soldering.
3. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.
4. If soldering is performed in place on site, protect the membrane beneath metal flashings from damage.

J. Aluminum Flashing: Rivet or weld joints in uncoated aluminum where necessary for strength.

## 3.3 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight.

B. All roof flashings should be terminated a minimum of 8 in. above the roofing membrane surface.

C. Roof-Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless steel draw band and tighten.

E. Counterflashing: Coordinate installation of membrane counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.

1. Secure in a waterproof manner by means of snap-in installation and sealant.

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Seal with elastomeric sealant and clamp flashing to pipes penetrating roof except for flashing on vent piping.

## 3.4 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches apart. Attach ends with rivets and solder to make watertight. Slope to downspouts.

1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet apart. Install expansion joint caps.

C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.

1. Provide elbows at base of downspout to direct water away from building.

D. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below gutter discharge.

## 3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

## 3.6 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

# SECTION 077200

# ROOF ACCESSORIES

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Roof hatches and safety rails.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 055000 - METAL FABRICATIONS for metal ladders.
2. Section 061000 - ROUGH CARPENTRY for wood cants and wood nailers.
3. Section 076200 - SHEET METAL FLASHING AND TRIM for shop- and field-fabricated metal flashing and counterflashing, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
4. Section 089000 - LOUVERS AND VENTS for louvers.
5. Division 23 - HEATING, VENTILATING, AND AIR CONDITIONING for roof-mounted ventilators.
6. Division 26 - ELECTRICAL for power supply and final connections for automatically operated heat and smoke vents.

### 1.3 SUBMITTALS

A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for roof accessories. Show layouts of roof accessories including plans and elevations. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other work.

## 1.4 QUALITY ASSURANCE

A. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Pack, handle, and ship roof accessories properly labeled in heavy-duty packaging to prevent damage.

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify required openings for each type of roof accessory by field measurements before fabrication and indicate measurements on Shop Drawings.

## 1.7 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

# PART 2 - PRODUCTS

## 2.1 ROOF HATCHES

A. Available Products: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babcock-Davis; ThermalMAX roof hatch.
2. Bilco; Thermally Broken Roof Hatch.

B. Roof Hatches, Thermally Broken Types: Fabricate roof hatches with insulated double-wall lids and insulated double-wall curb frame with integral deck mounting flange and lid frame counterflashing. Fabricate with welded or mechanically fastened and sealed corner joints.

Provide continuous weathertight perimeter gasketing and equip with corrosion-resistant or hot-dip galvanized hardware.

1. Loads: Fabricate roof hatches to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loads.
2. Type and Size: Lid type and size as indicated on Drawings.
3. Curb and Lid Material: Galvanized steel or aluminum sheet, 0.079 inch thick.
4. Insulation: Manufacturer's standard board insulation, R-18 min.
5. Curb: Fabricate units to minimum height of 12 inches.
6. Thermal Break: Fabricate with thermal break between interior and exterior surfaces.
7. Hardware: Galvanized steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
8. Ladder Safety Post: Manufacturer's standard ladder safety post. Post to lock in place on full extension. Provide release mechanism to return post to closed position.

C. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and complying with 29 CFR 1910.23 requirements and authorities having jurisdiction.

1. Height: 42 inches above finished roof deck.
2. Posts and Rails: Galvanized-steel pipe, 1-1/4 inches in diameter or galvanized-steel tube, 1-5/8 inches in diameter.
3. Flat Bar: Galvanized steel, 2 inches high by 3/8 inch thick.
4. Maximum Opening Size: System constructed to prevent passage of a sphere 21 inches in diameter.
5. Chain Passway Barrier: Galvanized proof coil chain with quick link on fixed end.
6. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
7. Post and Rail Tops and Ends: Weather resistant, closed or plugged with prefabricated end fittings.
8. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members.
9. Fabricate joints exposed to weather to be watertight.
10. Fasteners: Manufacturer's standard, finished to match railing system.
11. Finish: Manufacturer's standard.

## 2.2 MISCELLANEOUS MATERIALS

A. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.

B. Isolation Coating: ASTM D 1187, cold-applied asphalt emulsion, VOC compliant, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

C. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by roof accessory manufacturer. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

E. Elastomeric Sealant: ASTM C 920, polyurethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored and is ready to receive roof accessories.
2. Verify dimensions of roof openings for roof accessories.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions. Anchor roof accessories securely in place and capable of resisting forces specified. Use fasteners, separators, sealants, and other miscellaneous items as required for completing roof accessory installation. Install roof accessories to resist exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Install roof accessories to fit substrates and to result in watertight performance.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with isolation coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip-sheet, or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Roof Hatch Installation:

1. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.
2. Attach safety railing system to roof hatch curb.
3. Attach ladder safety post according to manufacturer's written instructions.

F. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

## 3.3 TOUCH UP

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 078410

PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 078440 - FIRE-RESISTIVE JOINT SYSTEMS for fire-resistive joint sealers.
2. Section 079200 - JOINT SEALANTS for standard joint sealers.
3. Division 21 - FIRE SUPPRESSION for fire-protection piping penetrations.
4. Division 22 - PLUMBING for piping penetrations.
5. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING for duct and piping penetrations.
6. Division 26 - ELECTRICAL for cable and conduit penetrations.
7. Division 27 - COMMUNICATIONS for cable and conduit penetrations.

1.3 COORDINATION

A. Jobsite conditions of each through-penetration firestop system must meet all details of the UL-Classified System selected. If jobsite conditions do not match any UL-classified systems, contact firestop manufacturer for alternative systems or Engineer Judgment Drawings.

B. Coordinate work with other trades to assure that penetration-opening sizes are appropriate for penetrant locations.

C. Verify that the schedule is current at the time of construction, and that each referenced system is suitable for the intended application.

1.4 PERFORMANCE REQUIREMENTS

A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

    a. Basis of Design: Hilti CFP-ES Endo-Shield High-Temperature Endothermic Mat LBC Red List Compliant.
    b. T-ratings shall be achieved by utilizing a Low Bio Persistent Endothermic Mat incorporating foil scrim on both sides.

4. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested in accordance with UL 1470

a. Basis of Design: Utilize LBC Red List Compliant Products, Hilti CFS-CID MD (Metal Deck) or CP680 Cast-in devices with the Water Barrier Module, with appropriate system to achieve W-Rating.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.

a. Basis of Design: Utilize LBC Red List Compliant Products, Hilti CFS-MSL (Modular Sleeve) or CP653 Cable Pathway Device, with appropriate system to achieve L-Rating.

E. Exposed Penetration Firestopping:

1. Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
2. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

a. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems demonstrating no evidence of water leakage when tested according to UL 1479.
b. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.

F. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

G. Large wall opening protective materials for use with U.L listed metallic and specified nonmetallic large electrical boxes, the following products are acceptable.

1. Basis of Design: Hilti CFP-ES Endo-Shield Low Bio Persistent Endothermic Mat with foil scrim on both sides, LBC Red List Compliant.

H. Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of zero (0_ as determined by ASTM G21.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.

C. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:

1. Types of penetrating items.
2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.

D. Qualification Data: For Installer.

1.6 QUALITY ASSURANCE

A. Inspecting Agency: Owner will engage a qualified testing agency, which complies with ASTM E 699 and ASTM E 3038 stndards, to perform tests and inspections and prepare test reports, as required by 2015 IBC 1705.17 and 1705.17.1. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

B. Installer Qualifications: For systems that utilize a pre-formed firestop product, at a minimum installer to be trained directly from manufacturer. For systems that require sealants, putties, or sprays, a firm that has been approved by FM Global according to FM Global 4991, “Approval of Firestop Contractors”, or been evaluated by UL and found to comply with its “Qualified Firestop Contractor Program Requirements.

C. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

D. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

E. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency meeting ASTM E 699 and ASTM E3038 standards. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:

a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed in the UL “Fire Resistance Directory.”

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

## 1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to the following:

1. Hilti, Inc. (Basis-of-design)
2. BioFireshield; RectorSeal Corporation.
3. Specified Technologies, Inc. (STI).
4. 3M; Fire Protection Products Division.

2.2 FIRESTOPPING MATERIALS

A. Schedule: Refer to the Firestopping Schedule at the end of this Section.

B. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

C. Materials: Provide through-penetration firestop systems containing primary materials and fill materials which are part of the tested assemblies indicated in the approved Through-Penetration Firestop System Schedule submittal. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.

D. Endothermic Mats: Wrap Solutions; Low Bio Persistent Endothermic Wrap incorporating foil scrim on both sides. Wrap evaluated for protection of cable pathways and liquid fuel lines, for firestopping of through-penetrations and membrane penetrations, and for achieving T-ratings. Wrap testing to incorporate protection of electrical metallic tubing (EMT), rigid metallic conduit (RMC), cable trays, liquid fuel lines, and electrical panels. Wrap to have a maximum weight of 1.4lbs/ft2. Wrap to accommodate the use of 18-gauge steel tie wire when installed around piping, conduits, and/or cable trays. Subject to compliance with requirements..

1. Basis of Design: Hilti CFP-ES Endo-Shield High-Temperature Endothermic Wrap, LBC Red List Compliant.

E. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated.

F. Testing: Use only firestop products that have been UL 1479, ASTM E 814 or UL 2079 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance

## 2.3 MIXING

A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

## 3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

A. General: Install through-penetration firestop systems to comply with Part 1 "Performance Requirements" Article and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for firestop systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Contractor to ensure a manufacturer's direct representative is on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. Training will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Inspecting Agency: Owner will engage a qualified testing agency, meeting ASTM E 699 and ASTM E3038 standards, to perform tests and inspections and prepare test reports, as required by 2015 IBC 1705.17 and 1705.17.1. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

C. Testing Services: Inspecting of completed installations of penetration firestopping shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of penetration firestopping for the next area until inspecting agency determines completed work shows compliance with requirements.

1. Inspecting agency shall state in each report whether inspected penetration firestopping comply with or deviate from requirements.

D. Remove and replace penetration firestopping where inspections indicate that they do not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and penetration firestopping complies with requirements.

## 3.5 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

**THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE**

| CONCRETE FLOORS | | UL-CLASSIFIED SYSTEMS | | | CONCRETE OR BLOCK WALLS | | UL-CLASSIFIED SYSTEMS | | |
|---|---|---|---|---|---|---|---|---|---|
| **TYPE OF PENETRANT** | **F-RATING HR** | **HILTI** | **3M** | **Rector-seal** | **TYPE OF PENETRANT** | **F-RATING HR** | **HILTI** | **3M** | **Rector-seal** |
| CIRCULAR BLANK OPENINGS | 1 | FA 0008 | CAJ0009 | CAJ-0012<br>CAJ-0041<br>FA-0016 | CIRCULAR BLANK OPENINGS | 1 | CAJ 0055, CAJ 0070 | CAJ2009 | CAJ-0012<br>CAJ-0041<br>WJ-0004 |
| | 2 | FA 0008<br>CAJ 0070 | CAJ0009 | CAJ-0012<br>CAJ-0041 | | 2 | CAJ 0055, CAJ 0070 | CAJ2009 | CAJ-0012<br>CAJ-0041<br>WJ-0004 |
| | 3 | FA 0006<br>CAJ 0055 | CAJ0009 | CAJ-0012<br>CAJ-0088 | | 3 | CAJ 0055 | CAJ2009 | CAJ-0012<br>CAJ-0088 |
| SINGLE METAL PIPES OR CONDUIT | 1 | CAJ 1226<br>CAJ 1278<br>FA 1017 | CAJ1058 | CAJ-1235<br>FA-1048<br>CAJ-1403<br>CAJ-1502 | SINGLE METAL PIPES OR CONDUIT | 1 | CAJ 1226, CAJ 1278, | CAJ1058 | CAJ-1235<br>CAJ-1403<br>WJ-1065<br>WJ-1090 |
| | 2 | CAJ 1226<br>CAJ 1278<br>FA 1014<br>FA 1029<br>CAJ 1155 | CAJ1058 | CAJ-1235<br>FA-1048<br>CAJ-1403<br>CAJ-1502 | | 2 | CAJ 1226, CAJ 1278, | CAJ1058 | CAJ-1235<br>CAJ-1403<br>WJ-1065<br>WJ-1090 |
| | 3 | CAJ 1226<br>CAJ 1278<br>FA 1017 | CAJ1058 | CAJ-1235<br>CAJ-1403<br>CAJ-1502 | | 3 | CAJ 1226, CAJ 1278, | CAJ1058 | CAJ-1235<br>CAJ-1403<br>CAJ-1502 |

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|---|---|---|---|---|---|---|---|---|---|
| | | FA 1192<br>CAJ 1155 | | | | | | | |
| | 4 | CAJ 8095<br>CBJ 1034 | CAJ1044 | FA-1073<br>FA-1075 | | 4 | CAJ 8095, CBJ 1034, WJ 1042 | CAJ1044 | |
| SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, ENT) | 1 | CAJ 2109<br>CAJ 2168<br>FA 2054<br>FA 2067 | CAJ2189<br>CAJ2117<br>CAJ2027 | CAJ-2348<br>CAJ-2661<br>CAJ-2597<br>FA-2235<br>FA-2277 | SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, ENT) | 1 | CAJ 2109, WJ 2108, WJ 2121 | CAJ2189<br>CAJ2117<br>CAJ2027 | WJ-2088<br>WJ-2266<br>CAJ-2661<br>CAJ-2597 |
| | 2 | CAJ 2109<br>CAJ 2168<br>FA 2054<br>FA 2067<br>FA 2213 | CAJ2189<br>CAJ2117 | CAJ-2348<br>CAJ-2661<br>CAJ-2597<br>FA-2235<br>FA-2277 | | 2 | CAJ 2109, WJ 2108, WJ 2121 | CAJ2189<br>CAJ2117<br>CAJ2127 | WJ-2088<br>WJ-2266<br>CAJ-2661<br>CAJ-2597 |
| | 3 | CAJ 2109<br>CAJ 2168<br>FA 2054<br>FA 2213 | CAJ2005<br>CAJ2117 | CAJ-2151<br>CAJ-2661<br>CAJ-2597 | | 3 | CAJ 2109, CAJ 2168, WJ 2091 | CAJ2189<br>CAJ2117<br>CAJ2027 | CAJ-2151<br>CAJ-2661<br>CAJ-2597 |
| | 4 | N/A* | CBJ2002 | | | 4 | WJ 2091 | CBJ2002 | |

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|---|---|---|---|---|---|---|---|---|---|
| SINGLE OR BUNDLED CABLES | 1 | FA 3007<br>CAJ 3095 | CAJ3021 | CAJ-3199<br>CAJ-3286<br>FA-3019 | SINGLE OR BUNDLED CABLES | 1 | CAJ 3095, WJ 3060 WJ 3074 | CAJ3021 | CAJ-3308<br>WJ-3072<br>WJ-3144 |
| | 2 | FA 3007<br>FA 3085<br>CAJ 3095 | CAJ3021 | CAJ-3199<br>CAJ-3286<br>FA-3019<br>CAJ-3308 | | 2 | CAJ 3095, WJ 3060 WJ 3074 | CAJ3021 | CAJ-3308<br>WJ-3072<br>WJ-3144 |
| | 3 | FA 3007<br>FA 3012<br>CAJ 3095 | CAJ3021 | CAJ-3199<br>CAJ-3286<br>FA-3019 | | 3 | CAJ 3095, WJ 3050 | CAJ3021 | CAJ-3199<br>CAJ-3286 |
| | 4 | N/A* | CBJ3016<br>CBJ3017 | | | 4 | WJ 3050 | CBJ3016<br>CBJ3017 | |
| CABLE TRAY | 1 | CAJ 4034<br>CAJ 4054<br>CAJ 4017 | CAJ4003 | CAJ-4047<br>CAJ-4062 | CABLE TRAY | 1 | CAJ 4034, CAJ 4054, WJ 4016, | CAJ4003 | CAJ-4062<br>WJ-4025 |
| | 2 | CAJ 4034<br>CAJ 4054<br>CAJ 4017 | CAJ4003 | CAJ-4047<br>CAJ-4062 | | 2 | CAJ 4034, CAJ 4054, WJ 4016, | CAJ4003 | CAJ-4062<br>WJ-4025 |
| | 3 | CAJ 4034<br>CAJ 4017 | CAJ4003 | CAJ-4047<br>CAJ-4062 | | 3 | CAJ 4034, WJ 8007 | CAJ4003 | CAJ-4047<br>CAJ-4062 |
| | 4 | N/A* | N/A | CAJ-4049 | | 4 | WJ 8007 | N/A | CAJ-4049 |

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|---|---|---|---|---|---|---|---|---|---|
| SINGLE INSULATED PIPES | 1 | FA 5016<br>FA 5017<br>CAJ 5090<br>CAJ 5091 | CAJ5080<br>CAJ5024<br>CAJ5017 | CAJ-5208<br>CAJ-5222<br>CAJ-5283<br>CAJ-8101 | SINGLE INSULATED PIPES | 1 | CAJ 5090, CAJ 5091, WJ 5042 | CAJ5080<br>CAJ5025<br>CAJ5017 | WJ-5079<br>WJ-5081<br>CAJ-5238 |
| | 2 | FA 5016<br>FA 5017<br>FA 5021<br>CAJ 5090<br>CAJ 5091 | CAJ5080<br>CAJ5024<br>CAJ5017 | CAJ-5208<br>CAJ-5222<br>CAJ-5283<br>CAJ-8101 | | 2 | CAJ 5090, CAJ 5091, WJ 5042 | CAJ5080<br>CAJ5025<br>CAJ5017 | WJ-5079<br>WJ5081<br>CAJ-5238 |
| | 3 | FA 5016<br>FA 5070<br>CAJ 5061<br>CAJ 5090 | CAJ5024<br>CAJ5017 | CAJ-5238<br>CAJ-5283 | | 3 | CAJ 5090, CAJ 5091, | CAJ5025<br>CAJ5017 | CAJ-5238<br>CAJ-5283 |
| | 4 | CBJ 5006 | CBJ5002<br>CBJ5003 | | | 4 | WJ 5028, CBJ 5006 | CBJ5002<br>CBJ5003 | |
| ELECTRICAL BUSWAY | 1 | CAJ 6006<br>CAJ 6017 | CAJ6001<br>CAJ6002 | CAJ-6025<br>CAJ-6027 | ELECTRICAL BUSWAY | 1 | CAJ 6006, CAJ 6017 | CAJ6001<br>CAJ6002 | WJ-6005<br>CAJ-6027 |
| | 2 | CAJ 6006<br>CAJ 6017 | CAJ6001<br>CAJ6002 | CAJ-6025<br>CAJ-6027 | | 2 | CAJ 6006, CAJ 6017 | CAJ6001<br>CAJ6002 | WJ-6005<br>CAJ-6027 |
| | 3 | CAJ 6006<br>CAJ 6017 | CAJ6001<br>CAJ6002 | CAJ-6027 | | 3 | CAJ 6006, CAJ 6017 | CAJ6001<br>CAJ6002 | CAJ-6027 |

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| NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS | 1 | CAJ 7046<br>CAJ 7051 | CAJ7003<br>CAJ7021 | CAJ-7067<br>CAJ-7082<br>CAJ-7088 | NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS | 1 | CAJ 7046<br>WJ 7029<br>WJ 7022 | CAJ7003<br>CAJ7021 | WJ-7023<br>WJ-7045<br>WJ-7096<br>WJ-7116 |
| | 2 | CAJ 7046<br>CAJ 7051 | CAJ7003<br>CAJ7021 | CAJ-7067<br>CAJ-7082<br>CAJ-7088 | | 2 | CAJ 7046, WJ 7029, WJ 7022 | CAJ7003<br>CAJ7021 | WJ-7023<br>WJ-7045<br>WJ-7096<br>WJ7116 |
| | 3 | CAJ 7046<br>CAJ 7051 | CAJ7003<br>CAJ7021 | CAJ-7082<br>CAJ-7088 | | 3 | CAJ 7046<br>CAJ 7051 | CAJ7003<br>CAJ7021 | CAJ-7082<br>CAJ-7088 |
| MIXED PENETRANTS | 1 | CAJ 8056<br>CAJ 8095<br>CAJ 8099 | CAJ8001<br>CAJ8013 | CAJ-8101<br>CAJ-8129<br>CAJ-8133 | MIXED PENETRANTS | 1 | CAJ 8096, CAJ 8099<br>WJ 8007 | CAJ8001<br>CAJ8013 | WJ-8032<br>WJ-8061 |
| | 2 | CAJ 8056<br>CAJ 8095<br>CAJ 8099 | CAJ8001<br>CAJ8013 | CAJ-8101<br>CAJ-8129<br>CAJ-8133 | | 2 | CAJ 8096, CAJ 8099<br>WJ 8007 | CAJ8001<br>CAJ8013 | WJ-8032<br>WJ-8061 |
| | 3 | CAJ 8056<br>CAJ 8095<br>CAJ 8099 | CAJ8001<br>CAJ8013 | CAJ-8133<br>CAJ-8204 | | 3 | CAJ 8099<br>WJ 8007 | CAJ8001<br>CAJ8013 | CAJ-8133<br>CAJ-8204 |
| | 4 | CAJ 8095 | CBJ8004 | | | 4 | WJ 8007 | CBJ8004 | |

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| | | | CBJ8005 | | | | | CBJ8005 | |
| **WOOD FLOORS** | | **UL-CLASSIFIED SYSTEMS** | | | **GYPSUM WALLBOARD ASSEMBLIES** | | **UL-CLASSIFIED SYSTEMS** | | |
| **TYPE OF PENETRANT** | **F-RATING** | **HILTI** | **3M** | **Rectorseal** | **TYPE OF PENETRANT** | **F-RATING** | **HILTI** | **3M** | **Rector-seal** |
| METAL PIPES OR CONDUIT | 1 | FC 1009<br>FC 1059 | FC1002 | FC-1084<br>FC-1125 | METAL PIPES OR CONDUIT | 1 | WL 1054<br>WL 1164<br>WL 1441 | WL1146 | WL-1152<br>WL-1343<br>WL-1454 |
| | | | | | | 2 | WL 1054<br>WL 1164<br>WL 1380<br>WL 1441 | WL1010<br>WL1146 | WL-1152<br>WL-1343<br>WL-1454 |
| | 2 | FC 1009<br>FC 1059 | FC1002 | | | 3 | WL 1110 | WL1001 | WL-1161 |
| NON-METALLIC PIPE OR CONDUIT | 1 | FC 2025<br>FC 2126 | FC2024 | FC-2087<br>FC-2089<br>FC-2398<br>FC-2400 | NON-METALLIC PIPE OR CONDUIT | 1 | WL 2078<br>WL 2075<br>WL 2128<br>WL 2649 | WL2088<br>WL2002 | WL-2262<br>WL-2346<br>WL-2569<br>WL-2672 |
| | | | | | | 2 | WL 2078<br>WL 2075 | WL2088<br>WL200 | WL-2262<br>WL-2346 |

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| | | | | | | | WL 2128<br>WL 2649 | 2 | WL-2569<br>WL-2672 |
| | 2 | FC 2025<br>FC 2126 | FC2024 | FC-2042<br>FC-2083 | | | | | |
| | | | | | | 3 | WL 2184, WL 2245 | N/A | WL-2544 |
| SINGLE OR BUNDLED CABLES | 1 | FC 3012<br>FC 3044 | FC3017 | FC-3063 | SINGLE OR BUNDLED CABLES | 1 | WL 3065<br>WL 3385<br>WL 3396<br>WL 3483 | WL3032<br>WL3030 | WL-3199<br>WL3269<br>WL-3354 |
| | | | | | | 2 | WL 3065<br>WL 3385<br>WL 3396<br>WL 3483 | WL3032<br>WL3030 | WL-3199<br>WL-3269<br>WL-3354 |
| | | | | | | 3 | WL 3385 | WL3289<br>WL3372 | WL-3234 |
| | 2 | FC 3012 | | FC-3018 | | | | | |

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| | | | FC3017 | | CABLE TRAY | 1 | WL 4011 WL 4019 | WL4004 | WL-4030 WL-4072 |
| | | | | | | 2 | WL 4011 WL 4019 | WL4004 | WL-4030 WL-4072 |
| | | | | | | 3 | WL 8014 | N/A | |
| INSULATED PIPES | 1 | FC 5004 FC 5036 FC 5037 | FC5014 | FC-5078 FC-5059 | INSULATED PIPES | 1 | WL 5029 WL 5096 | WL5040 WL5001 WL5032 | WL-5171 WL-5226 |
| | | | | | | 2 | WL 5029 WL 5240 WL 5096 | WL5040 WL5001 WL5032 | WL-5171 WL-5226 |
| | 2 | FC 5004 | N/A | FC-5059 | | 3 | WL 5029 WL 5073 | N/A | WL-5084 |
| NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS | 1 | FC 7013 | FC7001 | FC-7019 | NON-INSULATED MECHANICAL DUCTWORK WITHOUT DAMPERS | 1 | WL 7040 WL 7042 WL 7156 WL 7319 | WL7008 | WL-7046 WL-7081 WL-7199 WL-7170 |

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| | | | | | | 2 | WL 7040<br>WL 7042<br>WL 7156<br>WL 7319 | WL7008<br>WL7013<br>WL7016 | WL-7046<br>WL-7081<br>WL-7170<br>WL-7199 |
| MIXED PENETRANTS | 1 | FC 8014<br>FC 8026 | FC8013 | FC-8007<br>FC-8050 | MIXED PENETRANTS | 1 | WL 8004<br>WL 8013 | WL8010 | WL-8062<br>WL8108 |
| | | | | | | 2 | WL 8004<br>WL 8013 | WL8010<br>WL8002 | WL-8062<br>WL-8108 |
| | 2 | N/A* | N/A | | | 3 | WL 8014 | WL8069 | |

* No UL-Classified system is available. Engineering Judgement Required

END OF SECTION

SECTION 078440

FIRE-RESISTIVE JOINT SYSTEMS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the Work of this Section, including but not limited to fire-resistive joint systems for the following:

1. Floor-to-floor joints.
2. Floor-to-wall joints.
3. Head-of-wall joints.
4. Wall-to-wall joints.
5. Perimeter fire-resistive joint systems consisting of floor-to-wall joints between perimeter edge of fire-resistance-rated floor assemblies and exterior curtain walls.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 078410 - PENETRATION FIRESTOPPING for firestopping.
2. Division 21 - FIRE SUPPRESSION for fire-protection piping penetrations.
3. Division 22 - PLUMBING for piping penetrations.
4. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING for duct and piping penetrations.
5. Division 26 - ELECTRICAL for cable and conduit penetrations.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.

B. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

C. Fire-Resistive Joint Systems Schedule: For each fire-resistive joint system. Include location and design designation of qualified testing agency.

1. Where Project conditions require modification to a qualified testing agency's illustration for a particular fire-resistive joint system condition, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

D. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.

E. Qualification Data: For Installer.

F. Field quality-control test reports.

G. Research/Evaluation Reports: For each type of fire-resistive joint system.

1.5 QUALITY ASSURANCE

A. Inspecting Agency: Owner will engage a qualified testing agency, which complies with ASTM E 699 and ASTM E 3038 stndards, to perform tests and inspections and prepare test reports, as required by 2015 IBC 1705.17 and 1705.17.1. Independent inspecting agency shall comply

with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

B. Installer Qualifications: For systems that utilize a pre-formed firestop product, at a minimum installer to be trained directly from manufacturer. For systems that require sealants, putties, or sprays, a firm that has been approved by FM Global according to FM Global 4991, “Approval of Firestop Contractors”, or been evaluated by UL and found to comply with its “Qualified Firestop Contractor Program Requirements.

C. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

D. Source Limitations: Obtain fire-resistive joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.

E. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Firestopping tests are performed by a qualified testing and inspecting agency meeting ASTM E 699 and ASTM E3038 standards. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
2. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:

    a. Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.
    b. Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined building inspector, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, fire-resistive joint systems that may be incorporated into the Work include, but are not limited to the following:

1. Hilti, Inc. (Basis-of-design)
2. BioFireshield; RectorSeal Corporation.
3. Specified Technologies, Inc. (STI).
4. 3M; Fire Protection Products Division.

2.2 FIRE-RESISTIVE JOINT SYSTEMS

A. General: Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079.

1. Firestop Top Track Seal: For metal stud partitions installed on flat concrete slab (or concrete over metal deck) use LBC Red List Compliant one-piece, pre-formed, polyurethan foam based, firestop seal for use with standard head-joint top tracks and bottom-joint tracks, and slip-type head joint in fire-rated construction at top or bottom of partition to maintain continuity of the fire-resistance-rated assembly indicated. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle-over the top track or under the bottom-track.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft (0.00775 cu. m/s x m) of joint at 0.30 inch wg (74.7 Pa) at both ambient and elevated temperatures.

E. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.

F. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

G. Mold Resistance: Provide joint firestopping system with mold and mildew resistance rating of one (1) or less as determined by ASTM G21.

H. Rain and Water Resistance: Provide perimeter joint system tested in accordance with ASTM D6904 with less than 1 hour tack free time as tested in accordance with ASTM C679.

I. Testing: Use only firestop products that have been tested in accordance with ASTM E 1966 and/or ANSI/UL 2079 for specific rated construction conditions conforming to construction

assembly type, movement capability, spacing requirements, and fire-resistance-rating involved for each separate instance.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates or damaging adjoining surfaces.

### 3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.

B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

## 3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Services: Contractor to ensure a manufacturer’s direct representative is on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. Training will be done per manufacturer’s written recommendations published in their literature and drawing details.

B. Inspecting Agency: Owner will engage a qualified testing agency, meeting ASTM E 699 and ASTM E3038 standards, to perform tests and inspections and prepare test reports, as required by 2015 IBC 1705.17 and 1705.17.1. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports.

C. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.

1. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

D. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

F. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

## 3.5 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION

# SECTION 079200

# JOINT SEALANTS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Joint sealants and fillers.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 042000 - UNIT MASONRY for masonry control and expansion joint fillers and gaskets.
2. Section 088000 - GLAZING for glazing sealants.

### 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide assemblies capable of withstanding the effects of gravity loads and wind loads and stresses within limits and under conditions indicated without permanent deformation of components, metal fatigue, or permanent damage to fasteners and anchors; based on testing according to ASTM E 1592 and ASTM E 330 as applicable.

1. Wind Loads: As indicated on the Structural Drawings.

B. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

C. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

A. Product Data: For each joint-sealant, and each related accessory product indicated or required for installation, including limitations for storage, joint opening preparation, and installation of sealants and joint components. Indicate where primers will be used, or submit printed statement from sealant manufacturer that no primers are required for adequate adhesion.

1. Include written explanation to decipher code numbers used on material container to record manufacturer dates.
2. Include manufacturer’s requirements for cleaning substrates and surfaces condition to be encountered.

B. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

1. Provide two tubes of sealant and adequate cleaners and primers, along with package carton containing coded manufacturing date.

C. Qualification Data: For Installer.

D. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article. Include interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
3. Testing of sealants per ASTM C1021 dated within one year of submittal.

F. Field Test Report Log: For each elastomeric sealant application.

G. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements. Test reports to have

been made within three years of the submittal date showing compliance with ASTM C920, and the standards ASTM C920 references including C793 and C719, using the standard substrates.

H. Certificates: Manufacturer certification dated no earlier than one year prior to submittal indicating that sealants proposed for use have been tested and conform to requirements of Contract Documents and the following:

1. Sealant is compatible with and does not adhere to specified bond breaker and backer rod materials per ASTM C1087.
2. Sealant is compatible with and has been tested for adequate adhesion to each respective substrate. Include identification of primer(s) required to obtain adequate adhesion.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project. Contractor to submit documentation that Installer has not less than 5 years of documented, successful experience with work comparable to Work of this Project, acceptable to Manufacturer.

B. Source Limitations: Obtain each type of joint sealant, including preformed joint sealants, through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

    a. Adhesion Testing: Use ASTM C 794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
    b. Compatibility Testing: Use ASTM C 1087 to determine sealant compatibility when in contact with joint sealant backing and glazing and gasket materials.
    c. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with stone or other porous substrates.

2. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
3. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
4. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and

compatibility with, joint substrates and other materials matching those submitted not older than 24 months.

D. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:

    a. Each type of elastomeric sealant and joint substrate indicated on the Drawings.
    b. Each type of nonelastomeric sealant and joint substrate indicated on the Drawings.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

4. Report whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1. Review installation procedures and coordination with other Work.
2. Furnish for review at conference, samples of sealants on production runs of substrate materials as proof of adhesion of each sealant to each respective substrate.
3. Application of sealants shall not commence until all issues raised during the conference have been resolved.

## 1.6 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. In damp or rainy weather, for exterior sealants.
3. When joint substrates are wet. Do not install interior or exterior sealants until after substrate surfaces have thoroughly dried.
4. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
5. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to Project site in their original unopened containers bearing the name of manufacturer and brand, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store, handle, and protect products as recommended by manufacturer to prevent damage and deterioration, due to moisture, high or low temperatures, contaminants, or other causes.

C. Store sealants within sealant manufacturer’s recommended optimum temperature range for at least 16 hours before use. Store backer rod and bond breaker tape in clean, dry areas at 70 deg F so they will not become damp, wet, or frost-covered.

## 1.8 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion for urethane and acrylic sealants, and twenty years from date of Substantial Completion for silicone sealants.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 - PRODUCTS

### 2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: Provide colors as selected by the Architect from manufacturer’s full range of standard and custom colors; maximum of five colors, three standard colors and two custom colors.

### 2.2 JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Elastomeric sealants shall be nonstaining to porous substrates, including discoloration due to loss of polymers/oils. Provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Exterior Single-Component Neutral-Curing Silicone Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Dow Corning Corporation; 790.
    b. GE Silicones; SilPruf LM SCS2700.
    c. Tremco Inc.; Spectrem 1.
    d. Pecora Corporation; 864.

2. Extent of Use: Joints in exterior vertical and soffit surfaces.

D. Exterior Multicomponent Pourable Urethane Sealant:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bostik Findley; Chem-Calk 550.
    b. Meadows, W. R., Inc.; POURTHANE.
    c. Pecora Corporation; Urexpan NR-200.
    d. Tremco Inc.; THC-901.

2. Extent of Use: Joints in exterior horizontal surfaces.

E. Interior Latex Sealant: Comply with ASTM C 834, Type P, Grade NF.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

    a. Henkel Corp.; Loctite Polyseamseal Acrylic Caulk with Silicone.
    b. Pecora Corporation; AC-20+.
    c. Tremco Inc.; Tremflex 834.

2. Extent of Use: Non-moving joints at interior locations.

## 2.3 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: Type C (closed-cell polyethylene foam material with a surface skin), non-gassing, nonabsorbent to liquid water and gas, non-outgassing in unruptured state, round foam rod compatible with sealant, compressed not more than 25 to 33 percent of its dimension at time of installation in joint opening; for use on all exterior sealant joints.

1. HBR Closed Cell Backer Rod; Nomaco, Inc.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable. Liquid bond breaker and duct tape are not permitted.

## 2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces including by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods if required to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include concrete, masonry and unglazed surfaces of ceramic tile.
3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following metal, glass, porcelain enamel and glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

## 3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

## 3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

   a. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

   a. Whether sealants filled joint cavities and are free of voids.

b. Whether sealant dimensions and configurations comply with specified requirements.

c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements at no cost to the Owner.

## 3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

## 3.6 CURING AND PROTECTION

A. Cure sealants in accordance with manufacturer’s instructions to obtain maximum bond to surfaces, cohesive strength, and durability at earliest possible date.

B. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work at no cost to the Owner.

END OF SECTION

# SECTION 081110

# HOLLOW METAL DOORS AND FRAMES

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Exterior steel doors and frames, 3-hour fire-rated and UL752 Level 4 ballistic rated.
2. Interior steel doors and frames, 3-hour fire-rated where indicated.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 042000 - UNIT MASONRY for building anchors into masonry construction.
2. Section 087100 - DOOR HARDWARE for door hardware for steel doors.
3. Section 088000 - GLAZING for glazed lites.
4. Section 099000 - PAINTING AND COATING for field painting steel doors and frames.

### 1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, temperature-rise ratings, and finishes for each type of steel door and frame specified.

B. Shop Drawings:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Qualification Data: For Installer.

E. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASSA ABLOY.
2. Krieger.
3. Overly.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated, (Galvanized/Galvannealed) Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60/A60 metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Insulation: Comply with requirements in Section 092110 - GYPSUM BOARD ASSEMBLIES.

H. Glazing: Comply with requirements in Section 088000 - GLAZING.

I. Environmental Product Declarations (EPD): Product-specific Type III EPDs for hollow metal doors and frames are available from manufacturers listed herein.

J. Low-Emitting Materials: Provide building products in compliance with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

## 2.3 STANDARD STEEL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, mineral-board, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.

a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
b. Thermal-Rated (Insulated) Exterior Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 2.5 when tested according to ASTM C 1363.

3. Top and Bottom Edges: Closed with flush or inverted 0.042-inch-thick end closures or channels of same material as face sheets.
4. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated (galvanized/galvannealed) steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. 3-hour fire-rated and UL752 Level 4 ballistic rated.

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

1. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless), 1-3/4 inches thick.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

## 2.4 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated (galvanized/galvannealed) steel sheet.

1. Fabricate frames with full profile welded joints. Gauge as required to meet performance requirements.

C. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with full profile welded joints.
2. Frames for Level 2 Steel Doors: 0.053-inch-thick steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

## 2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

## 2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

## 2.7 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

## 2.8 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch-wide steel.

2.9 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Glazed Lites: Factory cut openings in doors.
3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Full Profile Welded Frames: Weld joints continuously; grind, fill, dress, and make smooth, flush, and not visible.
2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as doorframe. Fasten members at crossings and to jambs by butt welding.
3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Compression Type: Not less than two anchors in each jamb.
c. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Section 087100 - DOOR HARDWARE.

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 - ELECTRICAL.

## 2.10 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard epoxy primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Refer to Section 099000 – PAINTING AND COATING for field-applied coating.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

### 3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install frames with removable glazing stops located on secure side of opening.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for filling space between frames and masonry with insulation.
5. Concrete Walls: Solidly fill space between frames and concrete with insulation.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
8. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors according to NFPA 105.

## 3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

C. Metallic-Coated (Galvanized/Galvannealed) Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

# SECTION 083610

# SECTIONAL DOORS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Electrically-motor-operated bullet-resistant sectional overhead doors, UL752 Level 4 ballistic rated for door and frame.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 055000 - METAL FABRICATIONS for miscellaneous steel supports.
2. Division 26 - ELECTRICAL for electrical service and connections for powered operators and accessories.

### 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide sectional overhead doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:

1. Wind Loads: As indicated on the Structural Drawings.

B. Operation-Cycle Requirements: Provide sectional overhead door components and operators capable of operating for not less than 10,000 cycles.

1.4 SUBMITTALS

A. Product Data: For each type and size of sectional overhead door and accessory. Include the following:

1. Summary of forces and loads on walls and jambs.
2. Motors: Show nameplate data and ratings, characteristics, and mounting arrangements.

B. Shop Drawings: Details of construction and relationship with adjacent construction.

C. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation of units required for this Project.

B. Source Limitations: Obtain sectional overhead doors through one source from a single manufacturer.

1. Obtain operators and controls from sectional overhead door manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer: BulletStop by Thermostop or equal.

1. Bullet-Resistance: UL 752.
2. Facing: Galvanized steel over 4 inch thick anti-ballistic material and high-density polyurethane foam core.
3. Hardware: Extra heavy duty.
4. Balancing System: Counterweight top (not spring type).
5. Perimeter Gasket: Triple-lip flexible PVC gasket seal.
6. Electric Operator: Side-mounted Jackshaft motor, Model XTRA-GH.
7. Finish: Manufacturer’s standard enamel finish with color as selected by Architect.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. General: Install door, track, and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.

B. Fasten vertical track assembly to framing, spaced not less than 24 inches apart. Hang horizontal track from structural overhead framing with angle or channel hangers fastened to framing by welding or bolting or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Protect doors and tracks against damage from construction operations and placement of equipment and fixtures during the remainder of construction period.

### 3.2 ADJUSTING

A. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and with weathertight fit around entire perimeter.

B. Adjust belt-driven motors as follows:

1. Use adjustable motor-mounting bases for belt-driven motors.
2. Align pulleys and install belts.
3. Tension belt according to manufacturer's written instructions.

C. Touch-up Painting: Immediately after welding galvanized track to track supports, clean field welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

### 3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain sectional overhead doors.

END OF SECTION

SECTION 085110

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Fixed aluminum-framed windows with factory-installed glass and glazing, 3-hour fire-rated and UL752 Level 4 ballistic rated for frame and glazing.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 089000 – LOUVERS AND VENTS.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide aluminum windows capable of withstanding the following, including wind loads based on passing AAMA/NWWDA 101/I.S.2, Uniform Load Structural Test, at basic wind speed indicated and as required by Code:

1. Deflection: Design glass framing system to limit lateral deflections of glass edges to less than 1/175 of glass-edge length or 3/4 inch, whichever is less, at design pressure based on structural computations.
2. Wind and Seismic Loads: As indicated on the Structural Drawings, but not less than that required by Code.
3. Movements of supporting structure including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads as required by Code. Deflection may require special considerations including but not limited to head receptors.

B. Standards: Comply with ANSI Z97.1, ASTM C1036 and ASTM C1349..

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other Work, operational clearances, and the following:

1. Mullion details, including reinforcement and stiffeners.
2. Joinery details.
3. Expansion provisions.
4. Flashing and drainage details.
5. Weather-stripping details.
6. Thermal-break details.
7. Glazing details.
8. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation and used to determine the following:

a. Structural test pressures and design pressures from basic wind speeds indicated.
b. Deflection limitations of glass framing systems.

C. Samples for Verification: Full-size operable window of each type of window.

D. Qualification Data: For Installer, professional engineer and testing agency.

E. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

F. Product Test Reports: Based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of aluminum window. Test results based on use of downsized test units will not be accepted.

G. Maintenance Data: For operable window sash, operating hardware, weather stripping, and finishes to include in maintenance manuals.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

B. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in New Hampshire, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of windows that are similar to those indicated for this Project in material, design, and extent.

D. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01. Review methods and procedures related to aluminum windows including, but not limited to, the following:

1. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review required testing and inspecting procedures.

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

## 1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failure to meet performance requirements.
2. Structural failures including excessive deflection.
3. Water leakage, air infiltration, or condensation.
4. Faulty operation of movable sash and hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
6. Glazing failure.

B. Warranty Period: Ten years from date of Substantial Completion.

C. Warranty Period for Metal Finishes: Ten years from date of Substantial Completion.

D. Warranty Period for Glazing: Ten years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Manufacturer: Bulletblock HP600 with Armor-Gard SP4121G with glass-clad polycarbonate glazing by Insulgard or equal.

B. Fasteners: Aluminum, nonmagnetic stainless steel, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

1. Reinforcement: Where fasteners screw anchor into aluminum less than 0.125 inch (3.2 mm) thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
2. Exposed Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate.

C. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

D. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

## 2.2 FABRICATION

A. General: Fabricate aluminum windows, in sizes indicated, that comply with AAMA/NWWDA 101/I.S.2 for performance class and performance grade indicated. Include a complete system for assembling components and anchoring windows.

B. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

## 2.3 FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances; rough opening dimensions; levelness of sill plate; coordination with wall flashings, vapor retarders, and other built-in components; operational clearances; and other conditions affecting performance of work.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.
2. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components; Drawings; and Shop Drawings.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Metal Protection: Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in "Dissimilar Materials" Paragraph in Appendix B in AAMA/NWWDA 101/I.S.2.

## 3.3 PROTECTION AND CLEANING

A. Protect window surfaces from contact with contaminating substances resulting from construction operations. In addition, monitor window surfaces adjacent to and below exterior concrete and masonry surfaces during construction for presence of dirt, scum, alkaline deposits, stains, or other contaminants. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written recommendations.

B. Clean aluminum surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

C. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels and clean surfaces.

D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

END OF SECTION

SECTION 087100

DOOR HARDWARE

PART 1 –GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this section.

1.2 DESCRIPTION OF THE WORK

A. The work of this section includes the furnishing of door hardware as shown on the Drawings and as herein specified for the proper operation of wood and hollow metal doors which, without limiting the generality thereof includes:

1. Furnishing all required templates and schedules.
2. Installation Instructions.
3. Delivery of door hardware under this Section to the Contractor for installation.
4. Coordinate work with related trades.

1.3 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that relate directly to work of this Section include, but are not limited to:

1. Section 081110 – HOLLOW METAL DOORS AND FRAMES
2. Section 083610 – OVERHEAD SECTIONAL DOORS
3. Division 26 – ELECTRICAL
4. Division 28 – SAFETY AND SECURITY

1.4 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

1. Americans with Disabilities Act (ADA):
   Providing Accessibility and Usability for Physically Handicapped People.

2. Door and Hardware Institute (DHI):
   Ref. 1 Recommended Locations for Builders Hardware.

1.5 SUBMITTALS:

A. Schedules: Submit a complete Hardware Schedule, in DHI vertical format through the General Contractor for approval by the ARCHITECT/SPECIFIER. The Schedule shall list the 087100 Specification Hardware Set number next to the Schedule Heading Number and shall include a Door Index listing doors in numerical order with Schedule Heading Numbers and a condensed list of products, manufacturers, and quantities scheduled therein. Submittal shall be in Electronic PDF Format.

B. Catalog Cuts: Include with the Schedule two sets of catalogue cuts, together with product data sheets and installation instructions of all hardware items.

C. Templates: All required templates shall be furnished in accordance with the schedule. Furnish templates to the door and frame manufacturer sufficiently in advance so as not to delay progress of the work. However, no templates shall be issued or materials ordered until the schedule has been approved.

D. Samples: A sample of each item of hardware the successful bidder proposes to furnish shall be submitted for approval not later than ten (10) days after being requested. After review. samples shall be returned to the Supplier.

E. Shop Drawings: Details of electrified door hardware, indicating the following:

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following:

   a. System schematic.
   b. Point-to-point wiring diagram.
   c. Riser diagram.
   d. Elevation of each door.

2. Detail interface between electrified door hardware and fire alarm access control and building control and security systems.

1.6 WARRANTY/GUARANTEE

A. Attention is directed to the provisions of the CONDITIONS OF THE CONTRACT regarding warranties for the Work.

B. Manufacturers shall provide their standard warranties/guarantees for work under this Section. However, such warranties/guarantees shall be in addition to, and not in lieu of, all other liabilities which the manufacturers may have by law or by other provisions of the Contract Documents.

1.7 KEYING

A. Grandmaster Key and Master Key all Locks and Cylinders into a New Interchangeable Core Key System as directed by the Owner.

B. The General Contractor shall provide all cylinders with Construction Cores for use during construction. Permanent cores shall be shipped directly to the Owner for installation after job completion. All Construction Cores shall be returned to the Supplier upon substantial completion of the project (non-returned Cores shall be subject to invoicing).

C. The hardware supplier shall prepare an internal Keying Legend for the purpose of discussion in establishing the Permanent Keying Hierarchy. General Contractor shall arrange for a meeting with the Owner to finalize keying for this job. Owner shall approve the final Keying Legend Submittal.

D. Furnish the following quantities of keys (Owner to verify):

Four (4) ..... Grand Master Keys
Four (4) ..... Master Keys each Set
Three (3) ..... Change Keys each locking device
Six (6) ..... Construction Master Keys
Two (2)..... Control Keys

Keys shall be stamped, “DO NOT DUPLICATE”.

E. Installation of permanent cores shall be the responsibility of the Contractor as directed by the Owner.

F. Furnish one Key Cabinet, including envelopes, labels, tags with self-locking clips, receipt forms, three-way index, temporary markers, permanent markers, and standard metal hinged-type panel type cabinet for wall mounting. Key Cabinet shall have a capacity of 150 percent more than the number of cylinders under this Contract.

1.8 SPECIAL REQUIREMENTS

A. Hardware Supplier shall determine conditions and materials of all doors and frames for proper application of hardware.

B. Hardware Supplier shall be responsible for the accuracy of the quantities, sizes, finish and proper hardware to be furnished, whether specifically listed or not, and shall be responsible for determining all details, such as and of doors, bevel of locks, etc.

C. All lever trim for door locks to hazardous areas such as Mechanical, Electrical, Elevator Machine Rooms, etc., shall have a tactile surface to comply with requirements of the Authority Having Jurisdiction.

D. Tools for Maintenance: All special tools packed with hardware items shall be saved and turned over to the Owner upon completion of the Work.

E. Lock fronts, flush bolt faces, and strikes shall be beveled in accordance with manufacturer's standards.

F. Furnish strikes as required by details.

G. Handing of doors shall be verified by this supplier.

H. Refer to Hollow Metal, Wood and Aluminum Sections regarding adequate blocking and reinforcing for surface applied hardware. The use of thru-bolts shall be prohibited.

I. All electrified hardware items are to be interfaced with the Fire Alarm System and/or Security System.

AC = Access Control Interface
CR = Card Reader
DC = Door Contact
LX = Latchbolt Monitor
PIR = Passive Infrared Sensor
PS = Power Supply

RX = Request to Exit

J. Hardware not specifically listed for a particular opening shall be the same as hardware scheduled for similar openings.

PART 2 - PRODUCTS

2.0 QUALITY ASSURANCE

A. Hardware shall be furnished as specified herein.

B. All hardware shall be entirely free from imperfection in manufacture and finish. It is the responsibility of the Hardware Supplier to follow the manufacturers' catalogue requirements for the proper size and weight of hardware and fastenings, and the proper function of hardware in each case. All door sizes are to be noted on the Door Schedule and all hardware shall be in strict accordance with requirements of height, width, and thickness.

2.1 QUALITY OF MATERIALS

A. The products referenced throughout “Part 2 – Products” set a standard of quality for the major products for this project. They are taken from the catalogs of those manufacturers whose names appear in parentheses below. Manufacturers and products may include, but are not limited to, the following. Alternate equipment may be proposed by the Contractor. Approvals are subject to review by the Owner and the access control integrator for specification conformance and compatibility with the existing Airport access control system.

| ITEM | MANUFACTURERS |
|---|---|
| Butt Hinges | (McKinney) Hager, Stanley |
| Locksets | (Schlage) Best, Sargent |
| Exit Devices | (Von Duprin) Best, Sargent |
| Closers | (LCN) Best, Sargent |
| Pulls | (Rockwood) Hager, Ives |
| Stops | (Rockwood) Hager, Ives |
| OH Stops | (ABH) GJ, Rixson |
| Flush Bolts | (Rockwood) Hager, Ives |
| Thresholds/Gasketing | (Pemko) NGP, Zero |
| Automatic Door Operators | (Dorma) Horton, Tormax |

2.2 HINGES

A. Number of hinges or pivots per door: Two hinges or pivots are to be provided for doors up to and including five feet in height, and an additional hinge for each two-and-one-half feet (2-1/2'), or fraction thereof, of the height of the door.

B. Hinges for exterior doors shall be stainless steel, McKinney TA386 5” x 4-1/2” x NRP. Continuous Hinges, if required by Door Manufacturer, shall be equal to ABH A5500.

C. Hinges for interior doors shall be steel, McKinney “TA” Series, sized as follows:

| Door Thickness | Door Width | Hinge Weight | Hinge Height |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1-3/4" | Under 39" | Regular Weight | 4-1/2" |
| 1-3/4" | 39" and over | Heavy Weight. | 5" |
| 2" | Any | Heavy Weight | 5" |

Width of hinges shall be determined by trim conditions.

D. Hinges are to be of three knuckle concealed bearing design, equipped with full radial thrust and lateral bearing assemblies. The bearing assemblies are to be permanently lubricated and sealed. All hinges are to have positive non-rising pins and a hole in the bottom tip for easy pin removal. Pins shall be through hardened.

E. Hinges at all interior outswinging lockable doors shall have non-removable pins (NRP).

2.3 LOCKSETS

A. Unless noted otherwise, locksets and latchsets shall be heavy-duty mortise type, Schlage “L9000-07A” Lever Trim, in functions as noted in the Hardware Sets below.

B. All locks shall be furnished with 2-3/4 in. backset and wrought box strikes.

C. Furnish strikes with extended lips at deep reveals and where required to protect trim from being marred by latchbolt. At Prs. of Doors, strike shall be 7/8” Lip-to-Center.

D. Furnish Interchangeable Core Cylinders for all locking devices on this project.

E. Furnish all Electric Locksets with “RX” Request to Exit Switches and “LX” Latchbolt Monitoring Switches.

2.4 EXIT DEVICES – Unless noted otherwise:

A. Exit Devices shall be Von Duprin “98” Series, in applications as noted in the HW Sets below. Furnish narrow stile devices where required.

B. Lever trim shall match lockset trim.

C. Furnish cylinder dogging for all non fire rated exit devices. Furnish Fire Rated Devices, as required.

D. Furnish Power Supplies shall be Von Duprin PS900 Series as required to suit function specified. Interface with Access Control System and/or Fire Alarm System, as noted/required. Provide necessary Interface Cards.

E. Electric Power Transfers shall be Von Duprin EPT10.

F. Furnish all Electric Exit Devices with “RX” Request to Exit Switches and “LX-LC” Latchbolt Monitor Low Current Switch.

2.5 CLOSERS

A. Unless otherwise indicated in the HW Sets below, Overhead Surface Closers shall be LCN, non-sized, ADA approved, as follows

| | |
|---|---|
| Exterior Doors | 4040XP SCUSH MC-SRI |
| Interior Doors | 4040XP-MC Series. Furnish arm functions as noted in the HW Sets below. |

B. Unless specified otherwise, closers shall be mounted on that side of the opening least objectionable to the public view. Provide parallel arm type at reverse bevel conditions.

C. Template and install all door closers for the maximum degree of opening as indicated on the drawings (except where built in stops are specified).

D. Concealed Closers shall be Dorma RTS88/01.

2.6 DOOR PULLS/PROTECTION PLATES

A. Special Pulls shall be Rockwood RM3312-MP x Full Height (6” less than overall door height) x Type 12HD Mounting. Furnish Midpost 10” below Top Post.

B. Straight Pulls shall be Rockwood 112 x Type 1HD mounting, less finish washers. Screw Heads to be countersunk and flush with door face.

C. Kick Plates shall be Rockwood K1062, 10” high, except as noted. Width of plate shall be determined by the width of the door: plates shall be 2" LWOD on single doors, and 1" LWOD on pairs of doors. Armor Plates shall be Rockwood A1062, 34” high. Width of Plates shall be determined as Kick Plates above.

D. Push Plates shall be Rockwood 73G.

E. Push Bars shall be Rockwood 47-PB.

2.7 STOPS

A. Wall Stops shall be provided at 90-degree openings. Wall Stops shall be Rockwood 405. Refer to Rough Carpentry for adequate blocking

B. Floor Stops shall be provided where applicable and where conditions allow. Floor Stops shall be Rockwood 446.

C. Where neither a Wall Stop nor a Floor Stop can be used, furnish an Overhead Stop, ABH 9000 Series.

D. Overhead Stops for Exterior Doors shall be ABH N1000SA.

2.8 FLUSH BOLTS

A. Flush Bolts shall be Rockwood as follows, unless noted otherwise:

1. Manual Flush Bolts – 555-12” (Furnish 18-24” Top Rods at higher doors).
2. Automatic Flush Bolts – 2842/2942.
3. Self Latching Flush Bolts – 2845/2945.

B. Furnish dustproof strikes – Rockwood 570 – for all flush bolts.

C. Coordinators shall be Rockwood 2600 Series. Furnish Filler Plates. Coordinators to be painted to match Frame.

2.9 GASKETING/THRESHOLDS, Etc.

A. Gasketing shall be Pemko S88BL, applied at head and jambs.

B. Automatic Door Bottoms shall be mortise type, Pemko 420ASL/434ARL. If mortise type conflicts with material construction or other hardware, furnish surface type, Pemko 4301Series.

C. Sweeps shall be Pemko 315CN.

D. Overlapping Astragals shall be Pemko 357SS (if not provided By Door Manufacturer). Refer to Lockset Strike Lip dimension. Astragals shall not be notched.

E. Where a Set of Astragals is specified, furnish Pemko 18041 (2 pieces) x full height of opening.

F. Rain Drips shall be Pemko 346C and shall be furnished for all exterior doors.

G. Thresholds for exterior outswing doors shall be Pemko 2005AT. Refer to specific details.

H. Threshold for exterior inswing doors shall be Pemko 114 x Hook.

I. All Thresholds shall be cut-in around mullions, frame members, stops, mullions (not butted up against) and shall provide a continuous surface across the full width of the opening from jamb to jamb. All Thresholds shall be properly sealed, grouted and/or caulked and set in a full bed of mastic.

2.10 MISCELLANEOUS

A. Electromagnetic Locks to be Schlage M490 for single doors, M492 for double doors.

2.11 FINISHES

A. Unless otherwise noted, finish shall be as follows:

1. Butts (interior), Cylinders, Wall/Floor Stops, Flush Bolts, shall be satin chrome finish (US26D).
2. Butts (exterior), Locksets, Exit Devices, Pulls, Protection Plates, Catches, Post Stops etc. shall be satin stainless steel (US32D). Plates shall be B.S. .062 ga. Furnish Antimicrobial finish for all Levers, Exit Devices, Pushbars, Pulls and Push Plates.
3. Thresholds shall be Aluminum. Furnish with Pemkote.
4. Closers shall be powder coated aluminum (689).
5. Adhesive Gasketing shall be Black.

PART 3 - EXECUTION

3.01 MOUNTING POSITIONS

A. Mounting heights given are centerline heights from finished floor.

B. Hinges: Position top hinge five inches below head, bottom hinge ten inches above finished floor and intermediate hinge equally spaced between top and bottom hinges.

C. Locksets/Exit Devices: Unless shown otherwise, locate center of levers 40 inches above finished floor (or per manufacturers standard locations).

D. Deadlocks/Deadlatches: Unless shown otherwise, locate center of Cylinders 48 inches above finished floor (or per manufacturers standard locations).

E. Overhead Closers:

1. Verify each head condition prior to furnishing door closers.

2. Surface-mounted on Door: Surface shoe application for standard operation and soffit plate application for parallel arms. Provide special shoe plates and brackets where specified or where required by job conditions.

3. Set hardware plumb, level and in exact alignment and location. Conceal and countersink fasteners wherever possible.

3.02 ADJUSTING, CLEANING AND PROTECTION

A. Adjust hardware items to work smoothly, easily and correctly.

B. Clean exposed surfaces using non-abrasive materials and methods recommended by the manufacturer of the hardware being cleaned. Remove and replace work, which cannot be successfully cleaned, as judged solely by the Architect.

C. Provide temporary protection to ensure work being done without damage or deterioration at time of Final Acceptance. Levers shall be kept covered with heavy cloth, and other hardware shall be protected against damage until Substantial Completion of the Project. Remove protections and reclean as necessary immediately prior to Final Acceptance.

3.03 COMPLETION AND CONTINUED MAINTENANCE

A. Before completion of work of this Section, inspect work with Architect and adjust and correct work to leave operating parts in perfect operating condition, jointing to adjacent material tight, surfaces without blemishes or stains, work properly executed and complete, and defects and damaged work replaced or corrected.

3.04 CONSTRUCTION WASTE MANAGEMENT

A. Comply with the requirements of Section 017400, CONSTRUCTION WASTE MANAGEMENT, for removal and disposal of construction debris and waste.

3.05 HARDWARE SETS

A. Each Hardware Set listed below represents the complete hardware requirements for one opening (single door or pair of doors). Furnish the quantities required of each set for the work.

B. The numbers used opposite locksets/exit devices to identify the function are Schlage/Von Duprin numbers. Where “KN” is listed, outside lever shall be furnished with a tactile surface. Where “HW” is listed for Butts, furnish Heavy Weight.

C. HW Sets that do not appear on the Door Schedule shall be considered “Not Used” and/or saved for future use.

D. Security items are listed below the individual Hardware Sets for Hardware Set coordination and templating for doors and frames only. Refer to Security Section for details.

HW-1 (101, 102, 105A: Single-Leaf Exterior Door, Fire-rated)

| | |
|---|---|
| Butts | |
| 1 Electric Lockset | L9092EL |
| 1 Electric Power Transfer | |
| 1 Exit Device | |
| 1 Closer | |
| 1 Kick Plate | |
| 1 Set Gasketing | |
| 1 Sweep | |
| 1 Threshold | |
| CR, DC, & RX | By Security |
| 24V | |

HW-2 (103A, 104: Double-Leaf Exterior Door, Fire-rated)

| | |
|---|---|
| Butts | |
| 1 Electric Lockset | L9092EL |
| 2 Exit Devices | 9849L-BE-F LBL |
| 1 Electric Power Transfer | |
| 2 Pulls | |
| 2 Closers | |
| 1 Dual Electromagnetic Lock | |
| 1 Set Gasketing | By Door Manufacturer |
| 1 Overlapping Astragal | |
| 1 Threshold | |
| CR, DC, RX, & PS | By Security |
| 120V | |

HW-3 (103B, 103C: Single-Leaf Interior Door)

Butts
2 Pulls
1 Closer
1 Kick Plate
1 Threshold
1 Set Gasketing

HW-4 (105C: Single-Leaf Interior Door, Exit, Fire-rated)

Butts

1 Pull
1 Closer
1 Exit Device
1 Kick Plate
1 Threshold
Gasketing

Overhead Sectional Door 105B

No hardware set
2 CR, 1 DC By Security

- END OF SECTION -

SECTION 088000

GLAZING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Section 085110 – ALUMINUM WINDWS for factory glazing.

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written

instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Ballistic Protection: Provide glazing systems that have been tested and certified to meet UL 752 Level 4 ballistics performance.

C. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

a. Specified Design Wind Loads: As required by Code.
b. Specified Design Snow Loads for Sloped Glazing: As required by Code.
c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action.

1) Load Duration: 60 seconds or less.

d. Probability of Breakage for Sloped Glazing: 1 lite per 1000 for lites set more than 15 degrees off vertical and under wind and snow action.

1) Load Duration: 30 days.

e. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch, whichever is less.

1) For monolithic-glass lites heat-treated to resist wind loads.
2) For insulating glass.
3) For laminated-glass lites.

f. Minimum Glass Thickness for Exterior Lites: Not less than 6 mm.

D. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For laminated-glass lites, properties are based on products of construction indicated.
2. For insulating-glass units, properties are based on units with lites 6.0 mm thick and a nominal 1/2-inch-wide interspace.
3. Center-of-Glass Values: Based on using LBL-44789 WINDOW 6.3 computer program for the following methodologies:

a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
b. Solar Heat Gain Coefficient: NFRC 200.
c. Solar Optical Properties: NFRC 300.

## 1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Samples: 12-inch- square Samples for each type of glass and glass assembly, glazing sealants.

C. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

D. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements.

1. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

E. Qualification Data: For installers.

F. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

G. Product Test Reports: For each type of glazing products:

H. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance..

B. Source Limitations for Glass: Obtain the following through one source from a single manufacturer for each glass type: clear float glass, laminated glass and insulating glass.

C. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.

D. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

E. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.

1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

F. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.
5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

G. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.

1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test, unless required by authorities having jurisdiction.

H. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency] acceptable to authorities having jurisdiction.
2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

I. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Sloped Glazing Guidelines."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

J. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.

K. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.9 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to the Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten years from date of Substantial Completion.

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to the Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Five years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to the Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INSULATED BALLISTIC-PROTECTION UNITS

A. Insulating-Glass Unit Assemblies for Vertical Glazing: 2 inch thick (25.0 mm) insulating, ballistic-protection assembly consisting of glass-clad polycarbonate. Provide the following or equal:

1. Insulgard SP412-IG.

a. Visible Light Transmittance: 67 percent.
b. U Value (Winter): 0.42.
c. Solar Heat Gain Coefficient: 0.60.

B. Building Product Disclosure and Optimization, Environmental Product Declarations (EPD): Type III EPD.

2.2 GLASS PRODUCTS

A. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by an argon-filled interspace, and complying with ASTM E2190 and with requirements specified in this Section.

1. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
2. Sealing System: Dual seal, with primary and secondary sealants as follows:

a. Manufacturer's Standard Sealants. Butyl primary and silicone secondary sealants. Secondary sealant shall cover entire spacer bar at IGU perimeter.

3. Spacer Specifications: Manufacturer's standard spacer material. Spacer corners shall be bent, soldered, or welded. Keyed spacer corners will not be accepted. Spacer may have a mid-span spacer key located at the midpoint of the insulating glass unit head. Where a mid-span spacer key is used, the key must be fully embedded (all sides) in butyl sealant.

2.3 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Verify glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, interlayer of laminated glass, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
4. VOC Emissions: Provide sealants in compliance with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
5. VOC Content:

    a. Structural Glazing Adhesives: 100 g/L.
    b. Architectural Sealants: 250 g/L.

6. Methylene chloride and perchloroethylene may not be intentionally added to sealants.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Single-Component Neutral- and Basic-Curing Silicone Glazing Sealants:

    a. Dow Corning Corporation; 790.
    b. GE Silicones; SilPruf LM SCS2700.
    c. Tremco Inc.; Spectrem 1.

C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

## 2.4 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for project conditions.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.
2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.5 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.6 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Framing glazing to be compliant with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

K. Glazing Film: Apply squarely aligned to glass edges, uniformly smooth, and free from tears, air bubbles, wrinkles, and rough edges, in single sheet completely overlaying the back face of clean glass, according to manufacturer's written instructions, including surface preparation and application temperature limitations.

## 3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

## 3.5 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

## 3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION

# SECTION 089000

# LOUVERS AND VENTS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Fixed extruded-aluminum louvers and frames 3-hour fire-rated and UL752 Level 4 ballistic rated.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 079200 - JOINT SEALANTS for sealants installed in perimeter joints between louver frames and adjoining construction.
2. Division 23 - HEATING, VENTILATING AND AIR CONDITIONING for louvers that are a part of mechanical equipment.

### 1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and wind loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers. Loads as required by Code.

### 1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

1. For installed louvers indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Include sill, jambs, and head details showing the integration with adjacent air and water barriers.
3. Include details of the continuous sill pan with upturned back and end dams. Note on drawings how continuity will be maintained at the sill pan corners.

C. Samples for Verification: For each type of metal finish required.

D. Qualification Data: For professional engineer.

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

## 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

# PART 2 - PRODUCTS

## 2.1 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Fire-Rated Ballistic Louver Manufacturers: Blast and Ballistics, 3B or equal.

1. Louver Depth: As indicated on the Drawings.
2. Frame and Blade Nominal Thickness: As required to comply with structural performance requirements, but not less than 0.080 inch.
3. Performance Requirements: AMCA 550.
4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.
5. Free Area: Comply with requirements indicated on the Drawings.

B. General: Provide screen at each exterior louver. Secure screens to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches from each corner and at 12 inches o.c. Fabricate frames with mitered corners to louver sizes indicated.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening, aluminum, 1/2-inch-square mesh, 0.063-inch wire

## 2.2 ALUMINUM FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable only if they are within the range of approved Samples, or shall not exceed DE*a*b* of 2.0 from a single control sample. Noticeable variations in the same piece are not acceptable.'

## 2.3 MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.4 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

D. Integral sills shall include a continuous sill pan with back and end dams. Water that runs off the louver shall be collected in the sill pan and drained away from the building.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 - JOINT SEALANTS for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

# SECTION 099000

# PAINTING AND COATING

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Field painting of exposed interior items and surfaces.
2. Field painting of exposed exterior items and surfaces.
3. Surface preparation for painting.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 055000 - METAL FABRICATIONS for shop priming ferrous metal.
2. Section 081110 - HOLLOW METAL DOORS AND FRAMES for factory priming steel doors and frames.

### 1.3 DEFINITIONS AND EXTENT

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.

4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

B. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

C. Paint exposed surfaces, except where these Specifications indicate that the surface or material is not to be painted or is to remain natural. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces. If a color of finish is not indicated, Architect will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron supports, and surfaces of mechanical and electrical equipment that do not have a factory-applied final finish.

D. Do NOT paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Finished mechanical and electrical equipment.
b. Light fixtures.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

a. Foundation spaces.
b. Furred areas.
c. Ceiling plenums.
d. Utility tunnels.
e. Pipe spaces.
f. Duct shafts.
g. Elevator shafts.

3. Finished metal surfaces include the following:

a. Anodized aluminum.
b. Stainless steel.

c. Chromium plate.
d. Copper and copper alloys.
e. Bronze and brass.

4. Operating parts include moving parts of operating equipment and the following:

a. Valve and damper operators.
b. Linkages.
c. Sensing devices.
d. Motor and fan shafts.

5. Labels: Do not paint over UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.4 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

a. Disclose material ingredients by name and Chemical Abstract Service (CAS) Registry Number.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

B. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
3. Submit two 8 inch by 12 inch Samples for each type of finish coating for Architect's review of color and texture only.

C. Qualification Data: For Applicator.

## 1.5 QUALITY ASSURANCE

A. Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers and primers for each coating system from the same manufacturer as the finish coats.

## 1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily.

## 1.7 PROJECT CONDITIONS

A. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

## 1.8 EXTRA MATERIALS (ATTIC STOCK)

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: Furnish one unopened gallon of each type of paint and coating work, in color and gloss as used for the Project.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work are listed in the Finish Schedule at the end of this Section.

## 2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Paint Colors (PT-#): Provide colors as selected by Architect. Refer to Finish Schedule on the drawings.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for paint application.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

### 3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

2. Use low-emitting, environmentally friendly cleaning agents and procedures, including but not limited to trisodium phosphate (TSP) diluted with warm water. Do not use ammonia-, chlorine bleach-, or solvent-based cleaners, unless authorized in writing by Architect.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions and technical bulletins for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible primers or remove and reprime.
2. Cementitious Materials: Prepare concrete, concrete unit masonry, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

    a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
    b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
    c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.

3. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.

    a. Exterior Exposed Steel: Clean steel surfaces in accordance with SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning. Abrasive blast cleaned surfaces shall exhibit a uniform, angular profile of 1.5-3.0 mils. Prime cleaned surfaces within 8 hours and prior to surface rusting.
    b. Interior Exposed Steel, in Humid Environments: Clean steel surfaces in accordance with SSPC-SP 6/NACE No. 3 Commercial Blast Cleaning. Abrasive blast cleaned surfaces shall exhibit a uniform, angular profile of 1.5-3.0 mils. Prime cleaned surfaces within 8 hours and prior to surface rusting.
    c. Interior Exposed Steel, in Dry Environments: Clean steel surfaces in accordance with SSPC-SP2 or SP3 Hand or Power Tool Cleaning.

4. Galvanized Surfaces: Clean galvanized surfaces in accordance with SSPC-SP16 Brush off Blast Cleaning of Galvanized Steel and NonFerrous Metals, to achieve a minimum 1 mil anchor profile.

D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

## 3.3 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
3. Provide finish coats that are compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
7. Paint backsides of access panels and removable or hinged covers to match exposed surfaces.
8. Finish exterior doors and doors in wet areas on tops, bottoms, and side edges the same as exterior faces.
9. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Uninsulated metal piping.
2. Uninsulated plastic piping.
3. Pipe hangers and supports.
4. Tanks that do not have factory-applied final finishes.
5. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
6. Duct, equipment, and pipe insulation having "all-service jacket" or other paintable jacket material.
7. Mechanical equipment that is indicated to have a factory-primed finish for field painting.

G. Electrical items to be painted include, but are not limited to, the following:

1. Switchgear.
2. Panelboards.
3. Electrical equipment that is indicated to have a factory-primed finish for field painting.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

## 3.4 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during the period when paint is being applied:

1. The Owner may engage a qualified independent testing agency to sample paint material being used. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.
2. Testing agency will perform appropriate tests for the following characteristics as required by the Architect.
3. The Architect may direct Contractor to stop painting if test results show material being used does not comply with specified requirements. Contractor shall remove noncomplying paint from Project site, pay for testing, and repaint surfaces previously coated with the noncomplying paint. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

## 3.5 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

## 3.6 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

## 3.7 PAINT SCHEDULE

A. Schedule: Provide products and number of coats specified. Use of manufacturer's proprietary product names to designate colors, materials, generic class, standard of quality and performance criteria and is not intended to imply that products named are required to be used to the exclusion of equivalent performing products of other manufacturers.

B. Exterior Paint Schedule:

1. Exterior Galvanized Metal (not shop-finished under Section 055000 - METAL FABRICATIONS, Section 055100 - METAL STAIRS AND RAILINGS, and Section 081100 - HOLLOW METAL DOORS AND FRAMES), Alliphatic Acrylic Polyurethane System (Solvent-Based):

a. Surface Preparation: SSPC-SP16 Brush-off Blast of Galvanized Steel.
b. One Coat: Polyamide epoxy, high solids, low VOC, intermediate coat.

1) AkzoNobel; International Intergard 475 HS at 5.0-10.0 mils DFT.
2) Axalta (formerly Dupont); Corlar 2.1 ST at 3.0-5.0 mils DFT.
3) PPG; PMC Amerlock 400 Hi-Build Epoxy at 4.0-5.0 mils DFT.
4) Tnemec; V69 Hi-Build Epoxoline at 3.0 mils DFT (Basis of Design).

c. And One Coat: Aliphatic acrylic polyurethane, finish coat, semigloss.

1) AkzoNobel; International Interthane 990V at 2.0-3.0 mils DFT.
2) Axalta (formerly Dupont); Imron 2.1 SG at 2.0-4.0 mils DFT.
3) PPG; PMC Amercoat 450 HSG at 3.0 mils DFT.
4) Tnemec; 1095 Endura-Shield at 3.0 mils DFT (Basis of Design).

C. Interior Paint Schedule, Typical:

1. Concrete Floors: Surface preparation as recommended by manufacturer.

a. Two Coats: Tnemec Series 287 Enviro-Pox at 3-4 mils DFT each coat.

2. Interior Metal Doors and Frames, Acrylic Polymer Painted Finish:

a. One Coat: Approved primer, in shop under other Sections (where specified). If not shop primed, provide primer recommended by finish coating manufacturer.
b. And Two Coats: Tnemec 1029 Enduratone at 2.0 mils DFT.

END OF SECTION

SECTION 101400

SIGNAGE

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Code-required interior panel signage, including but not limited to, mechanical and electrical room signage..
2. Exterior signs as indicated.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign.

B. Shop Drawings: Include plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details.

1. Provide message list for each sign, including large-scale details of wording, lettering, artwork, and braille layout.

C. Samples for Verification: For each type of sign, include the following Samples to verify color selected:

1. Panel Signs: Full-size Samples of each type of sign required.
2. Approved samples will not be returned for installation into Project.

D. Maintenance Data: For signage cleaning and maintenance requirements to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each sign type through one source from a single manufacturer.

B. Regulatory Requirements: Comply with the Massachusetts Architectural Access Board, Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Field Measurements: Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. For signs supported by or anchored to permanent construction, advise installers of anchorage devices about specific requirements for placement of anchorage devices and similar items to be used for attaching signs.

PART 2 - PRODUCTS

2.1 PANEL SIGNS

A. General: Provide signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction as indicated. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch measured diagonally. Provide the following:

B. Tactile and Braille Copy: Manufacturer's standard process for producing copy complying with ADA Accessibility Guidelines and ICC/ANSI A117.1. Text shall be accompanied by Grade 2 braille. Produce precisely formed characters with square cut edges free from burrs and cut marks.

1. Raised-Copy Thickness: Not less than 1/32 inch

C. Symbols of Accessibility: Provide 6-inch- high symbol fabricated from opaque nonreflective vinyl film, 0.0035-inch nominal thickness, with pressure-sensitive adhesive backing suitable for both exterior and interior applications.

## 2.2 ACCESSORIES

A. Mounting Methods: Use double-sided vinyl tape fabricated from materials that are not corrosive to sign material and mounting surface.

B. Anchors and Inserts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion-bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Verify that items provided under other sections of Work are sized and located to accommodate signs.

C. Examine supporting members to ensure that surfaces are at elevations indicated or required to comply with authorities having jurisdiction and are free from dirt and other deleterious matter.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. General: Locate signs and accessories where indicated, using mounting methods of types described and in compliance with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.
2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.

B. Wall-Mounted Panel Signs: Attach panel signs to wall surfaces using methods indicated below:

1. Vinyl-Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use this method for vinyl-covered or rough surfaces.

## 3.3 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by the Architect.

END OF SECTION

# SECTION 104400

# FIRE-PROTECTION SPECIALTIES

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Portable fire extinguishers.
2. Mounting brackets for fire extinguishers.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Division 21 - FIRE PROTECTION for fire hose valves and standpipes.

### 1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each item.

1. Fire Extinguishers: Include rating and classification.

### 1.4 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

## PART 2 - PRODUCTS

### 2.1 PORTABLE FIRE EXTINGUISHERS

A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

### 2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged units.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated on the Drawings and acceptable to authorities having jurisdiction.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

C. Identification: Apply vinyl lettering at locations indicated.

END OF SECTION

# SECTION 107313

# AWNINGS

## PART 1 - GENERAL

### 1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

### 1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Prefabricated awnings with standing seam metal roofing at sectional doors.

B. Related Work: The following items are not included in this Section and are specified under the designated Sections:

1. Section 055000 - METAL FABRICATIONS for blocking, shims, reinforcing, and supplemental support members for connecting to awning frame and anchorage.
2. Section 061000 - ROUGH CARPENTRY for blocking, nailers, shims, reinforcing, framing, and furring for connecting to awning frame and anchorage.
3. Section 076200 – SHEET METAL FLASHING AND TRIM for gutters, downspouts, and snowguards.

### 1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include styles, material descriptions, construction details, fabrication details, dimensions of individual components and profiles, hardware, fittings, mounting accessories, features, and finishes for awnings.

B. Shop Drawings:

1. Include plans, elevations, sections, mounting heights, and attachment details.
2. Detail fabrication and assembly of awnings, including seam layout, spacing.
3. Show locations for blocking, reinforcement, and supplementary structural support.

C. Samples: For each exposed product and for each color and texture specified.

D. Evaluation Reports: For anchors and fasteners, from ICC-ES.

E. Operation and Maintenance Data: For awnings to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Fabricator's responsibilities include fabricating and installing awnings and providing professional engineering services needed to assume engineering responsibility.

B. Installer Qualifications: Fabricator of products.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of awnings in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Where awning installation is indicated to fit to other work, verify dimensions of other work by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for fenestration operation throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.6 WARRANTY

A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including framework.
b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Awning Warranty Period: Five years from date of Substantial Completion.
3. Graphics Warranty Period: Outdoor durability not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: Model LFS-TR (without box) by Lawrence Structures or equal:

1. Frame: Extruded aluminum.
2. Substrate: Standing seam steel.
3. Fabrication: Welded framework, mechanically attached sheeting.
4. Finish: 2-coat fluoropolymer, 70% resin. Color as selected by Architect.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design awnings and attachments.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Regulatory Requirements: Provide awnings complying with requirements of authorities having jurisdiction.

D. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Complying with performance requirements indicated and suitable for exposure conditions, supporting structure, anchoring substrates, and installation methods indicated. Corrosion-resistant or noncorrodible units; weather-resistant, compatible, nonstaining materials. Provide as required for awning assembly, mounting, and secure attachment. Number as needed to comply with performance requirements and to maintain uniform appearance; evenly spaced. Where exposed to view, provide finish and color as selected by Architect from manufacturer's full range.

## 2.3 AWNING FABRICATION

A. Frames: Preassemble awning frames in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

1. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
2. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
3. Weld corners and connections continuously. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed corners and connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
4. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications in place and to properly transfer loads.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for supporting members, blocking, inserts, installation tolerances, lighting, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 3.2 INSTALLATION

A. General: Install awnings at locations and in position indicated, securely connected to supports, free of rack, and in proper relation to adjacent construction. Use mounting methods of types described and in compliance with Shop Drawings and fabricator's written instructions.

B. Install awnings after other finishing operations, including joint sealing and painting, have been completed.

C. Slip fit frame connections accurately together to form hairline joints, and tighten to secure.

D. Weld frame connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.

1. Field Welding: Comply with the following requirements:

a. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
b. Obtain fusion without undercut or overlap.
c. Remove welding flux immediately.
d. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Anchoring to In-Place Construction: Use anchors, fasteners, fittings, hardware, and installation accessories where necessary for securing awnings to structural support and for properly transferring load to in-place construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come in contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

G. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and in a manner that prevents exterior moisture from passing through completed exterior wall and roof assemblies.

## 3.3 CLEANING AND PROTECTION

A. Touchup Painting: Immediately after erection, clean field welds, connections, and abraded areas. Paint uncoated and abraded areas with same or compatible material as used for shop-applied finish painting.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Galvanized Surfaces: Clean field welds, connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

# SECTION 22 00 00
# PLUMBING TRADE CONTRACTOR REQUIREMENTS

## PART 1 - GENERAL

### 1.01 TRADE CONTRACT REQUIREMENTS

A. The Plumbing Trade Contract includes the Work specified in the following Sections:
   1. All Division 22 Sections, "Plumbing."

B. Submit bids in accordance with the provisions of Massachusetts General Laws, Chapter 149A, as amended. The time and place of submission of Bids is set forth in the Instructions to Bidders.

C. For the following class or classes of work, list on the bid form the names of persons, firms and corporations furnishing to the sub-bidder labor or labor and materials for the class or classes or part thereof, the name of such class of work or part thereof, and the bid price for such class of work or part thereof: Plumbing Insulation

| | Class of Work | Section(s) | Paragraph References |
|---|---|---|---|
| 1. | Plumbing Insulation | 22 07 00 | All |

D. Submit each Bid on a form furnished by the Awarding Authority.

E. The work of this Trade Contract is shown on Drawings:
   1. PLUMBING P-Drawings

F. Bid Coordination:
   1. Trade Contract Bidders shall refer to the entire set of Drawings, including without limitation: the Work of other Trade Contacts; and Work shown on architectural, civil, structural, mechanical, electrical, plumbing and fire protection and other Drawings; for proper coordination.
   2. Trade Contract Bidders shall review Procurement and Contracting Requirements including Conditions of the Contract and Division 01 General Requirements. Without limitation or restriction, Division 01 General Requirements contain requirements and assignments of responsibility between the general Contractor and Trade Contract Bidders for alternates, administration, delegated design, submittals, quality control, cutting and patching, hoisting, scaffolding, temporary services, demolition, warranties, contract closeout and other requirements, which the bidder must carefully review to determine how its scope of work and its bid price may be affected.

G. Access Panels: For Work installed by the Plumbing Trade Contract Bidder in concealed locations where access is required, furnish access panels per Section 08 31 13 "Access Doors and Frames" for installation by trade constructing surrounding Work.

H. Resilient Ceiling Hangers: For Work installed by the Plumbing Trade Contractor in and above acoustically insulated/isolated rooms, provide resilient ceiling hangars per Section 09 22 16 "Non-Structural Metal Framing."

I. The Trade Contractor selected to perform this work will be required to furnish a performance bond and a payment bond, each in the amount of 100% of the Trade Contract price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 220000

# SECTION 22 14 13
# FACILITY STORM DRAINAGE PIPING

## PART 1 - GENERAL

### 1.01 TRADE CONTRACT REQUIREMENTS

A. Work of this Section is part of the Plumbing Trade Contract. Refer to Section 22 00 00 "Plumbing Trade Contractor Requirements" for additional information about this Trade Contract.

### 1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.03 SUMMARY

A. This Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

B. Related Sections:
   1. Section 07 84 13 "Penetration Firestopping". Firestopping of plumbing penetrations by firestopping subcontractor.

### 1.04 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

### 1.05 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

### 1.06 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. One manufacturer's product is to be provided for each category of products throughout the project, unless specific circumstances do not allow for this approach. Consult with the Architect/Engineer prior to bid to request deviation from this one-product contract requirement.

No change order will be considered for failing to comply with this requirement. Any installation of non-compliant products will be removed and replaced under this section with compliant products at no additional cost to the owner.

## PART 2 - PRODUCTS

### 2.01 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

### 2.02 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
   1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve, similar to husky SD 4000 or Clamp All Hi-Torq 80..

B. Manufacturers:
   1. Clamp-All Corp.
   2. Husky
   3. Tyler Pipe; Soil Pipe Div.

### 2.03 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

E. For interior wall, floor and ceiling penetrations, seal annular space between sleeve and pipe or pipe insulation using appropriate fire rating, size, depth, and location of joint. Comply with Division 07.

### 2.04 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex, Inc.

4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

## PART 3 - EXECUTION

### 3.01 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and coupled joints.

### 3.02 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

C. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

D. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

E. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1/4” per foot slope downward in direction of flow for piping NPS 3 and smaller; 1/8” per foot slope downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 1/4” per foot slope downward in direction of flow for piping NPS 3 and smaller; 1/8” per foot slope downward in direction of flow for piping NPS 4 and larger.

F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.03 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.04 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet , if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

E. Install supports for vertical cast-iron soil piping every 15 feet.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.

G. Install supports for vertical steel piping every 15 feet.

3.05 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.06 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
   4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   5. Prepare reports for tests and required corrective action.

3.07 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 14 13

# SECTION 22 14 23
# STORM DRAINAGE PIPING SPECIALTIES

## PART 1 - GENERAL

### 1.01 TRADE CONTRACT REQUIREMENTS

A. Work of this Section is part of the Plumbing Trade Contract. Refer to Section 22 00 00 "Plumbing Trade Contractor Requirements" for additional information about this Trade Contract.

### 1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.03 SUMMARY

A. This Section includes the following storm drainage piping specialties:
1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Flashing materials.

B. Related Sections:
1. Section 07 84 13 "Penetration Firestopping". Firestopping of plumbing penetrations by firestopping subcontractor.
2. Division 7 Section "Thermal and Moisture Protection" for flashing.

### 1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

### 1.05 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. One manufacturer's product is to be provided for each category of products throughout the project, unless specific circumstances do not allow for this approach. Consult with the Architect/Engineer prior to bid to request deviation from this one-product contract requirement. No change order will be considered for failing to comply with this requirement. Any installation of non-compliant products will be removed and replaced under this section with compliant products at no additional cost to the owner.

### 1.06 COORDINATION

A. Coordinate size and location of roof penetrations.

## PART 2 - PRODUCTS

### 2.01 ROOF DRAINS

A. Metal Roof Drains :
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
   2.
   3. Standard: ASME A112.21.2M.
   4. Pattern: Canopy, Roof or Scupper drain.
   5. Body Material: Cast iron
   6. Refer to drawing Schedules for the type of roof drains.

### 2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
   1. Standard: ASME A112.21.2M.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected piping.

### 2.03 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Fasteners: Metal compatible with material and substrate being fastened.

D. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

E. Solder: ASTM B 32, lead-free alloy.

F. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

E. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

F. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

G. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

## 1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Commissioning Authority.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

F. Examine test reports specified in individual system and equipment Sections.

G. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Balance dampers are open.
5. Windows and doors can be closed so indicated conditions for system operations can be met.

## 3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" (ASHRAE 111), NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation ".

C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound IP and [metric (SI) units.

## 3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

D. Verify that motor starters are equipped with properly sized thermal protection.

E. Check dampers for proper position to achieve desired airflow path.

F. Check for airflow blockages.

G. Check condensate drains for proper connections and functioning.

H. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

## 3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

## 3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

## 3.8 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

## 3.9 TOLERANCES

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.

## 3.10 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

## 3.11 FINAL REPORT

A. General: Prepare a certified written report.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.

6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Other system operating conditions that affect performance.

16. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.

17. Test Data (Indicated and Actual Values):

    a. Total air flow rate in cfm.
    b. Outdoor airflow in cfm.
    c. Return airflow in cfm.
    d. Outdoor-air damper position.
    e. Return-air damper position.

D. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.

2. Motor Data:

    a. Motor make, and frame type and size.

b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Fan rpm.
c. Discharge static pressure in inches wg.
d. Suction static pressure in inches wg.

E. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

## 3.12 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. final payment.

B. Prepare test and inspection reports.

END OF SECTION 230593

# SECTION 230713

# DUCT INSULATION

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, exposed outdoor air.
2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application at linkages of control devices.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. CertainTeed Corp.; Commercial Board.
    b. Fibrex Insulations Inc.; FBX.
    c. Johns Manville; 800 Series Spin-Glas.
    d. Knauf Insulation; Insulation Board.
    e. Manson Insulation Inc.; AK Board.
    f. Owens Corning; Fiberglas 700 Series.

## 2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

## 2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

## 2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White

D. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.7 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, with wing seal or closed seal.

3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; CHP-1.
2) GEMCO; Cupped Head Weld Pin.
3) Midwest Fasteners, Inc.; Cupped Head.
4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: Copper- or zinc-coated, low-carbon steel fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. C & F Wire.

## 2.8 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 m) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

## 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
    b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-

applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for **100** percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.

## 3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

## 3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

## 3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, exposed supply and outdoor air.
2. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
3. Outdoor, exposed supply and return.

## 3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular, supply-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75-lb/cu. ft. (12-kg/cu. m) nominal density.
2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

B. Exposed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m)] [3-lb/cu. ft. (48-kg/cu. m) nominal density.

C. Exposed, rectangular, exhaust-air duct insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

D. Exposed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m)] nominal density.

E. Exposed, exhaust-air plenum insulation shall be the following:
1. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb/cu. ft. (32-kg/cu. m) nominal density.

## 3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed:

1. None.

END OF SECTION 230713

SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A/454B:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: (1/4 inch equals 1 foot).
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L (ASTM B 88M, Type A or B) OR ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

## 2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig (3450 kPa).
8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:

1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig (3450 kPa).

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 deg F (116 deg C).
7. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.

1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F (4.4 deg C).
6. Superheat: Adjustable.
7. End Connections: Socket, flare, or threaded union.
8. Working Pressure Rating: 700 psig (4820 kPa).

H. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 deg F (135 deg C).

I. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

K. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. End Connections: Socket.
5. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig (14 kPa).
7. Rated Flow: 5 tons.
8. Working Pressure Rating: 500 psig (3450 kPa).
9. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

N. Receivers: Comply with ARI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.

4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

O. Liquid Accumulators: Comply with ARI 495.

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

## 2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-454B:

# PART 3 - EXECUTION

## 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-454B

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller: for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot-Gas and Liquid Lines: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

## 3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve].

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

## 3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

J. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

K. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

L. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

M. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

## 3.4 PIPE JOINT CONSTRUCTION

A. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

B. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

## 3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

## 3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

## 3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

## 3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Verify that compressor oil level is correct.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.
4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

D. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

# SECTION 233113

# METAL DUCTS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports[ and seismic restraints] shall withstand the effects of gravity[ and seismic] loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."
5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment**,** seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

## 1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

# PART 2 - PRODUCTS

## 2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

## 2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

## 2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.5 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

# PART 3 - EXECUTION

## 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

## 3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
3. Unconditioned Space, Exhaust Ducts: Seal Class C.

## 3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.4 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

## 3.5 CONNECTIONS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

## 3.6 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

## 3.7 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg (500 Pa)
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
e. SMACNA Leakage Class: 3.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg (500 Pa)

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts:.

a. Exposed to Airstream: Match duct material.

G. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm (5 m/s) or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

H. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 233113

# SECTION 233423

# HVAC POWER VENTILATORS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:
1. Centrifugal roof ventilators.
2. Propeller fans.

### 1.3 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acme Engineering & Manufacturing Corporation.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. Greenheck Fan Corporation.
4. Loren Cook Company.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drain.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches (300 mm)

F. Capacities and Characteristics: Refer to drawings.

## 2.2 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acme Engineering & Manufacturing Corporation.
2. Aerovent; a division of Twin City Fan Companies, Ltd.
3. Greenheck
4. Loren Cook Company.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

F. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

G. Accessories:
1. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Weathershield Front Guard: Galvanized steel with expanded metal screen.
4. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

H. Capacities and Characteristics: Refer to drawings.

## 2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Enclosure Type: Totally enclosed, fan cooled.

## 2.4 SOURCE QUALITY CONTROL

A. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.

C. Install units with clearances for service and maintenance.

## 3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
8. Shut unit down and reconnect automatic temperature-control operators.
9. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

## 3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Lubricate bearings.

END OF SECTION 233423

# SECTION 238126

# SPLIT-SYSTEM AIR-CONDITIONERS

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set for each air-handling unit.
2. Gaskets: One set for each access door.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Lennox International Inc.
3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
4. SANYO North America Corporation; SANYO Fisher Company.
5. Trane; a business of American Standard companies.
6. YORK; a Johnson Controls company.

2.2 INDOOR UNITS

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Filters: Permanent, cleanable.
8. Condensate Drain Pans:

    a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62..1
        2) Depth: A minimum of 2 inches (50 mm) deep.

    b. Single-wall, stainless]-steel sheet.

c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

1) Minimum Connection Size: NPS 1 (DN 25)

B. Ceiling/Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:

a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch (25 mm) deep.

b. Single-wall, stainless-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

1) Minimum Connection Size: NPS 1 (DN 25).

7. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.

3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 2 inches (50 mm).
3) Merv according to ASHRAE 52.2: 5.
4) Media: Interlaced glass fibers sprayed with nonflammable adhesive
5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

## 2.3 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant Charge: R-454B.
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F (7 deg C).
6. Mounting Base: Polyethylene.

## 2.4 ACCESSORIES

A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

E. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable-frequency-drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

## 2.5 CAPACITIES AND CHARACTERISTICS

A. Refer to drawings.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

## 3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION 238126

SECTION 238239.16

PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which propeller unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

# PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. QMark

2. Airtherm; a Mestek company.

3. Trane Inc.

## 2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

D. Comply with UL 823.

## 2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Seismic Performance: Propeller unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[ and the unit will be fully operational after the seismic event]."

## 2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

## 2.5 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F (288 deg C) at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

## 2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:
1. Wall-mounted thermostat.

2.8 CAPACITIES AND CHARACTERISTICS

A. Heating Capacity: Refer to drawings

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers provided by manufacturer.

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

## 3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

## 3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239.16

# SECTION 031000

# CONCRETE FORMING AND ACCESSORIES

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.

### 1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the project site.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Form-release agent.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

a. Location of construction joints is subject to approval of the Architect.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Minutes of preinstallation conference.

PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

## 2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

    a. Exterior-grade plywood (complying with DOC PS 1), metal, or other approved panel materials.

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

## 2.3 RELATED MATERIALS

A. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

B. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2. Form release agent for form liners shall be acceptable to form liner manufacturer.

F. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips.
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
5. Vertical joints in walls are not indicated on Drawings. If necessary to add joints, locate them near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

## 3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

END OF SECTION 031000

# SECTION 032000

# CONCRETE REINFORCING

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

### 1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

### 1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.
3. Mechanical splice couplers.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1. Reinforcement to Be Welded: Welding procedure specification in accordance with AWS D1.4.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Epoxy-Coated Reinforcement: CRSI's "Epoxy Coating Plant Certification."

C. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

2. Mechanical splice couplers.

D. Field quality-control reports.

E. Minutes of preinstallation conference.

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

B. Mechanical Splice Couplers: ACI 318 Type 1, same material of reinforcing bar being spliced; mechanical-lap type.

C. Steel Tie Wire: ASTM A1064, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain ASTM A884.

### 2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.
3. Mechanical Splice Couplers: Install in accordance with manufacturer's instructions.
4. Weld reinforcing bars in accordance with AWS D1.4.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

## 3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

## 3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

## 3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

END OF SECTION 032000

# SECTION 033000

# CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Vapor retarders.
5. Floor and slab treatments.
6. Liquid floor treatments.
7. Curing materials.
8. Accessories.
9. Repair materials.
10. Concrete mixture materials.
11. Concrete mixture class types.
12. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

### 1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

### 1.3 ACTION SUBMITTALS

A. Product data.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Slump or slump flow limit.
7. Air content.

8. Nominal maximum aggregate size.
9. Intended placement method.
10. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

C. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints if any required to construct the structure. Location of construction joints is subject to approval of the Architect.

## 1.4 INFORMATIONAL SUBMITTALS

A. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material certificates.

C. Material test reports.

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances in accordance with ACI 117 and in compliance with ASTM E1155.

E. Preconstruction test reports.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

## 1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/ Engineer.

C. Field Quality-Control Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C150, Type I Type II, gray.
2. Pozzolans: ASTM C618, Class C, F, or N.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
4. Silica Fume: ASTM C1240.

B. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33, Class 3S.
2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
3. Fine Aggregate: ASTM C33.
4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.
5. Alkali-Silica Reaction: Comply with one of the following for each aggregate used:

a. Expansion Result of Aggregate: Not more than 0.04 percent at one year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567. Do not use this option with fly ash with an alkali content greater than 4.0 percent. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent when tested in accordance with ASTM C1260.
c. Alkali Content in Concrete: Not to exceed 4lb./cu. yd. for aggregate with expansion greater than or equal to 0.04 percent and less than 0.12 percent or 3lb./cu.yd. for aggregate with expansion greater than or equal to 0.12 percent and less than 0.24 percent. Test aggregate reactivity in accordance with ASTM C1293. Calculate alkali content of concrete in accordance with ACI 301. Do not use this option with natural pozzolan or fly ash that has a calcium oxide content greater

than 18 percent or an alkali content greater than 4.0 percent; or for an aggregate with expansion at one year greater than or equal to 0.24 percent when tested in accordance with ASTM C1293.

C. Ground Calcium Carbonate or Aggregate Mineral Filler: ASTM C1797. Unless otherwise permitted, do not use mineral filler derived from carbonate sources in concrete for members assigned to Exposure Class S1, S2, or S3.

## 2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

B. Chemical Admixtures (do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete):

1. Water-Reducing Admixture: ASTM C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494, Type S.
7. Set-Accelerating Corrosion-Inhibiting Admixture: ASTM C1582.
8. Moisture-Vapor-Reducing Admixture: ASTM C494, Type S, hydrophilic, moisture-vapor-reducing, capable of reducing water absorption in and moisture-vapor emission from concrete (MVRA).

C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C1602.

## 2.4 VAPOR RETARDERS

A. Sheet Vapor Retarder, Class A: ASTM E1745. Include manufacturer's recommended thickness and adhesive or pressure-sensitive tape.

## 2.5 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 8 sieve.

## 2.6 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

## 2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: 8 ft. wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

G. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

H. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

I. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

J. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

## 2.8 ACCESSORIES

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

C. Bonding Agent: ASTM C1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements, and as follows:

1. Types I and II, nonload bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

## 2.9 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

## 2.10 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

D. Color Pigment: Add color pigment to concrete mixture in accordance with manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.11 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for foundation walls, footings and grade beams.

1. Exposure Class: ACI 318 Class F2.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum w/cm Ratio: 0.45.
4. Slump Range: 5 - 8 inches.
5. Air Content:

a. Exposure Classes F2: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cementitious materials.

B. Class B: Normal-weight concrete used for interior slabs-on-ground.

1. Exposure Class: ACI 318 Class F0 and Class S1.
2. Minimum Compressive Strength: 4000 psi at 28 days.
3. Maximum w/cm Ratio: 0.45.
4. Slump Range: 5 - 8 inches.
5. Air Content:

a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cementitious materials.

## 2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94 and furnish delivery ticket.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

A. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not proceed until unsatisfactory conditions have been corrected.

## 3.2 TOLERANCES

A. Comply with ACI 117.

## 3.3 INSTALLATION OF VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder in accordance with manufacturer's written instructions.

## 3.4 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

## 3.5 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.

    a. Continue reinforcement across construction joints unless otherwise indicated.

3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
4. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
6. Space vertical joints in walls as indicated on Drawings. Unless otherwise indicated on Drawings, locate vertical joints beside piers integral with walls, near corners, and in concealed locations where possible.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
1. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface, where joint sealants are indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints:

1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

## 3.6 APPLICATION OF FINISHING FLOORS AND SLABS

A. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

4. Do not add water to concrete surface. Use of an approved finishing aid is acceptable.
5. Do not apply troweled finish to concrete, which has a total air content greater than 3 percent.
6. Finish surfaces to the following tolerances, in accordance with ASTM E1155, for a randomly trafficked floor surface:

    a. Slabs on Ground:

        1) Specified overall values of flatness, $F_F$ 25; and of levelness, $F_L$ 20; with minimum local values of flatness, $F_F$ 17; and of levelness, $F_L$ 15.
        2) Specified overall values of flatness, $F_F$ 35; and of levelness, $F_L$ 25; with minimum local values of flatness, $F_F$ 24; and of levelness, $F_L$ 17.

## 3.7 APPLICATION OF FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.

    a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
    b. Remove projections larger than 1 inch.
    c. Tie holes do not require patching.
    d. Surface Tolerance: ACI 117, Class D.
    e. Apply to concrete surfaces for metal lap pan deck formed surfaces and those surfaces that are buried or covered with subsequent installed surfaces.

2. ACI 301 Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/4 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117, Class B.

    e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

3. ACI 301 (ACI 301M) Surface Finish SF-3.0:

    a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
    b. Remove projections larger than 1/8 inch.
    c. Patch tie holes.
    d. Surface Tolerance: ACI 117 Class A.
    e. Locations: Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

## 3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

    a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    b. Cast anchor-bolt insert into bases.
    c. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items.

1. Cast-in inserts and accessories, as shown on Drawings.
2. Screed, tamp, and trowel finish concrete surfaces.

## 3.9 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

    a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
    b. Continuous Sprinkling: Maintain concrete surface continuously wet.
    c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
    d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
    e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

        1) Recoat areas subject to heavy rainfall within three hours after initial application.
        2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.
2. Interior Concrete Floors:

    a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:

        1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

            a) Lap edges and ends of absorptive cover not less than 12 inches.
            b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

        2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

            a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
            b) Cure for not less than seven days.

        3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following not in cold weather:

a) Water.
b) Continuous water-fog spray.

b. Floors to Receive Penetrating Liquid Floor Treatments: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive.

a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
b) Cure for not less than seven days.

3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

c. Floors to Receive Polished Finish: Contractor has option of the following:

1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.

a) Lap edges and ends of absorptive cover not less than 12 inches.
b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.

2) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:

a) Water.
b) Continuous water-fog spray.

d. Floors To Receive Chemical Stain:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install curing paper over entire area of floor.

2) Install curing paper square to building lines, without wrinkles, and in a single length without end joints.
3) Butt sides of curing paper tight; do not overlap sides of curing paper.
4) Leave curing paper in place for duration of curing period, but not less than 28 days.

e. Floors To Receive Urethane Flooring:

1) As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
2) Rewet absorptive cover, and cover immediately with polyethylene moisture-retaining cover with edges lapped 6 inches and sealed in place.
3) Secure polyethylene moisture-retaining cover in place to prohibit air from circulating under polyethylene moisture-retaining cover.
4) Leave absorptive cover and polyethylene moisture-retaining cover in place for duration of curing period, but not less than 28 days.

f. Floors To Receive Curing and Sealing Compound:

1) Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller in accordance with manufacturer's written instructions.
2) Recoat areas subjected to heavy rainfall within three hours after initial application.
3) Repeat process 24 hours later, and apply a second coat. Maintain continuity of coating, and repair damage during curing period.

## 3.10 APPLICATION OF LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment in accordance with manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 28 days old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing.
4. Rinse with water; remove excess material until surface is dry.
5. Apply a second coat in a similar manner if surface has received a float finish or abrasive surface preparation.

## 3.11 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

## 3.12 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

    a. Limit cut depth to 3/4 inch.
    b. Make edges of cuts perpendicular to concrete surface.
    c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
    d. Fill and compact with patching mortar before bonding agent has dried.
    e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

    a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
    b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.

    a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    b. Feather edges to match adjacent floor elevations.

6. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

## 3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31.

2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

B. Delivery Tickets: Comply with ASTM C94.

C. Inspections:

1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172 to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.

   a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143:

   a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   b. Perform additional tests as needed.

3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.

   a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064:

   a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.

5. Concrete Density: ASTM C138:

   a. One test for each composite sample when strength test specimens are cast.

6. Compression Test Specimens: ASTM C31:

   a. Cast and standard cure two sets of four 6 inches by 12-inches or 4-inch by 8-inch cylindrical specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39.

    a. Test one set of two standard cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests:

    a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
    b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.

        1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.

11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

## 3.14 PROTECTION

A. Protect concrete surfaces.

B. Protect from petroleum stains.

C. Prohibit vehicles from interior concrete slabs.

D. Prohibit placement of steel items on concrete surfaces.

END OF SECTION 033000

# SECTION 034100

# PRECAST STRUCTURAL CONCRETE

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Precast structural concrete.

### 1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the project site.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.

C. Delegated Design Submittals: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, fabricator and testing agency.

B. Material certificates.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

1.6 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Structural Performance: Precast structural concrete units and connections to withstand design loads indicated within limits and under conditions indicated.

1. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

2.2 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A185, fabricated from galvanized-steel wire into flat sheets.

C. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.3 PRESTRESSING TENDONS

A. Strand: ASTM A416, Grade 270, uncoated, seven-wire, low-relaxation strand.

1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

## 2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C150, Type I or Type III, gray, unless otherwise indicated.

B. Supplementary Cementitious Materials:

1. Pozzolans: ASTM C618, Class C, F, or N, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C618, Class N.
3. Silica Fume: ASTM C1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33/C33M, with coarse aggregates complying with Class 4S or Class 4M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

## 2.5 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36.

B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Castings: ASTM A27, Grade 60-30.

D. High-Strength, Low-Alloy Structural Steel: ASTM A572.

E. Deformed-Steel Wire or Bar Anchors: ASTM A496 or ASTM A706.

## 2.6 BEARING PADS

A. Provide bearing pads for precast structural concrete units as recommended by precast fabricator for application.

## 2.7 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C150, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218.

B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C1218.

C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881, of type, grade, and class to suit requirements.

## 2.8 CONCRETE MIXTURES

A. Prepare design mixtures for each type of precast concrete required.

1. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.

C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 116 when tested according to ASTM C1218.

D. Normal-Weight Concrete Mixtures: Proportion by either laboratory trial batch or field test data methods according to ACI PRC-211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:

1. Minimum Compressive Strength (28 Days): 5000 psi.
2. Maximum Water-Cementitious Materials Ratio: 0.45.

E. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.

F. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.

G. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.9 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

K. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Architect's approval.

## 2.10 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

## 2.11 COMMERCIAL FINISHES

A. Commercial Grade: Remove fins and protrusions larger than 1/8 inch and fill holes larger than 1/2 inch. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch.

B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.

## 2.12 SOURCE QUALITY CONTROL

A. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C1610, ASTM C1611, ASTM C1621, and ASTM C1712.

B. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
2. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Field cutting of precast units is not permitted without approval of Architect.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units without coordination and control of the units erector.

F. Welding: Comply with applicable requirements in AWS D1.1 and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

## 3.2 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

## 3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections are subject to inspections.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

## 3.4 REPAIRS

A. Repair precast structural concrete units if permitted by Architect.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.

D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

## 3.5 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

Manchester·Boston
REGIONAL AIRPORT

# AIRFIELD LIGHTING VAULT EXPANSION

**AIP 3-33-0011-TBD-2025**

**AIRPORT IMPROVEMENT PROGRAM**

**CONSTRUCTION SAFETY AND PHASING PLAN (CSPP)**

DRAFT

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**March 2025**

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**Appendix A**

Construction Safety and Phasing Plan Drawings (G-200 to G-204)


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# Construction Safety and Phasing Plan
Airfield Lighting Vault Upgrades

## *1. General*

It is imperative that all personnel who may have a role in the safety and/or security of Manchester-Boston Regional Airport, and any associated construction and staging areas, be thoroughly familiar with their responsibilities as described herein, all personnel involved in the project are mutually responsible for the safety and security of Manchester-Boston Regional Airport and the traveling public. Safety and security must be the first priority when coordinating daily activities and work assignments.

Manchester-Boston Regional Airport is owned and operated by the City of Manchester, Department of Aviation. When the term "Airport" or "Airport Operator" is used herein it shall be understood to mean the City of Manchester, Department of Aviation.

## *2. Project Description*

The project consists of the following:

- Expansion and upgrade of the existing Airfield Lighting Vault.
- Construction of a new 700' 20-way electrical duct bank inside of the Airport Operations Area (AOA).
- Installation of communications/control, security, HVAC, and fire alarms within the building footprint.
- Construction of an underground oversized manhole for receiving of airfield electrical homeruns in the Taxiway Hotel infield, and one manhole structure on the homerun leg between the airfield lighting vault and the underground oversized manhole.
- Installation of a new storm drainage pipe within the project area.

Work items include:

- Construction safety and phasing to include barricades, lights, and signs.
- Excavation and embankment.
- Removal of structures, pipes, ducts and electrical equipment (lights, signs, etc.).
- Demolition of existing bituminous pavement.
- Bituminous pavement construction.
- New paint markings.
- Utility relocation work.
- Electrical Vault Expansion Construction.
- Turf establishment.
- Erosion and sediment control measures.

This project will be constructed in two (2) phases in order to minimize impacts to the Airport and its users. These phases are depicted and detailed on the attached Safety and Phasing Plans (herein referred to as drawings).

## *3. Coordination (reference Section 2.5 in FAA AC 150/5370-2G)*

Airport operational safety during construction will be discussed at the pre-bid and preconstruction meetings. Safety and phasing will be an agenda item in the weekly construction progress meetings.

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The contractor will provide a schedule for the upcoming week's work to the engineer and owner at the weekly construction progress meetings. The owner will issue any required Notice to Air Missions (NOTAMs) based on this schedule. Any deviation from the schedule will require a minimum of 72 hours of notification and will be subject to approval of the owner and engineer.

The MHT Communications Center is the primary point of contact for all airport communications and emergency operations. The Airport Communications Center will make the appropriate notifications including ARFF, Operations or Law Enforcement. If a security concern arises, contact the Airport Communications Center immediately at 603.624.6349, in the case of an emergency 603.628.6222, or via granite radio (call sign Granite 100), and request assistance from airport operations.

- **Airport Communications Center - Emergency: 628-6222**
  Airport Communications Center – Non-Emergency 628-6019
  Airport Operations & Facilities: 624-6592
  Londonderry Police Department – Airport Division: 628-6349
  Airport Fire Department (ARFF): 624-1614
  FAA ATCT: 621-1700

- **Advise Communications Center Dispatcher of the following:**

  a. Nature of the call (security/operations/medical etc.)
  b. Location of the incident
  c. Who it involves – description
  d. When it happened
  e. How it happened (if known)

The Airport will notify tenants, local users and any field operations personnel of the planned construction activity via the following methods or a combination thereof: public 'flyers', notification calls/emails/letters, local briefings, and project meetings.

**Coordination for Constant Current Regulator (CCR):**

The constant current regulators' purpose is to supply power to the airfield lighting systems on the runways and taxiways which are necessary for airport operations during low visibility weather conditions and all periods of darkness. The airfield lighting control and monitoring system (ALCMS) communicates with the CCRs to allow the air traffic control tower to activate individual lighting circuits and manipulate the brightness of lighting systems in response to changes in ambient lighting conditions.

To facilitate the transfer of the lighting circuits from the existing CCRs to the proposed new CCRs, the new CCR lineups and control system must be built, tested, and commissioned in full prior to demolition of the existing CCRs and control system, as the existing and new systems are incompatible. It is not possible to control the new CCRs from the existing control system, or the existing CCRs from the new control system, thus it is not possible to replace individual CCR lineups while maintaining power and control to all airfield lighting systems. The coordination for the CCR switchover will be as follows:

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General Coordination:

1. Owner and FAA ATCT coordination will be required in advance of any ALCMS modifications.
2. Swap from existing control system to proposed will occur only during daytime hours during Visual Flight Rule (VFR) conditions.
3. The existing control system and regulators will need to remain in place and available for service for 14 days after the transition to the proposed control system and regulators are functionally covering the airfield.
4. The contractor shall have staff available to respond to the airport within 30 minutes of any outage or failure of the ALCMS and/or regulator lineup 24 hours a day upon the commissioning of the regulator lineup for FAA ATCT use for the first five days.
5. The following steps shall only be undertaken once the proposed switchgear lineups and control system have been tested on site and functioned appropriately:

   Steps and Coordination for the Transfer from Existing Control System to New Control System:

1. Contractor shall coordinate with the Owner and FAA to ensure the existing regulators can be taken offline (NOTAMs for any regularly "on" circuits, e.g. Runway Guard Lights).
2. The Contractor shall have staff in the existing homerun structure in the Taxiway Hotel infield and in the airfield lighting vault to swap circuit connectivity from the existing homerun connection to the proposed homerun connections.
3. The Contractor shall swap circuits for the smaller regulator lineup from their existing power supply to the proposed regulator lineup.
4. Contractor shall test the proposed ALCMS for operation of the smaller regulator lineup to ensure proper functionality of the system and circuits.
5. The contractor may – once the system operates as expected for the smaller lineup – swap the cabling from the existing homerun connections to the proposed homerun connections.
6. Contractor shall test the proposed ALCMS for operation of the larger regulator lineup to ensure proper functionality of the system and circuits.
7. Contractor shall run the proposed regulator lineups and ALCMS continuously for a pre-determined burn-in period as prescribed by the vendor, or a minimum of 72 hours consecutively if more than the vendor's recommendation.

***8. Phasing (reference paragraph 2.6 in FAA AC 150/5370-2G)***

The work shall be completed in two distinct construction phases. Construction for Phase I will take place during daytime hours. Construction for Phase II will take place during the daytime and nighttime hours.

a. <u>Phase Elements</u>

1) Areas closed to aircraft operations:

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Phase 2 Work Area – Taxiway 'H' and the adjacent apron will be closed from 1,100' south of Taxiway 'B' to 1,500' north of Taxiway 'E'.

2) Phase Durations:

Phase 1: 240 Calendar Days

Phase 2: 67 Calendar Days

Overall Project Duration: 240 Calendar Days

3) Taxi Routes:

Phase 1 Work Area – Aircraft taxi routes will not be impacted during construction of Phase 1 Work Area.

Phase 2 Work Area – Taxiway 'H' will be closed from 1,100' south of Taxiway 'B' to 1,500' north of Taxiway 'E'.

4) Emergency Access Routes:
   - The Contractor shall ensure emergency services have access to all areas of the airport at all times. Airport Operations shall notify ARFF 72 hours prior to the start of construction.

5) Construction Staging Areas:
   - The construction staging area for this project shall be located as shown on the attached drawings.
   - Any deviations from the planned staging area location will be as determined by the Airport.
   - The height of equipment and stockpiles shall be limited to a maximum height of 25' above ground level (AGL) as shown on the drawings, unless otherwise noted. The Contractor shall notify the Airport of any deviation requests. The Contractor shall plan on a 45 working day working approval process by the FAA for any deviation requests.
   - Equipment stationed within a staging area shall not obstruct nor impede aircraft or airport vehicle movement or any protected imaginary surface.

6) Construction Access and Haul Routes:
   - Access to the airfield shall be via the designated haul routes and existing airport access Gate #4 as shown on the attached drawings.
   - Airport Operations will lock the access gate when the Contractor is not on-site. During all work hours the Contractor's security guard shall control access by allowing only authorized vehicles and personnel into the Airport.
   - Contractor will require gate guard and/or access control during Phase 2 of the project.

7) Impacts to Visual Aids/NAVAIDS:
   - No anticipated impacts to visual aids/NAVAIDS.

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8) Lighting and Marking Changes:
   - The Contractor shall cover portions of the existing airport lighting within the active construction area. The contractor will coordinate this work with Operations as needed.
   - No signage will be impacted as part of this project.
   - Centerline markings leading into work areas shall be removed by the Contractor as shown on the attached drawings.

9) Required hazard marking and lighting:
   - Refer to paragraph 7.b for vehicle marking and lighting.

10) Lead times:
    The Contractor shall provide the following:
    - 72 hour advanced notice prior to start of work and advancement to the next Phase of work.

b. Construction Safety Drawings
   - Refer to the attached Construction Safety and Phasing Plan Drawings (G-200 to G-204)

***9. Areas and Operations Affected by Construction Activity (reference paragraph 207 in FAA AC 150/5370-2G)***

a. Identification of Affected Areas
   1) Closing or partial closing of runways, taxiways, and aprons:
      - The Contractor shall refer to paragraph 4.a above for closure locations.
      - The Contractor shall refer to the attached drawings for the locations of construction barricades at the limits of the work for each phase of the project.

   2) Closing of ARFF access routes:
      - The Contractor shall ensure emergency vehicle access routes are not impeded during scheduled closures.

   3) Closing of access routes used by airport and airline support vehicles:
      - Unless approved by the Airport, the Contractor shall not use any access gates other than the construction entrance gate during the project.
      - The Contractor shall not impede access to the airfield through the construction entrance or along service roads.

   4) Interruption of utilities, including water supplies for firefighting:
      - No utilities, including water supplies for firefighting, are expected to be interrupted during construction. Temporary measures including generators will be required to maintain power during the cutover of the Eversource cables.
      - If required, the Contractor shall provide advance notice of any utility interruptions.

   5) Approach/departure surfaces affected by heights of objects:
      - Approach/departure surfaces are not anticipated to be affected by this project.

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6) Construction areas, storage areas and access routes near runways, taxiways, aprons, or helipads:
   - The Contractor shall refer to the construction areas, storage areas and access routes (haul routes) as shown on the attached drawings.
   - The Contractor shall note that the construction areas shall have a height limitation of 25'. Any equipment in excess of 25' will require the submission of a separate FAA Form 7460-1.
   - Access/haul routes are shown on the attached drawings. The Contractor shall ensure that all construction equipment shall give the right of way to aircraft. The Airport will provide escorts whenever the Contractor is working in the AOA. Contractor vehicle operators will remain with the escort at all times when traveling to and from the work site. The Contractor shall be responsible for maintaining pavements free of foreign object debris (FOD) by sweeping any construction debris from the pavements. The sweeper shall be motorized. The sweeper shall be equipped with a vacuum and have a no less than a 6 cubic yard storage container. The sweeper shall apply water prior to sweeping to minimize dust.

b. Mitigation of Effects

1) Temporary changes to runway and/or taxi operations:
   - Taxiway operations will be impacted during Phase 2 Work Area construction. Refer to paragraphs 4.a above.
   - The Contractor shall give a minimum of 72 hours advanced notice to the Airport prior to any phase for coordination of any runway/taxiway restrictions with the appropriate FAA Airports Regional or District Office and the FAA air traffic manager, and issuance of a corresponding NOTAM.

2) Detours for ARFF and other airport vehicles:
   - The Contractor's activities shall not create detours for emergency and Airport vehicles utilizing the airport without written consent from the airport.

3) Maintenance of essential utilities:
   - Essential utilities (electric, water, gas, sewer, phone) are not expected to be impacted as a result of this construction project. Temporary measures including generators will be required to maintain power during the cutover of the Eversource cables.
   - Should an unforeseen utility be encountered and determined to be essential, the contractor shall clear the area around the utility and it shall be protected.

4) Temporary changes to ATC procedures:
   - Aircraft ground traffic patterns will be impacted during this project due to partial taxiway closures. Refer to paragraphs 4.a above.

***6. Protection of NAVAIDs (reference paragraph 208 in FAA AC 150/5370-2G)***

- There are no anticipated impacts to NAVAIDS caused by this project.

***7. Contractor Access (reference paragraph 209 in FAA AC 150/5370-2G)***

The Contractor shall be provided with an escort by the Airport for all Phases. Refer to paragraph 4.a.6. For airport access and haul routes see attached drawings.

a. Location of Stockpiled Construction Materials

All stockpiles and construction materials shall be located within or adjacent to the Contractor's construction staging area. If there is any deviation from the planned area then the Contractor must obtain approval regarding the location of the stockpiled materials from the Airport. No materials shall be stockpiled within the TOFA or ROFA. The TOFA and ROFA dimensions are shown on the attached drawings.

b. Vehicle and Pedestrian Operations

1. Construction Site Parking:
   - Contractor employee parking shall be located in the Contractor's staging area as shown on the drawings. It is the Contractor's responsibility to establish a privately owned vehicle (POV) parking area and safely transport work crews from the POV parking area to the construction site. The Contractor must obtain approval regarding the location of the parked vehicles from the Airport prior to the start of construction. No personal vehicles shall operate on the airport outside of the designated parking area.

2. Construction Equipment Parking:
   - The Contractor shall park and service all construction vehicles in an area designated by the Airport outside the TOFA. Inactive equipment shall not be parked on a closed taxiway or runway. All equipment shall be returned to the construction staging area at night, on weekends, holidays and when not in use.

3. Access and haul roads:
   - The haul routes are defined as shown on the attached drawings. The Contractor shall not use any access or haul roads other than those approved. The Contractor's equipment shall not operate on any taxiways that are open to aircraft.
   - When required, the Contractor's equipment shall yield and give way to all aircraft. When aircraft and construction equipment are passing, the Contractor shall provide a minimum of 50 ft. clear distance between the equipment and wingtips.
   - The Contractor shall keep the haul routes clear of debris or FOD at all times.

4. Marking and lighting of vehicles:
   - All vehicles shall comply with FAA AC 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport.
   - All vehicles to be used on the airport shall have the company logo or name visible and legibly identified on both sides of vehicle.
   - Each construction vehicle shall be equipped with an approved yellow rotating or flashing beacon light and this light must be unobstructed from view.
   - Each piece of construction equipment shall have a 3' x 3' orange/white checkered flag attached to their highest point.

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5. Description of proper vehicle operations:
   - Contractor vehicle operators will remain with the Airport provided escort at all times when traveling to or from the work site.
   - At all times, vehicles shall give right of way to any passing aircraft.
   - When within the Airport Operations Area (AOA), all construction vehicles must remain within the designated work areas and travel along the planned haul routes.
   - If a vehicle is inoperable due to a mechanical emergency, it must be moved to a safe area, away from aircraft and airport vehicles, for normal repairs that take less than 10 minutes or removed from within the AOA for complex repairs requiring extended time.
   - Repairs involving the use of petrochemicals and other flammable fluids, aerosols, and powders, and small parts and accessories that can easily become FOD shall not be conducted on the airfield.
   - Vehicles that lose communications shall immediately return to the Contractor staging area along the approved haul route.

6. Required escorts:
   The Contractor shall be provided with an escort by the Airport for all Phases.

7. Training requirements for vehicle drivers:
   - Prior to operating on the Airfield, the Airport shall brief the Contractor's badged employees on the particular features of the airfield and areas affected by the construction activity.
   - The Contractor's badged employees shall also be briefed by the Airport on how to interpret the airport signage encountered along the haul routes and within the work area.

8. Situational awareness:
   - At all times, vehicles shall give the right of way to any passing aircraft.
   - Aircraft with their rotating beacons and/or strobe lights flashing are typical indications that the engine is running or that the engine start procedure has begun.
   - The Contractor shall treat all aircraft with caution, regardless of whether they are occupied or not.

9. Radio Communications:
   - The Contractor's site superintendent will be required to carry a portable radio to communicate with the gate guard(s) and airport operations.
   - The Airport Communications Center monitors four airport operating (granite) frequencies – i.e. Channels 1 through 4. All emergency calls and emergency communication shall take place on granite channel 1. When there is an emergency in progress, all communications relative to the emergency shall take place on channel 1. All other granite users shall utilize other assigned frequencies until the emergency situation has been resolved and the emergency alert is terminated by the airport communications center.

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- The ATCT will have direct communication with the Airport Operations personnel who are providing contractor escorts and operation safety oversight. This communication will take place on the MHT ground frequency.

10. Maintenance of the secured area of the airport:
    - All personnel with regular job duties and responsibilities within the AOA, including contractors, subcontractors, general workers and/or security personnel will obtain an MHT Security Identification Badge. In addition, all applicants will attend an airport security briefing prior to being granted access to any secure area.

    - All authorized visitors and short term workers will be issued a temporary escorted badge. Issuance of escorted badges will be noted in the daily security access log. The log and badges will be returned to airport operations at the close of each work day. The contractor's MHT badged supervisor(s) are required to coordinate AOA escort assignments with airport operations. An escorted worker will be informed (by the contractor) as to their MHT badged escort and will at all times remain within line of sight of the escort.

    - All personnel and vehicles that are granted access to the AOA will submit to random security inspections conducted by airport law enforcement, security, operations, and Transportation Security Administration personnel. Random inspections may occur at any time and may take place at the perimeter gates, on the AOA, and/or within other secure areas of the airport. Mirrors will be used to ensure a thorough inspection of the undercarriage of vehicles.

    - Security Gate #4 will be manned by an Airport approved security guard during normal business hours. The following procedures will be followed for contractor access:

        - Gate guards will have an approved means of communication, e.g. "granite" radio contact with his/her supervisors, the contractor, airport operations, and Airport Communications in the event of an emergency.

        - Vehicle Inspections will take place on the public side of the security fence prior to the gate being opened.

        - All personnel entering an AOA access gate will sign the daily security/AOA access log (once per day for all personnel except when leaving the secured area or hauling material off site). The daily log will be maintained by the gate guard and turned over to airport operations at the close of each work day.

***8. Wildlife Management (reference paragraph 210 in FAA AC 150/5370-2G)***

- The Contractor shall maintain the construction and staging areas so that they are kept clean and free of debris which might attract birds or other wildlife.
- The Contractor's dumpsters, if used, shall be the 'roll-away' type and be covered and emptied weekly or more frequently if full.
- The Contractor shall not permit standing water in the work site.

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- The Contractor shall notify the Airport upon detection of wildlife within the Airport's fence.

***9. Foreign Object Debris (FOD) Management (reference paragraph 211 in FAA AC 150/5370-2G)***

- The Contractor shall maintain a motorized vacuum sweeper on site to remove FOD from pavements. Refer to paragraph 5.a.6 for sweeper requirements.
- Any FOD that is tracked outside the work area or that is deemed a hazard by the Airport/Engineer shall be dealt with immediately with a sweeper.
- At the end of the work day, the work areas shall be swept and cleared of any FOD by the Contractor. The Contractor must get approval from the Engineer that the site is cleared of FOD prior to leaving the site for the night.

***10. Hazardous Material (HAZMAT) Management (reference paragraph 212 in FAA AC 150/5370-2G)***

- The Contractor shall comply with all Federal, State, and local laws and regulations controlling pollution of the environment and hazardous waste.
- The Contractor shall have on hand and accessible at all times the MSDS sheets for all chemicals on site.
- All construction equipment shall be serviced and refueled in the Contractor's staging area. Approved secondary containment shall be used during servicing and refueling. The Engineer must be notified of any spills. The Engineer will then contact Airport Communications who will make the appropriate notifications including ARFF.
- The Contractor shall have a HAZMAT management procedure manual in place. Copies shall be available upon request and must be included with the Safety Plan Compliance Document (SPCD).

***11. Notification of Construction Activities (reference paragraph 213 in FAA AC 150/5370-2G)***

The resident engineer and site superintendent shall be available 24-hours a day for any emergency involving the construction of the project. Any emergency involving the construction of the project will be notified to the airport, airfield maintenance, resident engineer, contractor, and engineer. Before beginning any construction activity, the contractor will, through airport operations and the resident engineer, ensure that all appropriate safeguards are in place and that all required notifications e.g., NOTAMs have been disseminated.

a. <u>List of Responsible Representatives/ Points of Contact</u>

A list of responsible representatives and the associated contact numbers shall be maintained in this document and shall be distributed to the Contractor, Engineer, and Airport. Any updates to the original list in this document must be made promptly and the full list reflecting those amendments shall be redistributed separately.

| | | |
|---|---|---|
| 1. | Emergency (Airport Comm. Center) | 603-628-6222 |
| 2. | Airport Owner/Operator | 603-628-6539 |
| 3. | Engineer (Jacobs) | John Pelletier – 603-518-1775 |
| 4. | Contractor (Office) | Name & # (TBD) |
| 5. | Contractor (Site Superintendent) | Name & # (TBD) |

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6. Tech Ops 603-621-1762

b. Notices to Air Missions (NOTAMs)
- The scope of work for this project requires the partial closures of Taxiway 'H'.
- The Contractor will notify the Engineer 72 hours prior to work requiring the issuance of a NOTAM including but limited to all taxiway closures. The airport operations representative will coordinate construction activities daily. The ATCT and tenants will be notified via the NOTAM system of any construction activity which may impact aircraft operations.

c. Emergency Notification Procedures
- The Airport shall be the first point of contact for any emergency involving the construction of the project after which the Engineer shall be immediately contacted as well.
- For an emergency requiring immediate medical attention the Airport Communication Center will be notified via the emergency number (603-628-6222) The Communication Center will dispatch ARFF.
- Refer to Section 15 "Special Conditions" in the event of an emergency on the Airfield.

d. Coordination with Emergency Response Personnel
- The ARFF Personnel will be notified a minimum of 72 hours prior to the notice to proceed of the project as well as any changes to the emergency access route or any deactivation and subsequent reactivation of waterlines and fire hydrants.

e. Notification to the FAA
- Prior to the start of construction, the Airport will file a FAA Form 7460-1, Notice of Proposed Construction or Alteration for the locations and anticipated heights of equipment. The Contractor shall review the submitted FAA Form 7460-1 and notify the Airport of any deviation requests. The Contractor shall plan on a 30 calendar approval process by the FAA for any deviation requests.

***12. Inspection Requirements (reference paragraph 214 in FAA AC 150/5370-2G)***

a. Daily Inspections
- Inspections to ensure compliance with this CSPP shall be performed on a daily basis by the Contractor and Engineer. A sample checklist is provided in Appendix 4 of FAA AC 150/5370-2G.
- Airport operations personnel make frequent checks of the airfield and work areas. In the event that a deficiency is found, airport operations personnel will contact the contractor and engineer.
- Safety issues are to be corrected immediately by the Contractor.
- All areas scheduled to be opened to aircraft shall be inspected by the Engineer and the Airport prior to completion of the work shift and opening of the area.
- At the conclusion of the workday, the contractor will ensure that the worksite is vacated, properly secured, and that all escorted badges are collected, accounted for, and returned to airport operations. Airport operations will make

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a final inspection prior to the contractor leaving. This may include a lighting inspection.

b. Final Inspections

- When the Contractor determines the Contract is completed, the Contractor shall notify the Engineer in writing and the Engineer will schedule a final inspection of the work with the appropriate parties.
- Any work found to be unsatisfactory at the time of the inspection shall be noted and the Contractor shall be provided instructions on how to remedy the deficient areas.
- Upon completion of any 'punch-list' work, the Engineer and Airport will inspect the areas again for acceptance.
- The FAA will be notified of the project completion and invited to attend the final inspection.

***13. Underground Utilities (reference paragraph 215 in FAA AC 150/5370-2G)***

- The contractor will notify DIGSAFE and all local utilities prior to beginning any excavations for this project. The FAA Tech Ops local office will be notified of the project and receive a copy of the construction plans. There are FAA utilities known to be located within the project limits. Contractor is responsible for coordination with FAA Tech Ops to establish the location of any FAA utilities within the project limits. Existing utilities to remain in place will be protected during construction.
- For any utilities that are damaged, the Contractor shall notify the resident engineer. The resident engineer will notify the Airport. The Contractor will be required to repair the damaged utilities to the Airport's satisfaction. Prior to the close of work each day, the Contractor will ensure that all lighting and navigational facilities are operational.

***14. Penalties (reference paragraph 216 in FAA AC 150/5370-2G)***

- If airport rules, regulations, or the safety plan are not followed, the project is to be shut down and will not resume until the contractor is in compliance and acknowledges he/she understands the rules/regulations.
- Badged personnel and drivers who deviate from the assigned haul routes or work areas are to have their airport access privileges revoked. Any worker (MHT badged or under escort) who engages in any activity other than that for which his/her access was granted, will be removed from the work area. Failure to submit to random security inspections will result in suspension of the MHT security I.D. badge and associated access privileges.
- If unauthorized access to the AOA or deviation from the assigned construction work area and haul route is observed, a call will be made immediately by the Contractor to the Airport Operations Personnel. If Airport Law Enforcement Officer is required, call the Airport Communications Center at 603.624.6349, or the emergency number 603.628.6222.

***15. Special Conditions (reference paragraph 217 in FAA AC 150/5370-2G)***

- The project work area is located on Taxiway 'H' and in close proximity to the Runway 17-35 Runway Safety Area. There are no anticipated problems with low visibility or snow removal resulting from the project. Any situations

involving an aircraft accident, security breach, or aircraft in distress will be handled with coordination between the Engineer, Site Superintendent, and Airport Operations. The Airport Communications Center is the primary point of contact for all on airport emergencies.

***16. Runway and Taxiway Visual Aids (reference paragraph 218 in FAA AC 150/5370-2G)***

a. General

- The project consists of partial taxiway closures.
- All markings shall comply with FAA AC 150/5340-1 (latest edition), Standards for Airport Markings.
- All Lighting shall conform to the current FAA AC 150/5340-30 (latest edition).

b. Markings

- Pavement markings leading into the work area will be removed by the Contractor as shown on the attached drawings.

c. Lighting and Visual NAVAIDS

- The portion of the taxiway that will be closed to traffic during each phase will have its taxiway lights deactivated. See the attached drawings for location of the lights to be deactivated.
- There will be no impacts to any other FAA or MHT navigation aids during the construction period.
- The airfield lighting will be tested at the end of each work day to ensure that there has been no disruption of service.

d. Signs

- The contractor shall refer to the Drawings for signs that, because of the taxiway closures, do not serve their normal function and are required to be turned off and have panels removed and replaced with black panels, if needed.

***17. Markings and Signs for Access Routes (reference paragraph 219 in FAA AC 150/5370-2G)***

- The contractor shall provide a sign at each vehicle access point to include the following: “No Unauthorized Vehicles Beyond This Point”. Sign shall be white with black text.

***18. Hazard marking and lighting (reference paragraph 220 in FAA AC 150/5370-2G)***

- Hazard marking and lighting will be installed to prohibit aircraft, vehicles, and pedestrians from entering areas closed for construction and to prevent construction personnel from entering areas open to aircraft.
- Interlocked construction barricades will be installed around the active work areas. The barricades will act as boundary to prevent aircraft or unauthorized vehicles from entering the work area. The barricades will be equipped with flashing red lights and orange and white flags.
- All barricades used will meet the requirements set forth in AC 150/5370-2G. Approximately 200 barricades will be provided by the owner and maintained at all times by the contractor. The contractor shall provide and maintain the

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remainder of required barricades. Any deficiencies observed by the Engineer or Airport Operations will be immediately corrected by the Contractor.

***19. Work Zone Lighting for Nighttime Construction (reference paragraph 2.21 in FAA AC 150/5370-2G)***

- Lighting equipment must adequately illuminate the work area meeting the requirements of AC 150/5370-10 for minimum illumination levels during nighttime paving.
- All support equipment, except haul trucks, must be equipped with artificial illumination to safely illuminate the immediate surrounding area.
- Light towers will be positioned and adjusted to aim away from the ATCT and active runway to prevent blinding effects. Shielding may be necessary.
- Light towers will be removed from the work area prior to being reopened to aircraft operations.

***20. Protection of Runway and Taxiway Safety Areas (reference paragraph 221 in FAA AC 150/5370-2G)***

a. Runway Safety Area (RSA)
- The RSA locations are shown on the attached drawings.
- Prior to the start of construction, the RSA in the work areas will be surveyed and marked out by the Contractor as shown on the Drawings to ensure no unauthorized entrance into these areas occurs.

b. Runway Object Free Area (ROFA)
- The ROFA locations are shown on the attached drawings.
- Construction, including excavations, will be permitted in the ROFA during work in associated work areas. However, equipment must be removed from the ROFA when not in use, and materials shall not be stockpiled in the ROFA.
- Prior to the start of construction, the ROFA in the work areas will be surveyed and marked out by the Contractor to ensure no unauthorized entrance into these areas.

c. Taxiway Safety Area (TSA)
- The TSA locations are shown on the attached drawings.
- There will be no work associated with this project inside the TSA while the taxiway is open for aircraft operations.
- A NOTAM will be issued for the work in this area.
- Open trenches or excavations in the TSA are not permitted to be left open when the taxiway is open for aircraft operations. Trenches shall be backfilled before the taxiway is opened.
- Where required the Contractor will install erosion control in the TSA in a manner compliant with the TSA construction standards. That is, the TSA must be cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations, and must be capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and firefighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.

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- Prior to the start of construction, the TSA will be surveyed and marked out in the work areas by the Contractor to ensure no unauthorized entrance into these areas occurs.

d. Taxiway Object Free Area (TOFA)
- The TOFA locations are indicated on the drawings.
- There will be no work associated with this project inside the Taxiway Object Free Area of an active taxiway.
- The Contractor shall notify the Airport 72 hours prior to commencing work in this area.
- A NOTAM will be issued for the work in this area.
- Prior to the start of construction, the TOFA will be surveyed and marked out in the work areas by the Contractor to ensure no unauthorized entrance into these areas occurs.

e. Runway Visibility Zone (RVZ)
- The RVZ locations are indicated on the drawings.
- The Contractor shall coordinate with airport personnel at the start of each workday for work taking place within the RVZ. Authorization must be granted, on a daily basis, by the ATCT to proceed with work within the RVZ, subject to weather limitations.
- A NOTAM will be issued for the work in this area.
- Prior to the start of construction, the RVZ will be surveyed and marked out in the work areas by the Contractor to ensure no unauthorized entrance into these areas occurs.

f. Runway Obstacle Free Zone (OFZ)
- The OFZ will not be affected during this project.

g. Runway Approach/Departure Areas and Clearways
- The runway approach/departure surfaces and clearways will not be affected during this project.

***21. Other Limitations on Construction (reference paragraph 222 in FAA AC 150/5370-2G)***
- No use of tall equipment (cranes, etc.) shall occur until a 7460-1 determination letter is issued by the FAA for such equipment. The Contractor shall plan on a 45 working day approval process by the FAA for any deviation requests. The maximum crane height for building construction shall be limited to 50’ AGL.
- Use of open flame welding torches shall not be permitted unless fire safety precautions are provided and the Airport and ARFF have approved their use. ARFF will maintain a fire watch during times when open flame welding will take place. Electrical blasting caps and flare pots will not be used on or within 1,000 feet of the airport.
- Smoking shall not be permitted in the AOA at any time. Anyone caught smoking in the AOA will be subject to fines and/or removal from the project.
- The Contractor shall not leave any trenches or other excavations open at night, on weekends, or at other times when the Contractor is not on site, except as approved by the Airport Operations and the Engineer. All excavations shall

be backfilled and pavement properly repaired and cured prior to the area being reopened to aircraft traffic.

- Excavations exceeding 3 inches in depth shall not be left open within active safety areas unless excavations are covered with approved plates.
- Prior to the close of work for each day, the Contractor shall ensure that the work areas are graded away from pavements at a maximum slope of 5% and shall be left in such condition that it will readily and effectively drain and not pose a hazard to aircraft or vehicles.

***22. Airport Watch Program.***

The "Airport Watch Program" was established to visually remind all airport employees, users, and tenants of their role in maintaining a safe and secure airport. If you see something suspicious, report it to your supervisor and to the airport communications center immediately. With the willing assistance of many watchful eyes and alert ears, the airport will remain a safe and secure environment for travelers, employees, contractors, and the general public.

***23. Acronyms and Abbreviations***

AC - Advisory Circular
AOA - Airport Operations Area
ARFF - Airport Rescue and Fire Fighting
ASDA - Accelerated Stop Distance Available
ASOS - Automated Surface Observing System
ATO - Air Traffic Office
CSPP - Construction Safety and Phasing Plan
CTAF - Common Traffic Advisory Frequency
FAA - Federal Aviation Administration
FBO - Fixed Based Operator
FOD - Foreign Object Debris
Ft - feet
HAZMAT - Hazardous Materials
LDA - Landing Distance Available
MHT - Manchester-Boston Regional Airport
NAVAID - Navigational Aid
NOTAM - Notice to Air Missions
NTP - Notice to Proceed
OFA - Object Free Area
OFZ - Obstacle Free Zone
PAPI - Precision Approach Path Indicator
POV - Privately Owned/Operated Vehicle
REIL - Runway End Identifier Lights
ROFZ - Runway Object Free Zone
ROFA - Runway Object Free Area
RSA - Runway Safety Area
RW - Runway
TODA - Take-off distance available
TOFA - Taxiway Object Free Area
TORA - Take-off run available
TWY - Taxiway

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UNICOM - Universal Communications

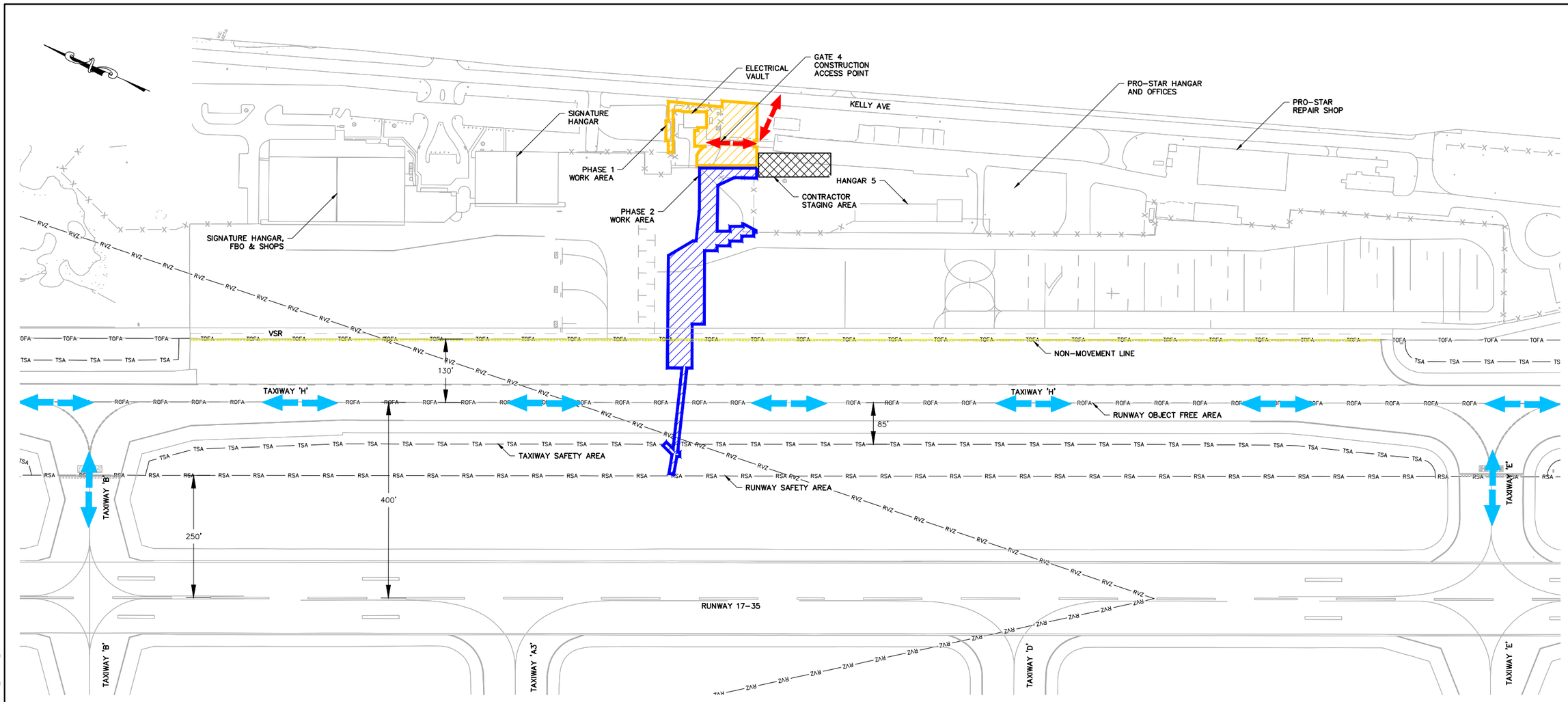
***24. Comments/Revisions Log***

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**Appendix A**

Construction Safety and Phasing Plan Drawings (G-200 to G-204)

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## SAFETY & PHASING PLAN OVERVIEW

SCALE: 1"=100'

LEGEND

- PHASE 1 WORK AREA
- PHASE 2 WORK AREA
- STAGING AREA
- HAUL ROUTE
- CONSTRUCTION BARRICADES (G-204.1)
- "NO ENTRY" SIGN (G-204.2)
- CONSTRUCTION SIGN (G-204.3)
- TAXIWAY CLOSURE MARKER (G-204.4)
- SNOW FENCE (G204.5)
- TRAFFIC CONES (G204.7)
- AIRCRAFT TAXI ROUTE
- NON-MOVEMENT LINE
- RSA — RUNWAY SAFETY AREA
- ROFA — RUNWAY OBJECT FREE AREA
- TSA — TAXIWAY SAFETY AREA
- TOFA — TAXIWAY OBJECT FREE AREA
- GS — GLIDE SLOPE CRITICAL AREA
- RVZ — RUNWAY VISIBILITY ZONE

NOTES

1. TOTAL PROJECT DURATION IS 240 CALENDAR DAYS. CONSTRUCTION IS ANTICIPATED TO BEGIN IN LATE SEPTEMBER 2025.
   1.1. PHASE 1 DURATION: 240 CALENDAR DAYS
   1.2. PHASE 2A DURATION: 67 CALENDAR DAYS
   1.3. PHASE 2B DURATION: 28 CALENDAR DAYS
2. ALL PHASES OF CONSTRUCTION MAY OCCUR CONCURRENTLY.
3. CONTRACTOR SHALL MAINTAIN ACCESS TO THE VEHICLE SERVICE ROAD (VSR) FOR EMERGENCY AND AIRPORT VEHICLES AT ALL TIMES.
4. THE FENCE LEADING TO THE AIRPORT OPERATIONS AREA (AOA) SHALL BE CLOSED AND LOCKED FOR THE DURATION OF ONGOING WORK IN THE VAULT. NO UNAUTHORIZED ACCESS IS PERMITTED DURING THIS TIME.

GENERAL SAFETY AND PHASING NOTES

1. THE CONTRACTOR SHALL SUBMIT TO THE OWNER AND RPR A SAFETY PLAN COMPLIANCE DOCUMENT (SPCD) FOR APPROVAL. THE SPCD SHALL BE PREPARED IN ACCORDANCE WITH THE FAA APPROVED CONSTRUCTION SAFETY AND PHASING PLAN (CSPP) INCLUDED IN THE CONTRACT SPECIFICATIONS. THE SPCD SHALL INCLUDE A WRITTEN METHOD OF OPERATIONS THAT DETAIL THE PRECAUTIONS PROPOSED FOR THE CONTROL OF VEHICLE TRAFFIC INCLUDING SIGNS, ESCORTS AND ANY OTHER MEASURES PROPOSED. THE CONTRACTOR SHALL FOLLOW THE APPROVED PLAN EXPLICITLY AFTER APPROVAL. THE OWNER MAY CLOSE THE WORK AT ANY TIME THE APPROVED PLAN IS VIOLATED SO AS NOT TO ENDANGER THE AIRPORT OR AIRCRAFT OPERATIONS. SUCH A CLOSURE SHALL NOT BE CONSIDERED A VALID REASON FOR EXTENDING THE CONTRACT TIME OR ANY CLAIM FOR EXTRAS BY THE CONTRACTOR. REFER TO ADVISORY CIRCULAR A/C NO. 150/5370-2G "OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION" FOR AIRFIELD CONSTRUCTION SAFETY REQUIREMENTS.
2. THE CONTRACTOR SHALL COMPLY WITH ALL AIRPORT SECURITY REQUIREMENTS AS DIRECTED BY AIRPORT OPERATIONS AND IN THE SPECIFICATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY NECESSARY PROVISIONS TO ACCESS THE WORK AREA AND FOR PROVIDING GATE SECURITY AT ALL TIMES. GATE SECURITY SHALL BE PROVIDED BY AN AIRPORT APPROVED SECURITY GUARD AND/OR SECURITY SERVICE COMPANY. REFER TO ALLOWANCE PAY ITEM. THIS APPROVED SECURITY GATE GUARD MUST PROPERLY IDENTIFY, REGULATE, AND DIRECT ALL CONSTRUCTION VEHICLES ENTERING THE SECURITY IDENTIFICATION DISPLAY AREA (SIDA) OF THE AIRPORT. ALL VEHICLES MUST BE INSPECTED PRIOR TO ENTERING THE SIDA. FULL-TIME COMPETENT AND RESPONSIBLE EMPLOYEES OF THE CONTRACTOR, SUCH AS SUPERINTENDENTS AND FOREMEN, SHALL OBTAIN AN AIRPORT SIDA BADGE. TEMPORARY CONSTRUCTION BADGES WILL BE ISSUED ON A DAILY BASIS TO INDIVIDUALS THAT DO NOT HAVE AN AIRPORT SECURITY BADGE. INDIVIDUALS ENTERING THE SIDA MUST BE IN A VEHICLE. WALKING THROUGH A VEHICLE GATE IS NOT PERMITTED. UNAUTHORIZED ITEMS SHALL NOT ENTER THE CONSTRUCTION SITE PER TSA SECURITY REQUIREMENTS.
3. PARKING OF PERSONAL VEHICLES (POV) AT THE WORK SITE WILL NOT BE PERMITTED. LOCATION FOR THE PARKING OF VEHICLES SHALL BE AS DESIGNATED ON THESE DRAWINGS. THE CONTRACTOR SHALL PROVIDE ADEQUATE AND SAFE TRANSPORTATION FROM THE AREA WHERE PERSONAL VEHICLES ARE PARKED AND THE WORK SITE. EMPLOYEES AND DRIVERS OF WORK VEHICLES WILL BE INSTRUCTED AS TO THE PROPER ACCESS ROADS. IN NO CASE WILL VEHICLES OR EQUIPMENT OPERATE ON PAVEMENT INTENDED FOR AIRCRAFT USE UNLESS APPROVED BY AIRPORT OPERATIONS. THE CONTRACTOR SHALL INSTRUCT MATERIAL SUPPLIERS, SUB-CONTRACTORS AND ALL PERSONS UNDER THEIR CONTROL AS TO THE PROCEDURES TO BE FOLLOWED WHEN DELIVERING MATERIALS AND/OR OPERATING ON THE AIRFIELD.
4. THE CONTRACTOR'S PERSONNEL AND VEHICLES WILL NOT HAVE ACCESS TO THE ENTIRE AIRPORT, BUT SHALL BE LIMITED TO THE SPECIFIED WORK AND STAGING AREAS. ALL SECURITY ARRANGEMENTS SHALL BE SUBJECT TO THE APPROVAL OF THE AIRPORT. CONTRACTOR VEHICLES MUST BE READILY IDENTIFIABLE WITH COMPANY NAME AND LOGO ON BOTH SIDES OF VEHICLE. ALL CONTRACTOR'S MOTORIZED VEHICLES OPERATING IN THE AOA SHALL BE EQUIPPED WITH AN AMBER FLASHING LIGHT AND A THREE FOOT SQUARE FLAG CONSISTING OF INTERNATIONAL ORANGE AND WHITE SQUARES (SEE DETAIL ON THE SAFETY DETAILS DRAWINGS) DISPLAYED IN FULL VIEW ABOVE THE VEHICLE.
5. CONTRACTOR SHALL COORDINATE WITH AIRPORT OPERATIONS TO ENSURE ARFF VEHICLES HAVE A ROUTE TO CROSS THE ACTIVE CONSTRUCTION AREA IF NEEDED. THE CONTRACTOR SHALL YIELD TO ALL VEHICLES ON THE VSR.

HORIZONTAL SCALE
1" = 100'
100 0 50 100 200


ORION ENGINEERS & ASSOCIATES
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SCALE: 1" = 100'
DATE: MARCH 2025
DESIGNED BY: DD
DRAWN BY: SR
CHECKED BY: AV
APPROVED: JPP

MANCHESTER • BOSTON REGIONAL AIRPORT
AIRFIELD LIGHTING VAULT EXPANSION

# SAFETY & PHASING PLAN OVERVIEW

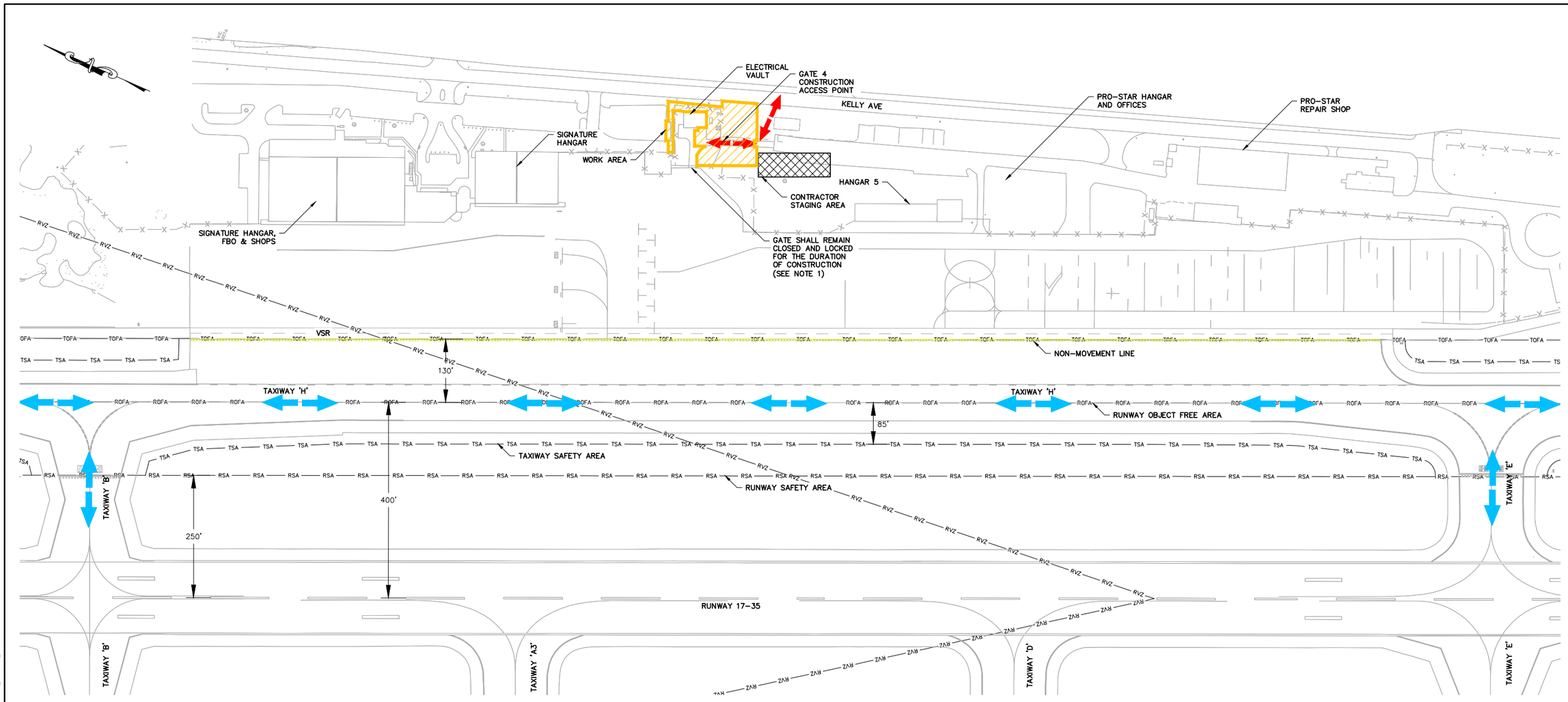
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JE FILE: E2X97905

DRAWING NO.
G-200
SHEET 4 OF 75
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ISSUED FOR BIDDING - NOT FOR CONSTRUCTION


Jacobs - C:\Users\Ddabu\Orion Engineers & Associates\Jacobs MHT On-Call Engineering - Documents\01_Vault Upgrades\03_Engl\02_Dwgs\02 - Safety and Phasing Plans- G200.dwg [G2.0] March 03, 2025 - 2:48pm [Ddabu]




## SAFETY & PHASING PLAN (PHASE 1)

SCALE: 1"=100'

LEGEND

- PHASE 1 WORK AREA
- PHASE 2 WORK AREA
- STAGING AREA
- HAUL ROUTE
- CONSTRUCTION BARRICADES (G-204.1)
- "NO ENTRY" SIGN (G-204.2)
- CONSTRUCTION SIGN (G-204.3)
- TAXIWAY CLOSURE MARKER (G-204.4)
- SNOW FENCE (G204.5)
- TRAFFIC CONES (G204.7)
- AIRCRAFT TAXI ROUTE
- NON-MOVEMENT LINE
- RSA — RUNWAY SAFETY AREA
- ROFA — RUNWAY OBJECT FREE AREA
- TSA — TAXIWAY SAFETY AREA
- TOFA — TAXIWAY OBJECT FREE AREA
- GS — GLIDE SLOPE CRITICAL AREA
- RVZ — RUNWAY VISIBILITY ZONE

### PHASE 1 NOTES

1. THE FENCE LEADING TO THE AIRPORT OPERATIONS AREA SHALL BE CLOSED AND LOCKED FOR THE DURATION OF ONGOING WORK IN THE VAULT. NO UNAUTHORIZED ACCESS IS PERMITTED DURING THIS TIME.
2. THE OVERALL DURATION OF PHASE 1 SHALL BE 240 CALENDAR DAYS.
3. ALL PHASES OF CONSTRUCTION MAY OCCUR CONCURRENTLY.
4. CONSTRUCTION IS ANTICIPATED TO BEGIN IN LATE SEPTEMBER 2025.

### GENERAL SAFETY AND PHASING NOTES

1. THE CONTRACTOR SHALL SUBMIT TO THE OWNER AND RPR A SAFETY PLAN COMPLIANCE DOCUMENT (SPCD) FOR APPROVAL. THE SPCD SHALL BE PREPARED IN ACCORDANCE WITH THE FAA APPROVED CONSTRUCTION SAFETY AND PHASING PLAN (CSPP) INCLUDED IN THE CONTRACT SPECIFICATIONS. THE SPCD SHALL INCLUDE A WRITTEN METHOD OF OPERATIONS THAT DETAIL THE PRECAUTIONS PROPOSED FOR THE CONTROL OF VEHICLE TRAFFIC INCLUDING SIGNS, ESCORTS AND ANY OTHER MEASURES PROPOSED. THE CONTRACTOR SHALL FOLLOW THE APPROVED PLAN EXPLICITLY AFTER APPROVAL. THE OWNER MAY CLOSE THE WORK AT ANY TIME THE APPROVED PLAN IS VIOLATED SO AS NOT TO ENDANGER THE AIRPORT OR AIRCRAFT OPERATIONS. SUCH A CLOSURE SHALL NOT BE CONSIDERED A VALID REASON FOR EXTENDING THE CONTRACT TIME OR ANY CLAIM FOR EXTRAS BY THE CONTRACTOR. REFER TO ADVISORY CIRCULAR A/C NO. 150/5370-2G "OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION" FOR AIRFIELD CONSTRUCTION SAFETY REQUIREMENTS.
2. THE CONTRACTOR SHALL COMPLY WITH ALL AIRPORT SECURITY REQUIREMENTS AS DIRECTED BY AIRPORT OPERATIONS AND IN THE SPECIFICATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY NECESSARY PROVISIONS TO ACCESS THE WORK AREA AND FOR PROVIDING GATE SECURITY AT ALL TIMES. GATE SECURITY SHALL BE PROVIDED BY AN AIRPORT APPROVED SECURITY GUARD AND/OR SECURITY SERVICE COMPANY. REFER TO ALLOWANCE PAY ITEM. THIS APPROVED SECURITY GATE GUARD MUST PROPERLY IDENTIFY, REGULATE, AND DIRECT ALL CONSTRUCTION VEHICLES ENTERING THE SECURITY IDENTIFICATION DISPLAY AREA (SIDA) OF THE AIRPORT. ALL VEHICLES MUST BE INSPECTED PRIOR TO ENTERING THE SIDA. FULL-TIME COMPETENT AND RESPONSIBLE EMPLOYEES OF THE CONTRACTOR, SUCH AS SUPERINTENDENTS AND FOREMEN, SHALL OBTAIN AN AIRPORT SIDA BADGE. TEMPORARY CONSTRUCTION BADGES WILL BE ISSUED ON A DAILY BASIS TO INDIVIDUALS THAT DO NOT HAVE AN AIRPORT SECURITY BADGE. INDIVIDUALS ENTERING THE SIDA MUST BE IN A VEHICLE. WALKING THROUGH A VEHICLE GATE IS NOT PERMITTED. UNAUTHORIZED ITEMS SHALL NOT ENTER THE CONSTRUCTION SITE PER TSA SECURITY REQUIREMENTS.
3. PARKING OF PERSONAL VEHICLES (POV) AT THE WORK SITE WILL NOT BE PERMITTED. LOCATION FOR THE PARKING OF VEHICLES SHALL BE AS DESIGNATED ON THESE DRAWINGS. THE CONTRACTOR SHALL PROVIDE ADEQUATE AND SAFE TRANSPORTATION FROM THE AREA WHERE PERSONAL VEHICLES ARE PARKED AND THE WORK SITE. EMPLOYEES AND DRIVERS OF WORK VEHICLES WILL BE INSTRUCTED AS TO THE PROPER ACCESS ROADS. IN NO CASE WILL VEHICLES OR EQUIPMENT OPERATE ON PAVEMENT INTENDED FOR AIRCRAFT USE UNLESS APPROVED BY AIRPORT OPERATIONS. THE CONTRACTOR SHALL INSTRUCT MATERIAL SUPPLIERS, SUB-CONTRACTORS AND ALL PERSONS UNDER THEIR CONTROL AS TO THE PROCEDURES TO BE FOLLOWED WHEN DELIVERING MATERIALS AND/OR OPERATING ON THE AIRFIELD.
4. THE CONTRACTOR'S PERSONNEL AND VEHICLES WILL NOT HAVE ACCESS TO THE ENTIRE AIRPORT, BUT SHALL BE LIMITED TO THE SPECIFIED WORK AND STAGING AREAS. ALL SECURITY ARRANGEMENTS SHALL BE SUBJECT TO THE APPROVAL OF THE AIRPORT. CONTRACTOR VEHICLES MUST BE READILY IDENTIFIABLE WITH COMPANY NAME AND LOGO ON BOTH SIDES OF VEHICLE. ALL CONTRACTOR'S MOTORIZED VEHICLES OPERATING IN THE AOA SHALL BE EQUIPPED WITH AN AMBER FLASHING LIGHT AND A THREE FOOT SQUARE FLAG CONSISTING OF INTERNATIONAL ORANGE AND WHITE SQUARES (SEE DETAIL ON THE SAFETY DETAILS DRAWINGS) DISPLAYED IN FULL VIEW ABOVE THE VEHICLE.

HORIZONTAL SCALE
1" = 100'
100 0 50 100 200

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MANCHESTER • BOSTON REGIONAL AIRPORT
AIRFIELD LIGHTING VAULT EXPANSION

# SAFETY & PHASING PLAN PHASE 1

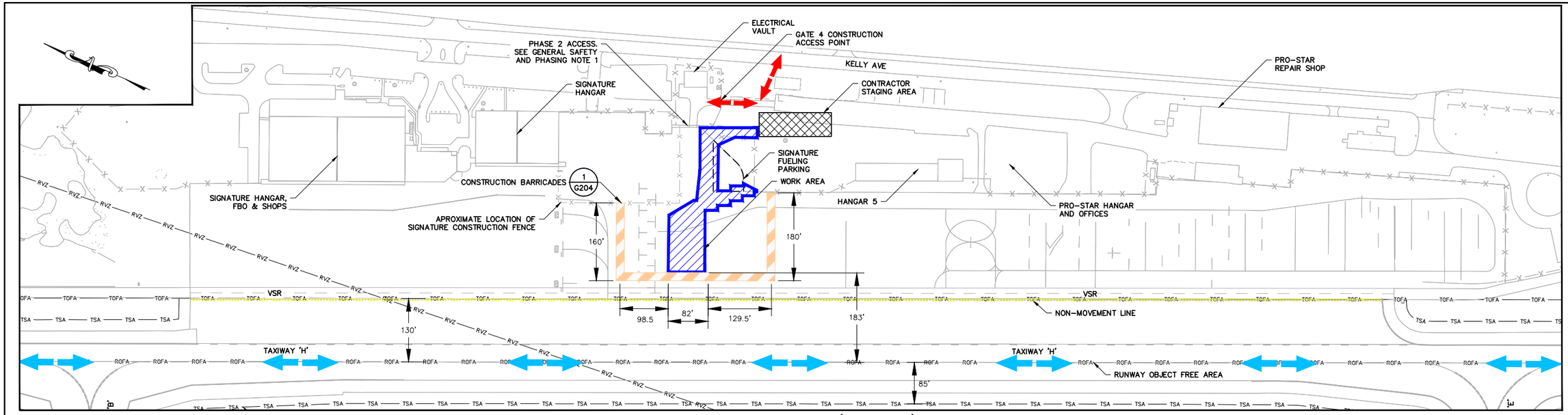
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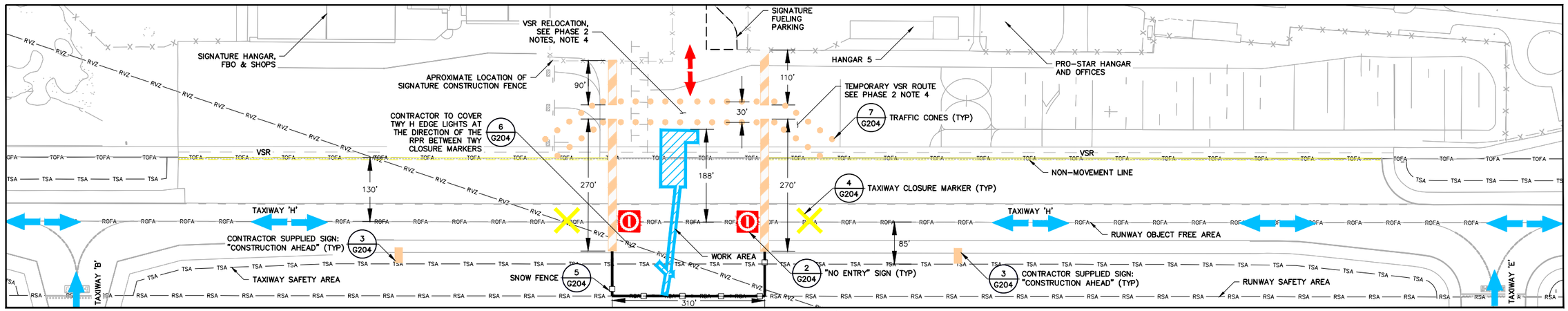
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SAFETY & PHASING PLAN (PHASE 2A)

SCALE: 1"=100'




SAFETY & PHASING PLAN (PHASE 2B)

SCALE: 1"=100'

LEGEND

- PHASE 1 WORK AREA
- PHASE 2A WORK AREA
- PHASE 2B WORK AREA
- STAGING AREA
- HAUL ROUTE
- CONSTRUCTION BARRICADES (G-204.1)
- "NO ENTRY" SIGN (G-204.2)
- CONSTRUCTION SIGN (G-204.3)
- TAXIWAY CLOSURE MARKER (G-204.4)
- SNOW FENCE (G-204.5)
- TRAFFIC CONES (G-204.7)
- AIRCRAFT TAXI ROUTE
- NON-MOVEMENT LINE
- RSA — RUNWAY SAFETY AREA
- ROFA — RUNWAY OBJECT FREE AREA
- TSA — TAXIWAY SAFETY AREA
- TOFA — TAXIWAY OBJECT FREE AREA
- GS — GLIDE SLOPE CRITICAL AREA
- RVZ — RUNWAY VISIBILITY ZONE

PHASE 2 NOTES

1. THE OVERALL DURATION OF PHASE 2 IS 67 CALENDAR DAYS. CONSTRUCTION IS ANTICIPATED TO BEGIN IN LATE SEPTEMBER 2025.
   1.1. THE DURATION OF PHASE 2A IS 67 CALENDAR DAYS.
   1.2. THE DURATION OF PHASE 2B IS 28 CALENDAR DAYS.
2. ALL PHASES OF CONSTRUCTION MAY OCCUR CONCURRENTLY.
3. TAXIWAY 'H' SHALL BE CLOSED FOR THE DURATION OF PHASE 2B FROM 1,100' SOUTH OF TAXIWAY 'B' TO 1,500' NORTH OF TAXIWAY 'E'.
4. VEHICLE SERVICE ROAD (VSR) ACCESS FOR AIRPORT MAINTENANCE AND EMERGENCY VEHICLES SHALL BE MAINTAINED AT ALL TIMES. CONTRACTOR SHALL SEQUENCE PHASE 2A SUCH THAT VSR RELOCATION SHOWN IN PHASE 2B IS OPERATIONAL BY ADDING TEMPORARY STEEL PLATES OR AGGREGATE BASE.
5. SEE SHEET G-204 FOR SEQUENCING PLAN FOR SWITCHOVER TO NEW HOMERUN.

GENERAL SAFETY AND PHASING NOTES

1. THE CONTRACTOR SHALL SUBMIT TO THE OWNER AND RPR A SAFETY PLAN COMPLIANCE DOCUMENT (SPCD) FOR APPROVAL. THE SPCD SHALL BE PREPARED IN ACCORDANCE WITH THE FAA APPROVED CONSTRUCTION SAFETY AND PHASING PLAN (CSPP) INCLUDED IN THE CONTRACT SPECIFICATIONS. THE SPCD SHALL INCLUDE A WRITTEN METHOD OF OPERATIONS THAT DETAIL THE PRECAUTIONS PROPOSED FOR THE CONTROL OF VEHICLE TRAFFIC INCLUDING SIGNS, ESCORTS AND ANY OTHER MEASURES PROPOSED. THE CONTRACTOR SHALL FOLLOW THE APPROVED PLAN EXPLICITLY AFTER APPROVAL. THE OWNER MAY CLOSE THE WORK AT ANY TIME THE APPROVED PLAN IS VIOLATED SO AS NOT TO ENDANGER THE AIRPORT OR AIRCRAFT OPERATIONS. SUCH A CLOSURE SHALL NOT BE CONSIDERED A VALID REASON FOR EXTENDING THE CONTRACT TIME OR ANY CLAIM FOR EXTRAS BY THE CONTRACTOR. REFER TO ADVISORY CIRCULAR A/C NO. 150/5370-2G "OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION" FOR AIRFIELD CONSTRUCTION SAFETY REQUIREMENTS.
2. THE CONTRACTOR SHALL COMPLY WITH ALL AIRPORT SECURITY REQUIREMENTS AS DIRECTED BY AIRPORT OPERATIONS AND IN THE SPECIFICATIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY NECESSARY PROVISIONS TO ACCESS THE WORK AREA AND FOR PROVIDING GATE SECURITY AT ALL TIMES. GATE SECURITY SHALL BE PROVIDED BY AN AIRPORT APPROVED SECURITY GUARD AND/OR SECURITY SERVICE COMPANY. REFER TO ALLOWANCE PAY ITEM. THIS APPROVED SECURITY GATE GUARD MUST PROPERLY IDENTIFY, REGULATE, AND DIRECT ALL CONSTRUCTION VEHICLES ENTERING THE SECURITY IDENTIFICATION DISPLAY AREA (SIDA) OF THE AIRPORT. ALL VEHICLES MUST BE INSPECTED PRIOR TO ENTERING THE SIDA. FULL-TIME COMPETENT AND RESPONSIBLE EMPLOYEES OF THE CONTRACTOR, SUCH AS SUPERINTENDENTS AND FOREMEN, SHALL OBTAIN AN AIRPORT SIDA BADGE. TEMPORARY CONSTRUCTION BADGES WILL BE ISSUED ON A DAILY BASIS TO INDIVIDUALS THAT DO NOT HAVE AN AIRPORT SECURITY BADGE. INDIVIDUALS ENTERING THE SIDA MUST BE IN A VEHICLE. WALKING THROUGH A VEHICLE GATE IS NOT PERMITTED. UNAUTHORIZED ITEMS SHALL NOT ENTER THE CONSTRUCTION SITE PER TSA SECURITY REQUIREMENTS.
3. PARKING OF PERSONAL VEHICLES (POV) AT THE WORK SITE WILL NOT BE PERMITTED. LOCATION FOR THE PARKING OF VEHICLES SHALL BE AS DESIGNATED ON THESE DRAWINGS. THE CONTRACTOR SHALL PROVIDE ADEQUATE AND SAFE TRANSPORTATION FROM THE AREA WHERE PERSONAL VEHICLES ARE PARKED AND THE WORK SITE. EMPLOYEES AND DRIVERS OF WORK VEHICLES WILL BE INSTRUCTED AS TO THE PROPER ACCESS ROADS. IN NO CASE WILL VEHICLES OR EQUIPMENT OPERATE ON PAVEMENT INTENDED FOR AIRCRAFT USE UNLESS APPROVED BY AIRPORT OPERATIONS. THE CONTRACTOR SHALL INSTRUCT MATERIAL SUPPLIERS, SUB-CONTRACTORS AND ALL PERSONS UNDER THEIR CONTROL AS TO THE PROCEDURES TO BE FOLLOWED WHEN DELIVERING MATERIALS AND/OR OPERATING ON THE AIRFIELD.
4. THE CONTRACTOR'S PERSONNEL AND VEHICLES WILL NOT HAVE ACCESS TO THE ENTIRE AIRPORT, BUT SHALL BE LIMITED TO THE SPECIFIED WORK AND STAGING AREAS. ALL SECURITY ARRANGEMENTS SHALL BE SUBJECT TO THE APPROVAL OF THE AIRPORT. CONTRACTOR VEHICLES MUST BE READILY IDENTIFIABLE WITH COMPANY NAME AND LOGO ON BOTH SIDES OF VEHICLE. ALL CONTRACTOR'S MOTORIZED VEHICLES OPERATING IN THE AOA SHALL BE EQUIPPED WITH AN AMBER FLASHING LIGHT AND A THREE FOOT SQUARE FLAG CONSISTING OF INTERNATIONAL ORANGE AND WHITE SQUARES (SEE DETAIL ON THE SAFETY DETAILS DRAWINGS) DISPLAYED IN FULL VIEW ABOVE THE VEHICLE.
5. CONTRACTOR SHALL COORDINATE WITH AIRPORT OPERATIONS TO ENSURE ARFF VEHICLES HAVE A ROUTE TO CROSS THE ACTIVE CONSTRUCTION AREA IF NEEDED. THE CONTRACTOR SHALL YIELD TO ALL VEHICLES ON THE VSR.
6. ALL TAXIWAY LIGHTS WITHIN THE WORK AREA WILL BE DISABLED FOR THE DURATION OF THE PHASE. THIS WILL BE ACHIEVED BY JUMPING OUT A SECTION OF THE CIRCUIT AND/OR COVERING LIGHTS. REMAINING LIGHTS OUTSIDE THE WORK AREA MUST REMAIN OPERATIONAL AT ALL TIMES.

RUNWAY SAFETY AREA (RSA), RUNWAY OBJECT FREE AREA (ROFA), AND TAXIWAY OBJECT FREE AREA (TOFA) NOTES

1. THE RUNWAY SAFETY AREA (RSA) AND RUNWAY OBJECT FREE AREA (ROFA) ARE DEFINED SURFACES SURROUNDING THE RUNWAY. THE RSA WIDTH IS 500 FEET AND THE ROFA WIDTH IS 800 FEET, CENTERED ON THE RUNWAY CENTERLINE. THE RSA EXTENDS BEYOND THE END OF THE RUNWAY. WORK WITHIN THE RSA SHALL BE COMPLETED WHEN THE RUNWAY IS CLOSED. CONSTRUCTION EQUIPMENT SHALL BE REMOVED FROM THE ROFA WHEN NOT IN USE. STOCKPILING MATERIAL IN THE ROFA IS NOT PERMITTED.
2. THE TAXIWAY OBJECT FREE AREA (TOFA) IS A DEFINED SURFACE SURROUNDING THE TAXIWAY. THE TOFA WIDTH IS 259 FEET, CENTERED ON THE TAXIWAY CENTERLINE. WORK WITHIN THE TOFA SHALL BE COMPLETED WHEN THE TAXIWAY IS CLOSED.
3. THE CONTRACTOR SHALL COORDINATE WITH AIRPORT PERSONNEL AT THE START OF EACH WORKDAY FOR WORK TAKING PLACE WITHIN THE RUNWAY VISIBILITY ZONE (RVZ). AUTHORIZATION MUST BE GRANTED, ON A DAILY BASIS, BY THE AIR TRAFFIC CONTROL TOWER (ATCT) TO PROCEED WITH WORK WITHIN THE RVZ, SUBJECT TO WEATHER LIMITATIONS.
4. PRIOR TO ANY AIRPORT MOVEMENT AREA RE-OPENING TO AIRCRAFT, THE ROFA AND TOFA SHALL BE:
   4.1. CLEARED AND GRADED AND HAVE NO RUTS, HUMPS, DEPRESSIONS, OR OTHER SURFACE VARIATIONS.
   4.2. DRAINED BY GRADING OR OTHER TEMPORARY MEASURES TO PREVENT WATER ACCUMULATION.
   4.3. CAPABLE, UNDER DRY CONDITIONS, OF SUPPORTING AIRCRAFT RESCUE AND FIRE FIGHTING (ARFF) EQUIPMENT, AND THE OCCASIONAL PASSAGE OF AN AIRCRAFT WITHOUT CAUSING STRUCTURAL DAMAGE TO THE AIRCRAFT.
   4.4. FREE OF OBJECTS, EXCEPT FOR OBJECTS THAT NEED TO BE IN THE TOFA DUE TO THEIR FUNCTION. IN NO CASE SHALL ANY OBJECTS EXCEED 3 INCHES ABOVE GRADE.
   4.5. ANY STRUCTURES AND/OR DROP-OFFS IN EXCESS OF 3" SHALL BE RAMPED PRIOR TO THE END OF EACH WORK SHIFT. TEMPORARY RAMPING SHALL BE GRADED TO A MAXIMUM OF -3%.

HORIZONTAL SCALE
1" = 100'
100 0 50 100 200

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AIRFIELD LIGHTING VAULT EXPANSION

SAFETY & PHASING PLAN PHASE 2

REVISIONS

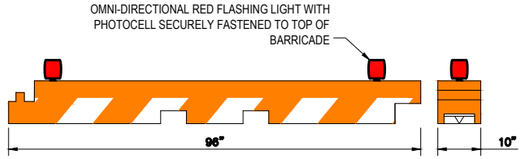
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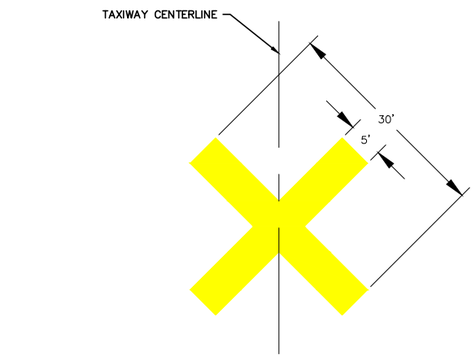
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NOTES:

1. MHT OPERATIONS SHALL HAVE FINAL DETERMINATION FOR THE PLACEMENT OF EACH TYPE OF BARRICADE.
2. WATER BALLASTED BARRICADES SHALL BE PLACED AND CONNECTED END TO END TO CREATE A CONTINUOUS BARRICADE UNLESS NOTED OR SPECIFIED BY THE RPR OR MPA OPERATIONS.
3. ALL BARRICADES SHALL MEET THE EXISTING FAA REQUIREMENTS OF FAA ADVISORY CIRCULAR 150/5370-2 (CURRENT EDITION).
4. BARRICADES SHALL BE ADEQUATELY WEIGHTED DOWN TO WITHSTAND HIGH WINDS AND/OR JET BLAST.
5. THE BARRICADES SHALL BE CHECKED DAILY TO ENSURE THEY REMAIN FULL OF WATER.
6. THE CONTRACTOR SHALL CONFIRM THE NUMBER OF BARRICADES NEEDED FOR EACH PHASE WITH WORKING FLASHERS ARE READY AND AVAILABLE PRIOR TO THE START OF THE PHASE. THE CONTRACTOR SHALL REVIEW THE PROPOSED LAYOUT WITH THE RPR.

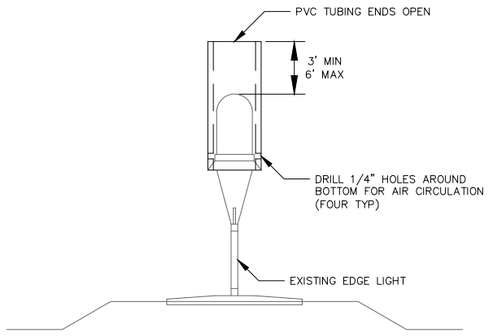
1 / G204 WATER BALLASTED LIGHTED SAFETY BARRICADE
NOT TO SCALE




NOTES:

1. THE CONTRACTOR SHALL INSPECT THE TAXIWAY CLOSURE MARKERS TWO (2) TIMES PER DAY.
2. MATERIAL SHALL BE SECURED AGAINST JET BLASTS AS APPROVED BY THE AIRPORT AND RPR.
3. IF FABRIC IS USED, FABRIC SHALL BE SCREWED TO THE PAVEMENT. AT THE COMPLETION OF THE WORK, THE SCREW HOLES SHALL BE FILLED WITH ASPHALT BASED CAULK.
4. TAXIWAY CLOSURE MARKERS SHALL BE PROVIDED BY THE CONTRACTOR.
5. TAXIWAY CLOSURE MARKERS ARE INCIDENTAL TO THE SAFETY AND PHASING PAYMENT LINE ITEM.

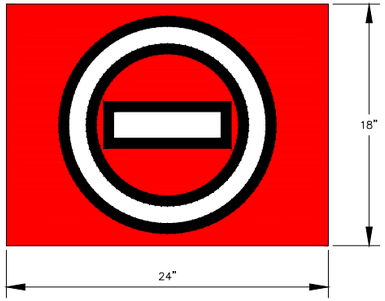
4 / G204 TAXIWAY CLOSURE MARKER
NOT TO SCALE




NOTE:

1. PVC CAN EXTEND TO TOP OF COVER PLATE AT CONTRACTOR'S PREFERENCE

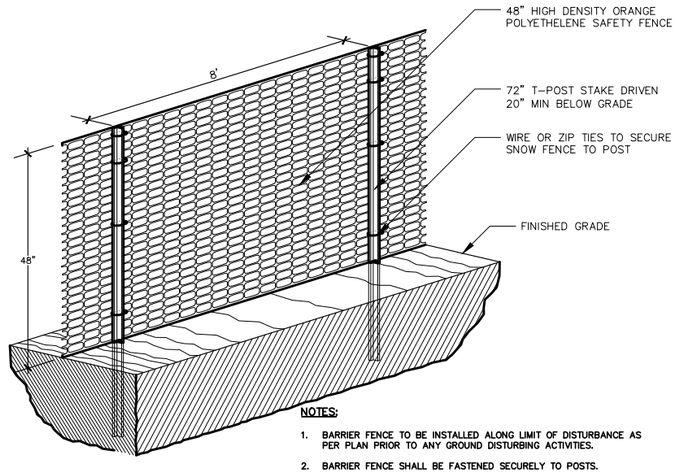
6 / G204 TAXIWAY LIGHT COVER
NOT TO SCALE




NOTE:

1. INSCRIPTION SHALL CONFORM TO AC 150/5345-44L, TABLE B-3, SIZE 1.

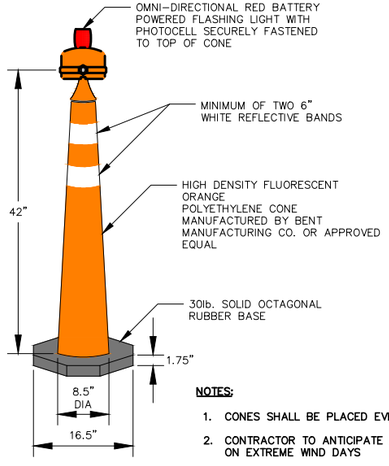
2 / G204 "NO ENTRY" SIGN
NOT TO SCALE




NOTES:

1. BARRIER FENCE TO BE INSTALLED ALONG LIMIT OF DISTURBANCE AS PER PLAN PRIOR TO ANY GROUND DISTURBING ACTIVITIES.
2. BARRIER FENCE SHALL BE FASTENED SECURELY TO POSTS.
3. THE FENCING MUST REMAIN IN PLACE FOR THE DURATION OF EACH PHASE OF WORK; ANY CHANGE OF THE BARRIER FENCING MUST BE APPROVED BY THE RPR.

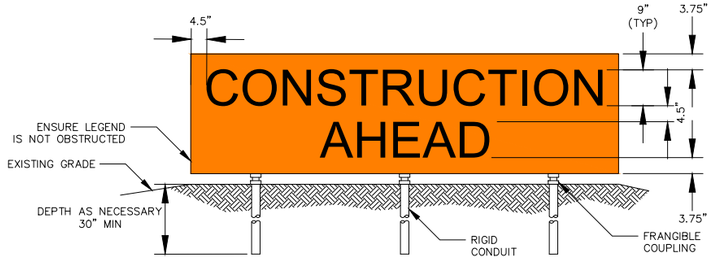
5 / G204 SNOW FENCE
NOT TO SCALE




NOTES:

1. CONES SHALL BE PLACED EVERY 10' O.C.
2. CONTRACTOR TO ANTICIPATE DOUBLING RUBBER BASES ON EXTREME WIND DAYS

7 / G204 LIGHTED CHANNELIZER CONE
NOT TO SCALE




NOTES:

1. SIGN SHALL BE CONSTRUCTED IN ACCORDANCE WITH "ENGINEERING BRIEF #93 – GUIDANCE FOR THE ASSEMBLY AND INSTALLATION OF TEMPORARY ORANGE CONSTRUCTION SIGNS".
2. SIGN PANELS MUST BE CONSTRUCTED OF MATERIALS OF DURABILITY APPROPRIATE FOR THE LENGTH OF TIME THE SIGN IS TO BE USED, MEETING THE REQUIREMENTS OF THE MANUFACTURER OF THE RETROREFLECTIVE SHEETING TO BE USED.
3. LETTERING MUST BE BLACK, APPLIED BY DIRECT APPLIED CHARACTER OR SCREEN PROCESS.
4. BACKGROUND COLOR OF SIGNS MUST BE FLUORESCENT ORANGE, MEETING THE REQUIREMENTS OF ASTM D4956, "SPECIFICATION FOR RETROREFLECTIVE SHEETING FOR TRAFFIC CONTROL", FOR TYPE III OR TYPE IV SHEETING.
5. NO SIGN SHALL BE ANCHORED INTO AIRFIELD PAVEMENT.

3 / G204 "CONSTRUCTION AHEAD" SIGN
NOT TO SCALE

**GENERAL COORDINATION NOTES:**

1. OWNER AND FAA ATCT COORDINATION WILL BE REQUIRED IN ADVANCE OF ANY ALCMS MODIFICATIONS.
2. SWAP FROM EXISTING CONTROL SYSTEM TO PROPOSED WILL OCCUR ONLY DURING DAYTIME HOURS DURING VISUAL FLIGHT RULE (VFR) CONDITIONS.
3. THE EXISTING CONTROL SYSTEM AND REGULATORS WILL NEED TO REMAIN IN PLACE AND AVAILABLE FOR SERVICE FOR 14 DAYS AFTER THE TRANSITION TO THE PROPOSED CONTROL SYSTEM AND REGULATORS ARE FUNCTIONALLY COVERING THE AIRFIELD.
4. THE CONTRACTOR SHALL HAVE STAFF AVAILABLE TO RESPOND TO THE AIRPORT WITHIN 30 MINUTES OF ANY OUTAGE OR FAILURE OF THE ALCMS AND/OR REGULATOR LINEUP 24 HOURS A DAY UPON THE COMMISSIONING OF THE REGULATOR LINEUP FOR FAA ATCT USE FOR THE FIRST FIVE DAYS.
5. THE FOLLOWING STEPS SHALL ONLY BE UNDERTAKEN ONCE THE PROPOSED SWITCHGEAR LINEUPS AND CONTROL SYSTEM HAVE BEEN TESTED ON SITE AND FUNCTIONED APPROPRIATELY:

**STEPS AND COORDINATION FOR THE TRANSFER FROM EXISTING CONTROL SYSTEM TO NEW CONTROL SYSTEM:**

1. CONTRACTOR SHALL COORDINATE WITH THE OWNER AND FAA TO ENSURE THE EXISTING REGULATORS CAN BE TAKEN OFFLINE (NOTAMS FOR ANY REGULARLY "ON" CIRCUITS, E.G. RUNWAY GUARD LIGHTS).
2. THE CONTRACTOR SHALL HAVE STAFF IN THE EXISTING HOMERUN STRUCTURE IN THE TAXIWAY HOTEL INFIELD AND IN THE AIRFIELD LIGHTING VAULT TO SWAP CIRCUIT CONNECTIVITY FROM THE EXISTING HOMERUN CONNECTION TO THE PROPOSED HOMERUN CONNECTIONS.
3. THE CONTRACTOR SHALL SWAP CIRCUITS FOR THE SMALLER REGULATOR LINEUP FROM THEIR EXISTING POWER SUPPLY TO THE PROPOSED REGULATOR LINEUP.
4. CONTRACTOR SHALL TEST THE PROPOSED ALCMS FOR OPERATION OF THE SMALLER REGULATOR LINEUP TO ENSURE PROPER FUNCTIONALITY OF THE SYSTEM AND CIRCUITS.
5. THE CONTRACTOR MAY –ONCE THE SYSTEM OPERATES AS EXPECTED FOR THE SMALLER LINEUP –SWAP THE CABLING FROM THE EXISTING HOMERUN CONNECTIONS TO THE PROPOSED HOMERUN CONNECTIONS.
6. CONTRACTOR SHALL TEST THE PROPOSED ALCMS FOR OPERATION OF THE LARGER REGULATOR LINEUP TO ENSURE PROPER FUNCTIONALITY OF THE SYSTEM AND CIRCUITS.
7. CONTRACTOR SHALL RUN THE PROPOSED REGULATOR LINEUPS AND ALCMS CONTINUOUSLY FOR A PRE-DETERMINED BURN-IN PERIOD AS PRESCRIBED BY THE VENDOR, OR A MINIMUM OF 72 HOURS CONSECUTIVELY IF MORE THAN THE VENDOR'S RECOMMENDATION.

PHASE 2B: SEQUENCING PLAN FOR SWITCHOVER TO NEW HOMERUN


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SCALE: NOT TO SCALE
DATE: MARCH 2025
DESIGNED BY: DD
DRAWN BY: DD
CHECKED BY: AV
APPROVED: JPP

MANCHESTER • BOSTON REGIONAL AIRPORT
AIRFIELD LIGHTING VAULT EXPANSION

# SAFETY & PHASING PLAN DETAILS

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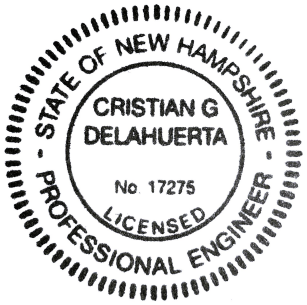
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# 100% Geotechnical Design Report

Revision: 0

Manchester Boston Regional Airport
MHT

Airfield Lighting Vault Expansion Project
March 4, 2025






# 100% Geotechnical Design Report

| | | | |
|---|---|---|---|
| **Client name:** | Manchester Boston Regional Airport | | |
| **Project name:** | Airfield Lighting Vault Expansion Project | | |
| **Client reference:** | MHT | **Project no:** | E2X97905 |
| **Document no:** | | **Project manager:** | Nick Deres |
| **Revision:** | 0 | **Prepared by:** | Xiaogui (Joe) Zhou<br>Glenn Larose, P.E.<br>Cristian Delahuerta, P.E. |
| **Date:** | March 4, 2025 | **File name:** | MHT_Lighting Vault Expansion_100%Geotech. Design Report |

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| Revision | Date | Description | Author | Checked | Reviewed | Approved |
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| 0 | 03/04/2025 | 100% Geotechnical Design Report | XZ/GL | GL | CD | CD |
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# 1. Introduction

## 1.1 Project Summary

The primary objective of Manchester Boston Regional Airport's Lighting Vault Expansion Project (the Project) is to increase the electrical system capacity for future airport expansion.

This report focuses on geotechnical design and construction recommendations associated with the foundations for the new lighting vault expansion building. Project site and existing lighting vault can be found on the Locus Plan in **Figure 1** and shown on the exploration location plan on **Figure 2.**

## 1.2 Scope of Services

The following is a summary description of the Geotechnical Engineering services provided by our firm and presented in this Report:

1. Reviewed available topographical and geological maps, and existing record plans of the existing lighting vault building.
2. Performed a site visit to analyze site characteristics and access constraints that might affect the subsurface exploration program (see item 3 below), such as the presence of overhead and noticeable underground utilities.
3. Developed, procured and oversaw a limited subsurface exploration program consisting of two geotechnical test borings to obtain subsurface soil, bedrock and groundwater information at the Project site.
4. Observed and recorded the subsurface conditions encountered at each boring location, managed the soil and bedrock samples, tracked quantities, and prepared boring logs for each exploration.
5. Developed, commissioned and administered a laboratory testing program on selected samples of soil collected from each boring location, to characterize distinct soil units and determine their Engineering properties.
6. Developed 30%, 95% and 100% geotechnical design and construction recommendations for the proposed building foundations.

## 1.3 Authorization

Our work was performed in accordance with the terms and conditions of our Sub-consultant Agreement with Manchester Boston Regional Airport dated September 09, 2024, and our Notice to Proceed (NTP) dated September 09, 2024.

## 1.4 Project Datum

All elevations in this report are expressed in feet and are referenced to the North American Vertical Datum of 1988 (NAVD88).

## 1.5 Existing Conditions

The existing lighting vault at the Manchester-Boston Regional Airport (MHT) is a 25-year-old structure located along the airport's eastern boundary at No. 1 Airport Drive, in Manchester, New Hampshire. The structure develops within an approximately 47.0 ft x 32.3 ft footprint area and consists of a single-story above-ground concrete masonry structure with partial footprint, single-level underground space. The basement perimeter walls, and above-ground structure foundations are built on cast-in-place (CIP) concrete, while the roof consists of precast, hollow-core, post tensioned concrete planks. The above-ground walls are comprised of 8-inch CMU blocks as the main structure with 4-inch CMU blocks as the exterior veneer. The building's basement is approximately 825 sf. The first floor is approximately 1,170 sf and consists of a storge room, regulator room and generator room.

The building is situated within a small, chain link fenced yard, with gates on both the southern and western sides providing access. The southern swing gate allows vehicle access from Kelly Avenue, while the western double swing gate connects directly to the interior of MHT. Paved roads lead from both gates to the front of the lighting vault, and the remaining yard area consists of grass. There is a diesel tank adjacent to the light vault and a resistive load bank at the southeast corner of the yard which are founded on a concrete pad. A gas line, drain line and overhead power line run adjacent to the fence along the eastern boundary. A sewer line is located across the yard generally from north to the south. Additionally, underground electrical lines run from a pad-mounted transformer south of the lighting vault, within the fenced area, to an electric meter box located at the southwest corner, outside of the fence.

Existing as-builts for the existing building can be found in **Appendix H.**

## 1.6 Proposed Development

The proposed lighting vault expansion will consist of a single story, masonry, rectangularly shaped addition founded at ground level, added onto the south wall of the existing structure with a layout providing approximately 1,000 sf of new space. No basement is proposed for the new addition. The proposed addition will generally be constructed of the same materials as the existing building which will consist of cast in place concrete spread footings, reinforced concrete slab on grade floor, CMU wall system and precast hollow core concrete plank roof deck. The roof will be insulated to provide a conditioned space to meet the equipment manufacturer's requirements to maintain an acceptable operating environment. The finished floor elevation of the proposed addition will match the finished ground floor elevation of the existing structure at El. 234.

# 2. Subsurface Investigation Program

Subsurface explorations were performed by Geologic Earth Exploration Inc. out of Norfolk, Massachusetts and observed by Jacobs between September 23 and 26, 2024. The intent of the subsurface exploration was to perform field testing and collect soil samples and core samples of bedrock for laboratory testing to evaluate geotechnical properties for use in design. The subsurface explorations included two test borings designated as JB-1(OW) and JB-2. The borings were advanced to 84 feet and to approximately 35 feet of depth, respectively. Boring JB-1(OW) was terminated approximately ten feet into bedrock. Boring JB-2 was terminated in Glacial Till. The boring locations are shown on **Figure 2** in **Appendix A.** Detailed field logs of the test borings are presented in **Appendix B**.

## 2.1 Soil and Rock Core Sampling and Field Testing

***Soil Sampling***

Standard split-spoon soil samples were collected, and Standard Penetration Tests (SPT) were performed using a 2-inch outside diameter, 2-foot-long split-spoon sampler in general accordance with ASTM D1586 at the depth intervals noted on the boring logs. The sampler was advanced using an automatic 140-pound hammer allowed to fall a distance of 30 inches. N-sized drill rods with an outside diameter of 2-5/8 inches were used to drive the split spoons over a sampling length of two feet. The number of blows required to drive the sampler from 6 to 18 inches of penetration was recorded as the SPT N-value. As noted on the field logs, in some instances, typically in very dense soils, decomposed rock, or in the presence of obstructions, the sampler was not advanced completely through the intended 24-inch sample drive due to high resistance from the soil.

Representative soil samples from select sampling intervals were placed in glass jars and labeled with the project name, Jacob's project number, boring designation, sample designation, sample depth interval, blows per six inches of penetration and sampling date. The Jacobs field representative described the soil samples using the Modified Burmister System. A description of the Modified Burmister System is included in **Appendix B**.

***Rock Core Sampling***

Rock core samples were obtained from boring JB-2 using an "NX"-sized double-tube diamond core barrel. Rock classifications provided on the boring logs are in accordance with the modified International Society for Rock Mechanics (ISRM) system. Both the Rock Quality Designation (RQD) and Rock Core Recovery (REC) values were calculated for each rock core run. RQD is defined as the sum of the recovered rock core pieces measuring longer than four inches divided by the total length of core run, expressed in percent. REC is defined as the sum of the recovered rock pieces divided by the total length of core run, expressed in percent.

Rock core photographs are included in **Appendix D**.

## 2.2 Groundwater Observation Wells

A 40-ft deep groundwater observation well was installed in boring JB-1(OW) utilizing 2-3/8-inch PVC riser and slotted riser with a flush-mounted road box at the surface. No. 2, ½-inch and ¼-inch Holliston Sand were used to backfill the borehole and a Bentonite seal was set at a depth from 6 to 8 ft. Refer to the JB-1(OW) monitoring well installation log included in **Appendix B**.

# 3. Laboratory Testing

## 3.1 Soil Testing

Laboratory tests were conducted to confirm visual classification of selected split spoon samples. All laboratory soil classification tests were performed by GeoTesting Express, LLC, of Acton, MA. The tests results are summarized in Table 3.1. Detailed laboratory test reports are presented in **Appendix C.**

**Table 3.1: Laboratory Soil Classification Summary**

| Boring Designation | Sample No. | Sample Depth (ft) | Gravel (%) | Sand (%) | Fines (%) | AASHTO Soil Classification |
|---|---|---|---|---|---|---|
| JB-1(OW) | S-2 | 2-4 | 2.5 | 84.8 | 12.7 | Silty Gravel and Sand A-2-4 (0) |
| JB-1(OW) | S-3 | 4-6 | 4.1 | 83.1 | 12.8 | Silty Gravel and Sand A-2-4 (0) |
| JB-2 | S-5 | 8-10 | 0.0 | 90.7 | 9.3 | Fine Sand A-3 (1) |
| JB-2 | S-8 | 14-16 | 0.0 | 47.9 | 52.1 | Silty Soils A-4 (0) |

## 3.2 Soil Corrosivity Testing

At Jacobs' request corrosivity testing (ASTM D4972, D4327 and G57) were also performed at the GeoTesting Express facilities on selected fill soil obtained from the borings, generally in the upper six feet. The selected soil samples were tested for pH, chlorides, sulfates and electrical resistivity. Laboratory test results indicate non-corrosive conditions, in accordance with AASHTO LRFD Bridge Manual criteria.

Based on the corrosivity test results, we recommend that the steel reinforcement for shallow foundations in permanent direct contact with the soil have a minimum concrete cover of three inches per the International Building Code and ACI318. The laboratory corrosivity test report in its entirety, is included in **Appendix C.**

A summary of the supplemental corrosion testing results is presented in Table 3.2. Detailed laboratory test results are provided in **Appendix C**.

**Table 3.2: Laboratory Soil Corrosivity Summary**

| Boring Designation | Sample ID | Depth (ft) | Resistivity As-Received (ohm-cm) | pH | Chloride (ppm) | Sulfate (ppm) |
|---|---|---|---|---|---|---|
| JB-1(OW) & JB-2 | Composite | 0-6 | 12,578 | 7.62 | 15.0 | 1.0 |

**Notes:**

ND = None Detected

N/A = Not Tested

# 4. Geologic Setting

The MHT Lighting Vault is located at the boundary between Manchester and Londonderry, New Hampshire, within the jurisdiction of Manchester. According to the Rockingham County soil survey map from the United States Department of Agriculture (USDA), the site is characterized by deep soils formed from gray glacial till or glacial outwash.

The United States Geological Survey (USGS) bedrock geology map of New Hampshire places the MHT Lighting Vault within the Massabesic Gneiss Complex, a Late Proterozoic formation. This region includes quartzose-feldspathic gneiss, biotite schists, granofels, and calc-silicate rocks, which are intruded by, and grade into, pink gneissic granite, resulting in the formation of migmatite.

The bedrock obtained from the exploration program indicates that bedrock at the Project site is Gneiss.

# 5. Subsurface Conditions

General subsurface conditions encountered in the explorations, in order of increasing depth, typically consist of the following strata: fill, sand and/or sandy silt, glacial till, weathered bedrock and bedrock. The

soil depths, thicknesses, and elevations referenced herein should be considered approximate as subsurface conditions are known only at the exploration locations. Conditions between explorations may differ significantly from those shown in the subsurface profiles and described below.

Refer to the exploration logs provided in **Appendix B** for detailed subsurface conditions at each exploration locations. A summary of subsurface conditions is provided in Table 5.1.

## 5.1 Soil and Rock

### 5.1.1 Fill

Fill was encountered from the ground surface (or below 6-inches of asphalt, where paved) in both borings and encountered to depths extending to approximately six feet below ground surface (bgs). The nature of the fill varied between the two boring locations and ranged from loose to dense, light brown to dark brown/black, fine to coarse sand with trace to little gravel and little silt. Trace grass and roots were observed at boring JB-1(OW) generally in the first and second SPT sample. SPT N-Values within the fill layer ranged from 6 to 41 blows per foot (bpf) but were generally around 16 bpf.

### 5.1.2 Sand

A sand layer beneath the fill layer was encountered at both borings with thicknesses ranging from 6 to 12 feet. The sand and gravel layer ranged from medium dense to very dense, fine to coarse sand with trace to little gravel and trace to little silt, with a range of SPT N-values from 25 to 59 bpf but were generally around 35 bpf.

### 5.1.3 Sandy Silt

A sandy silt layer was encountered in JB-2 at a depth of 12 feet and a thickness of 4 feet. The sandy silt layer ranged from medium dense to dense, silt with fine to medium sand. SPT N-values ranged from 22 to 35 bpf.

### 5.1.4 Glacial Till

A glacial till layer directly underlying the sand or sandy silt layer was encountered in both borings but was fully penetrated only at JB-1(OW). The thickness of this layer reached up to 52.8 feet at boring JB-1(OW). This layer typically consisted of gray, very dense fine to coarse sand with little to trace gravel and trace silt. Recorded SPT N values were typically over 100 bpf.

### 5.1.5 Boulders

A boulder, approximately one foot thick, was encountered approximately at 26.5 ft of depth at boring JB-2, as indicated by an increase in drilling effort during advancement of the rollerbit in the glacial till stratum.

### 5.1.6 Weathered Bedrock

Weathered bedrock was encountered at boring JB-1(OW) beneath the glacial till as indicated by an increase in drilling effort. The thickness of the weathered bedrock was approximately three feet corresponding to EL.161.2 to El. 158.2.

### 5.1.7 Bedrock

Bedrock was cored at boring JB-1(OW), where the top of bedrock was encountered approximately at EL. 158. The bedrock cores generally consisted of moderately hard, fresh to slightly weathered, extremely to slightly fractured, fine to coarse grained, dark bluish gray, GNEISS. Rock recovery percentage and Rock Quality Designation (RQD) values for each core run are indicated on the boring logs.

## 5.2 Groundwater

Groundwater was measured in the casing during drilling at JB-2 at an elevation 223.7 feet; however, the use of wash boring techniques may have locally altered water levels due to the introduction of water during the drilling process. Jacobs observed a groundwater level after approximately one day in the observation well at JB-1(OW) on September 26, 2024, at elevation 218.7.

Please note that local or periodic fluctuations of groundwater levels should be expected, as levels may be influenced by season, precipitation, construction activity and other factors. Therefore, groundwater elevations presented herein may not be representative of water levels encountered at the time of construction.

**Table 5.1: Summary of Subsurface Conditions**

| Boring Designation | Approx. Ground Surface EL. (ft) | Approx. Fill Thickness (ft) | Approx. Top of Natural Soils EL. (ft) | Approx. Top of Bedrock EL. (ft) | Bottom of Boring EL. (ft) | Approx. Groundwater EL. (ft) |
|---|---|---|---|---|---|---|
| JB-1 (OW) | 231.7 | 6 | 225.7 | 157.7 | 147.7 | 218.7 |
| JB-2 | 232.7 | 6 | 226.7 | NE3 | 197.9 | 223.7 |

**Notes:**
1. Ground surface elevation at boring locations were interpolated from topographic contours and reference NAVD88.
2. See test boring logs in **Appendix B** for additional information.
3. NE = Not Encountered.

# 6. Seismic Characterization and Design Considerations

Our determination of site coefficients ($S_1$ and $S_s$) for use in structural design were determined using the ASCE 7-22 Hazard Tool and are based on guidelines and requirements under ASCE 7-22.

The subsurface profile at the site is representative of Site Class C. This site class is based on SPT N-values obtained from test boring information obtained during our study, and in general accordance with ASCE 7-22 and ASCE 7-16.

For Site Class C, we recommend that the design response spectra for the Project site be developed using the following coefficients:

$$S_{DS} = 0.260 \qquad S_{D1} = 0.059$$

where:

- $S_{DS}$ = design spectral acceleration coefficient at 0.2-sec period.
- $S_{D1}$ = design spectral acceleration coefficient at 1.0-sec period.

In accordance with ASCE 7-22 Table 11.6.2-1 and 11.6.2-2, $0.167 \leq S_{DS} \leq 0.33$ and $S_{D1} < 0.167$ which indicates that the Project site is located within both Seismic Design Category B and A, respectively. ASCE 7-

22 requires that the more conservative design category between $S_{DS}$ and $S_{D1}$ be followed; therefore, we recommend that the Project site be classified as **Seismic Design Category B**.

The complete Seismic Site Class and Seismic Design Category evaluations are presented in **Appendix F.**

# 7. Liquefaction

The liquefaction potential of the site soils was analyzed using the Simplified Procedure outlined by Youd and Idriss (Ref.: *"Liquefaction Resistance of Soils: Summary Report from 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction of Soils"*. ASCE Journal of Geotechnical and Geoenvironmental Engineering; April 2001) and data obtained from the test borings. Our analysis was based on the observed subsurface conditions, observed groundwater conditions, recorded SPT N-values and estimated percentage of fine contents.

A site-modified peak horizontal ground surface acceleration (PGAM) of 0.250 g was used in the analysis based on the assigned Site Class C following the ASCE-7-22 characterization method. Based on our analyses, in our opinion and experience the existing soils underlying the site are not susceptible to liquefaction as the associated safety factors against liquefaction were greater than 2.5.

Our analyses of liquefaction potential are presented in detail in **Appendix F.**

# 8. Geotechnical Recommendations

Our geotechnical design recommendations presented herein are based on the following initial assumptions, as discussed with the Project's Structural Engineer:

1. Except as noted under item 3 below, the structural walls for the proposed addition will be supported on 4-foot-wide continuous footings bearing a minimum of four feet below final exterior grade on compacted granular in situ fill or natural granular soils of adequate engineering properties.
    - Factored Bearing Pressure below footings: 928 pounds per square foot (psf)
2. The interior floor for the proposed addition will be supported on a 12-inch-thick, reinforced concrete slab-on-grade on imported Gravel Borrow over in situ compacted, granular fill soils. Rigid insulation and a vapor barrier will be installed beneath the slab on grade. The northern side of the slab on grade will be partially supported on the existing basement wall and foundation.
3. The southern wall of the existing building directly abutting the proposed addition will be stripped of its 8-inch-thick combined CMU veneer, rigid insulation and mortar net to clear enough space for installation on its basement wall and foundation of the 8-inch CMU northern wall of the proposed addition.
4. The new generator will be located outside of the proposed building footprint and will be founded on a reinforced concrete slab on grade foundation.

## 8.1 Allowable Bearing Pressure

The recommended maximum net allowable bearing pressure is based on the geometry and dimensions of the proposed continuous footings, criteria and recommendations from the 2020 AASHTO LRFD Bridge Design Specifications, International Building Code (IBC) and a review of existing as-builts. We have assumed

that the continuous footings will be founded on compacted, granular in situ fill or dense natural granular soils. We recommend the following maximum allowable bearing pressure for design:

- Compacted in situ granular fill or natural soils: 4,000 pounds per square foot (psf)

We have estimated that the total settlement of new shallow strip foundations under 4,000 psf of uniform pressure will not exceed ½-inch. Accordingly, no significant differential settlement or angular distortion of the new foundations of the proposed addition should occur. However, we understand that unlike the remainder of the walls of the proposed addition, its northern wall will not be built on new shallow strip footings but will be built instead on the basement wall of the abutting existing structure. Therefore, although the magnitude of the settlement of the new foundations of the proposed addition may be relatively small, as noted, it may result in an abrupt differential settlement and sharp angular distortion at the line of contact between the existing building and the proposed addition.

The complete allowable bearing pressure evaluation of the new foundations for the proposed addition is presented in detail in **Appendix G.**

## 8.2 Building Slab on Grade

A reinforced concrete slab-on-grade foundation is proposed for the interior floor of the proposed building addition. A minimum 12-inch-thick base course consisting of compacted Gravel Borrow should be provided below the slab to act as a cushion for the floor slab. A minimum of two inches of rigid insulation and a minimum 10-mil vapor barrier is recommended on top of the Gravel Borrow and below the slab on grade. The recommended base course gradation requirements are presented in Table 8.1 below.

**Table 8.1: Base Course Gradation Requirements (Gravel Borrow)**

| Sieve Size | Percent Finer by Weight |
|---|---|
| 3-inch | 100 |
| ½-inch | 50 – 85 |
| No. 4 | 40 – 75 |
| No. 40 | 10 – 35 |
| No. 200 | 0 – 8 |

The base course material shall consist of durable sand and gravel and shall be free from ice and snow, roots, sod, rubbish and other deleterious or organic matter. Existing onsite granular fill below the base course not containing organics may remain in proposed slab areas provided they prove stable during proof compaction as discussed herein. Subgrade preparation recommendations are provided later in this report.

We recommend the following Subgrade Modulus $K_s$ referenced to a one foot by one foot plate load area for slab on grade design, based on the properties of the existing site soils:

- Subgrade Modulus ($K_s$): 150 pounds per cubic inch (pci)

### 8.2.1 Evaluation of Impacts on Existing Foundation

Jacobs evaluated the impacts of the proposed CMU north wall and portion of the slab on grade founded on the south wall of the existing concrete basement.

A portion of the existing concrete basement wall will be demolished to create a 1.0'-5.0" x 7.0" shelf to support the new CMU wall and a portion of the floor slab of the vault extension. Jacobs structural engineers have calculated a bearing pressure at the bottom of footing of the existing building at approximately 1.2 ksf. The estimated added bearing pressure at the bottom of footing due to the north wall of the proposed addition is 0.928 ksf. Foundation notes No. 3 on drawing VLT-S-001 from the New Airfield Lighting Vault as-built plan set prepared by Edwards and Kelcey, Inc., dated 10/19/2000 indicates that the existing building foundations were designed for a bearing resistance of 4.0 ksf. Based on the Structural Engineer's calculations, the new bearing pressure of approximately 2.2 ksf onto the existing basement wall due to the proposed building wall and slab will not exceed its design bearing resistance of 4.0 ksf. Accordingly, in our opinion the south wall of the existing vault can safely support the added load.

## 8.3 Generator Slab on Grade

A reinforced concrete slab-on-grade foundation is proposed for the new generator. A minimum 12-inch-thick base course consisting of compacted Gravel Borrow should be provided below the slab as shown in Table 8.1. The base course material shall consist of durable sand and gravel and shall be free from ice and snow, roots, sod, rubbish and other deleterious or organic matter. Existing onsite granular fill below the base course not containing organics may remain in proposed slab areas provided they prove stable during proof compaction as discussed herein.

# 9. Construction Considerations

## 9.1 Soil removal and Subgrade Preparation

The existing diesel fuel tank with concrete pad, resistive load bank, electric meter and pad-mounted transformer are presently located at or in the vicinity of the proposed construction. It is our understanding that these structures will be removed, and their foundations demolished by the contractor.

After demolition of existing foundations and prior to performing any required grading operations and excavations in the proposed footing and slab construction areas, these areas should be stripped of topsoil, subsoil, vegetation, stumps, boulders and other man-made obstructions, if present. The topsoil may be placed in a designated area for reuse during final site grading in landscaped areas. Unsuitable soils should be removed within the bearing zone of influence of the proposed slab and foundations, defined by a one horizontal to one vertical (1H:1V) line sloping down and out from one foot outside the bottom exterior edges of the proposed foundations and slab-on-grade, to competent soils.

To reduce disturbance, final subgrade excavations should be made with as few passes of the backhoe bucket as possible. It is recommended that a backhoe bucket fitted with a smooth blade be used during final subgrade excavation and preparation. It is expected that the overburden fill soils can be excavated using conventional earth moving equipment.

The subgrade surfaces should be proof-compacted with a minimum of 10 passes of a heavy, self-propelled vibratory roller capable of delivering a minimum of 20,000 lbs of dynamic force. In confined areas, proof-roll with a minimum of 8 to 10 passes of a heavy vibratory plate compactor or walk-behind vibratory drum roller. Loose or soft zones observed during proof compaction should be over excavated to firm and stable soils and replaced with compacted Gravel Borrow (see Table 8.1 above). Where exposed subgrades are at or near the groundwater level, static proof compaction methods should be used in lieu of vibratory methods, if approved by the Project Geotechnical Engineer. Exposed subgrade soils should be protected from disturbance.

### 9.1.1 Drainage and Frost Protection

Proper drainage of construction areas should be provided to protect the subgrades from the detrimental effects of weather conditions. The exposed subgrade soils should be kept free of standing water at all times. The site should be graded to carry any surface runoff away from the work areas. Construction traffic should be controlled to prevent excessive stresses and disturbance to the subgrade. The Contractor shall sequence the work so that large areas are not excavated to final subgrade and left exposed to the weather (rain, freezing temperatures, etc.) for any time which would cause softening or disturbance to the subgrade.

Based on groundwater level readings observed and recorded during our field explorations program, seepage due to groundwater within the footing excavations is not anticipated. However, the need for placing a 3-inch-thick lean concrete mud mat or a layer of ¾-inch crushed stone to protect the bearing surface should be evaluated in the field. Crushed stone, if used, should be wrapped by non-woven filter fabric, such as Mirafi 160N, or equivalent.

Following observation of the bearing soils by a representative of the Project Geotechnical Engineer, it is recommended that, where possible, footing reinforcing steel and concrete be placed the same day as the footing excavation is made, to avoid significant moisture content changes in the bearing soils.

## 9.2 Fill Placement and Compaction

This section of this report applies to fill required for replacement of soil removed during subgrade preparation, as well as for backfill below the slab-on-grade, generator pad and proposed footings.

Generally, fill should be placed systematically in horizontal lifts not exceeding 8-inches in thickness prior to compaction. Compaction equipment should preferably consist of large, self-propelled vibratory roller capable of generating a minimum 20,000 pounds of dynamic force. In confined areas and within two feet of existing building wall face or as otherwise recommended in this Report, the thickness of loose layers should be reduced to a maximum of 6-inches and be compacted with manually operated, power compactor acceptable to the Project Geotechnical Engineer.

Fill should be placed and compacted to the minimum percent compaction requirements outlined in Table 9.1 below.

**Table 9.1: Fill Compaction Requirements**

| Description | Minimum Percent Compaction (ASTM D-1557) |
|---|---|
| General Site Fills, Fill below Footings and Slabs, fill below Generator Pad | 95 |
| Landscaped Areas | 90 |

**Notes:**

1. Minimum Percent Compaction based on the Modified Proctor Compaction Test (ASTM D-1557).

Crushed stone, where used, should be densified to an unyielding surface.

We do not anticipate that the existing fill at the Project site meets the requirements for reuse as Gravel Borrow. Accordingly, existing soils excavated during construction may only be used as General Fill for grading purposes as may be specified throughout the project site.

## 9.3 Perimeter Foundation Drain

In accordance with the International Building Code and Project requirements, a foundation drain should be placed around the perimeter foundations of the proposed addition. The foundation drain should extend not less than 12-inches beyond the outside edge of the footing. The foundation drain should consist of a minimum 6-inch diameter slotted or perforated pipe placed above the top of footing elevation, surrounded by a minimum of 6-inches of ¾ inch crushed stone wrapped in geotextile (Mirafi 140N or equivalent). The crushed stone should not contain more than 10-percent material that passes through the No. 4 sieve. The drain should be designed to tie into the existing buildings foundation drain system and discharge by gravity to a subsurface drainage feature. Cleanouts should be provided for the foundation drain.

## 9.4 General Site and Excavation Safety

It is anticipated that space and groundwater conditions will permit the use of sloped, open-cut techniques. The contractor should comply with Occupational Safety and Health Administration (OSHA) excavation safety requirements. Care should be taken not to undermine the existing building foundations during construction within their zone of influence.

All Contractors and Subcontractors of all tiers engaged in the work discussed in this report must be fully cognizant of applicable local, state, and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards. Insofar as construction site safety generally is the Contractor's sole responsibility, the Contractor alone is responsible for the means, methods, and sequencing of construction operations. We are providing the information herein in good faith, solely as a service to our client. Under no circumstances should any information or recommendations in this report be interpreted, directly or by implication or inference, to signify that Jacobs Engineering assumes responsibility for construction site safety, or for the safety of the Contractor's operations. In particular, the Contractor should be aware that slope height, slope inclination and the depths of excavations (including utility trench excavations) should in no case exceed the limits specified in local, state, or federal safety regulations, e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. The side slopes or the support systems of any excavation (including utility trenches) deeper than 20 feet, must be designed, and stamped by a Professional Engineer registered in the State of New Hampshire. Likewise, the Contractor is advised to provide protection against the elements for all exposed slopes of open-cut excavations. As an additional safety measure, it is recommended that the Contractor maintain stockpiles of materials and vehicular traffic a minimum distance equal to one excavation depth away from the top edge of open excavations.

# 10. Limitations

This report and the recommendations contained herein have been prepared for the exclusive use of the Jacobs design team, MHT and their representatives for specific application to the proposed Manchester Boston Regional Airport Lighting Vault Expansion Project.

This report was prepared in accordance with generally accepted soil and foundation engineering practices. No warranty, expressed or implied, is made. The analyses, design and recommendations submitted in this Report are based in part upon the data obtained from subsurface explorations available at the time of preparation of this Report. Subsurface stratification variations away from the location of the explorations are anticipated. The reported groundwater conditions reflect short-term observations and only represent the conditions at the time of the explorations and as noted on the exploration logs. The nature and extent of variations away from the explorations may not become evident until construction. If significant variations then appear, or if there are changes in the nature, design, or location of the proposed structure, it may be necessary to reevaluate the recommendations of this report.

We appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions regarding this report.

Very truly yours,

**Jacobs Engineering Group**



**Xiaogui Zhou**

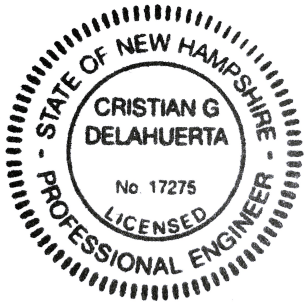
Staff Geotechnical Engineer



**Glenn G. Larose, PE**

Geotechnical Engineer

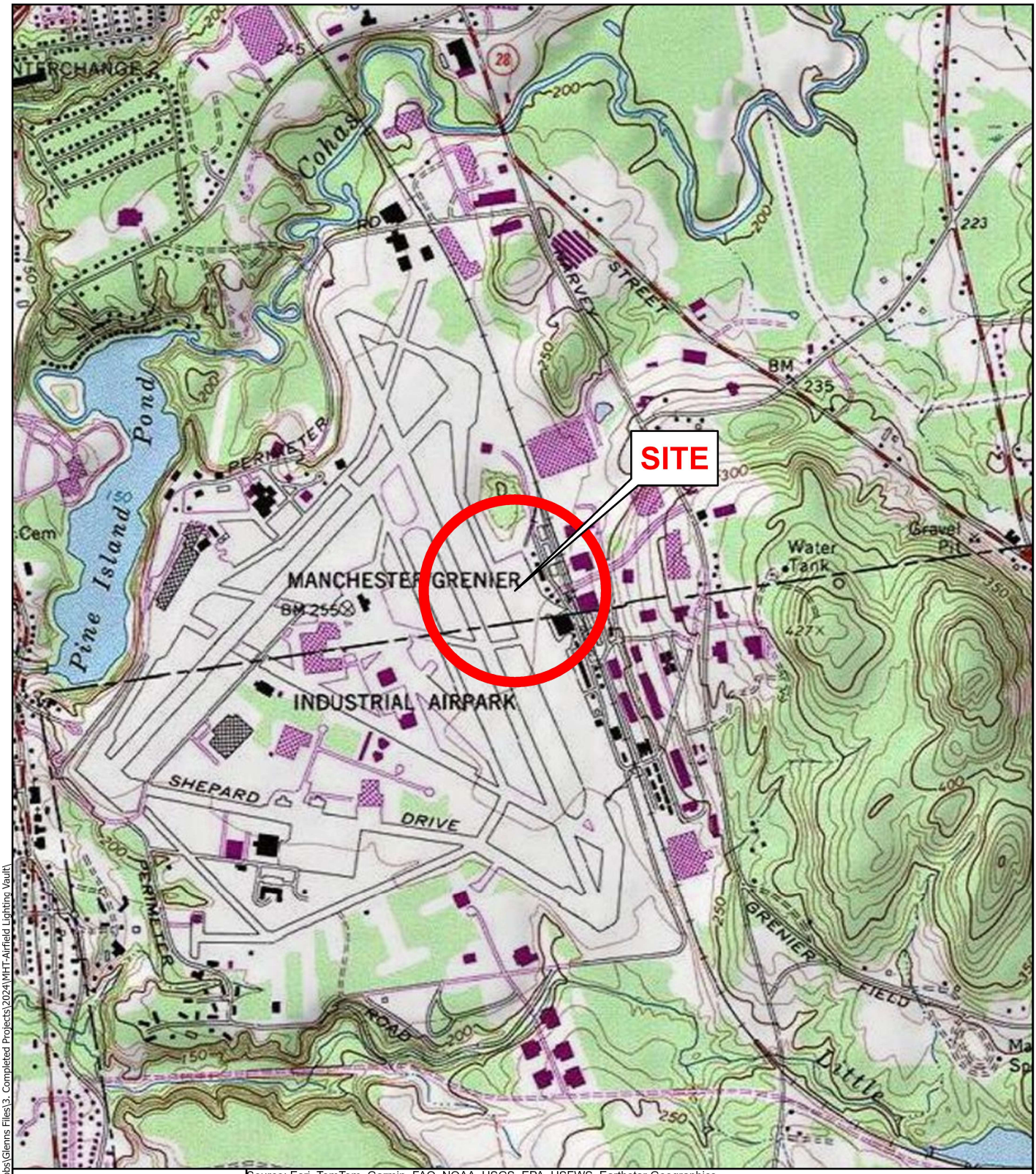





**Cristian G. Delahuerta, PE**

Senior Geotechnical Engineer/Reviewer

# Appendix A. Figures




Source: Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS, Earthstar Geographics, Copyright:© 2013 National Geographic Society, i-cubed

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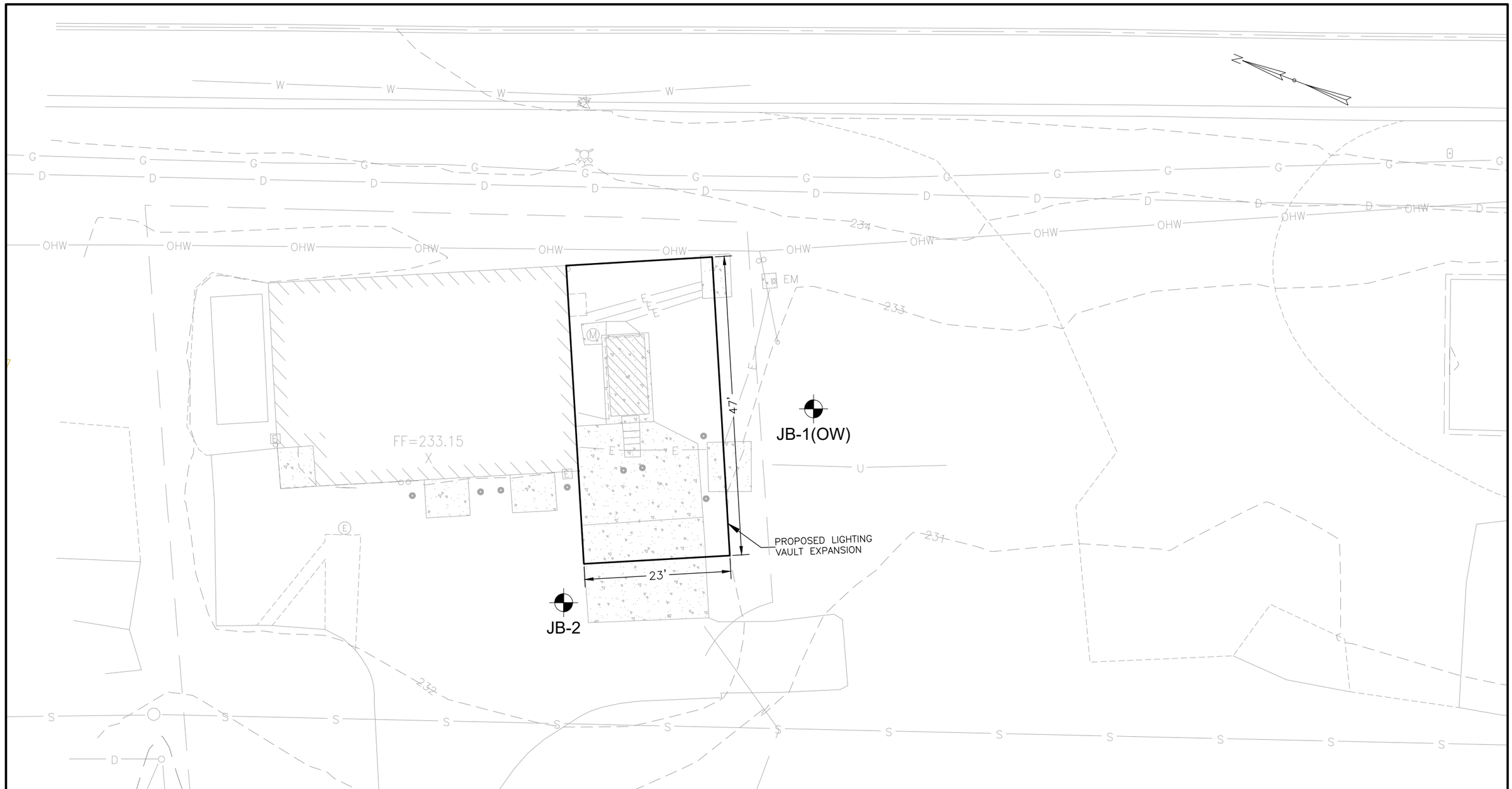
Jacobs

MANCHESTER - BOSTON REGIONAL AIRPORT
AIRFIELD LIGHTING VAULT PROJECT
MANCHESTER, NEW HAMPSHIRE

PROJECT NO.
E2X97905

FIGURE NO.
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NOTES:

1. THE BASE MAP WAS DEVELOPED FROM PLANS AND ELECTRONIC FILES ENTITLED, "MHT LIGHTING VAULT TOPO PLAN, ORIGINAL SCALE: 1"=20', DRAWING NO.: 1 OF 1, CAD FILE: 8530A-MHT LIGHTING VAULT TOPO PLAN.dwg.
2. THE LOCATION AND ELEVATIONS OF THE EXPLORATIONS WERE APPROXIMATELY DETERMINED BY TAPE MEASUREMENTS AND LEVEL SURVEY FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THE DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3. ELEVATIONS, IN FEET, ARE REFERENCED TO THE NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88)

LEGEND

JB-XX — APPROXIMATE LOCATION OF TEST BORINGS PERFORMED BY GEOLOGIC INC. AND OBSERVED BY JACOBS PERSONNEL BETWEEN SEPTEMBER 23 & 26, 2024

JB-XX (OW) — APPROXIMATE LOCATION OF OBSERVATION WELL PERFORMED BY GEOLOGIC INC. AND OBSERVED BY JACOBS PERSONNEL BETWEEN SEPTEMBER 23 & 26, 2024

0 15 30
SCALE IN FEET

LIGHTING VAULT EXPANSION PROJECT
MANCHESTER, NEW HAMPSHIRE

# EXPLORATION LOCATION PLAN

| | | | |
|---|---|---|---|
| PREPARED BY: Jacobs | | PREPARED FOR: MANCHESTER - BOSTON REGIONAL AIRPORT | |
| PROJ MGR: ND | REVIEWED BY: CD | CHECKED BY: CD | FIGURE 2 |
| DESIGNED BY: GL | DRAWN BY: GL | SCALE: 1" = 15' | |
| DATE: 1/30/2025 | PROJECT NO. E2X97905 | REVISION NO. | |

O:\INFRASTRUCTURE\GEOTECHNICAL\MANCHESTER BOSTON AIRPORT\3. GEOTECHNICAL REPORT\2. CAD\EXPLORATION LOCATION PLAN.DWG

# Appendix B. Site Investigation

# Jacobs

# BORING LOG KEY

120 St. James Ave
5th Floor
Boston, Massachusetts
02116

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

## COLUMN DESCRIPTIONS

1. ELEV (feet): Elevation in feet as per datum specified on log.
2. DEPTH (feet): Depth in feet below the ground surface or barge.
3. SAMPLE DATA: Type of soil/rock sample and data collected over the depth interval shown.
4. N-VALUE (Uncorrected): Cumulative number of uncorrected blows for the middle two six-inch intervals (blows/foot).
5. SAMPLE NUMBER: Sample identification number.
6. DEPTH INTERVAL (feet): Depth interval of the soil or rock sample collected.
7. PEN/REC (inch/inch): Soil or rock sample penetration / amount of soil or rock recovered.
8. PID (parts per million): PID reading observed during drilling.
9. LAYER NAME: Inferred name and delineation of subsurface strata.
10. SOIL AND ROCK DESCRIPTION: Description of material encountered.
11. NOTES: Comments/observations regarding drilling/sampling made by driller or field personnel.

## BURMISTER SOIL CLASSIFICATION (INORGANIC)

| COMPONENT | NAME | PROPORTIONAL TERM | PERCENT BY WEIGHT |
|---|---|---|---|
| MAJOR | GRAVEL<br>SAND<br>FINES* | n/a | > 50 |
| Minor | Gravel<br>Sand<br>Fines* | and<br>some<br>little<br>trace | 35 - 50<br>20 - 35<br>10 - 20<br>0 - 10 |

| GRADATION DESIGNATIONS | PROPORTIONS OF GRANULAR COMPONENT |
|---|---|
| fine | < 10% coarse & medium |
| medium | < 10% coarse & fine |
| fine to medium | < 10% coarse |
| medium to coarse | < 10% fine |
| fine to coarse | all > 10% |

| PARTICLE SIZE DEFINITIONS | | | |
|---|---|---|---|
| *SOIL* | *FRACTION* | *SIEVE NO.* | *SIEVE SIZE* |
| Gravel | coarse<br>fine | 3 in to 3/4 in<br>3/4 in to No.4 | 75mm - 19mm<br>19mm - 4.75mm |
| Sand | coarse<br>medium<br>fine | No.4 to No.10<br>No.10 to No.40<br>No.40 to No.200 | 4.75mm - 2.0mm<br>2.0mm - .43mm<br>0.43mm - 0.08mm |
| Silt | n/a | < No.200 | < 0.075mm |

| GRANULAR SOILS | | PLASTICITY | PLASTICITY INDEX | FINES* | THREAD DIAMETER | FINE SOILS | | |
|---|---|---|---|---|---|---|---|---|
| *DENSITY* | *SPT N-VALUE* | | | | | *CONSISTENCY* | *SPT N-VALUE* | *UC STRENGTH* |
| Very Loose | < 4 | Non-Plastic | 0 | SILT | None | Very Soft | < 2 | < 0.25 tsf |
| Loose | 4 - 10 | Slight | 1 - 5 | Clayey SILT | 1/4" (6mm) | Soft | 2 - 4 | 0.25 - 0.50 tsf |
| Medium Dense | 10 - 30 | Low | 5 - 10 | SILT & CLAY | 1/8" (3mm) | Medium | 4 - 8 | 0.50 - 1.0 tsf |
| Dense | 30 - 50 | Medium | 10 - 20 | CLAY & SILT | 1/16" (1.5mm) | Stiff | 8 - 15 | 1.0 - 2.0 tsf |
| Very Dense | > 50 | High | 20 - 40 | Silty CLAY | 1/32" (0.75mm) | Very Stiff | 15 - 30 | 2.0 - 4.0 tsf |
| | | Very High | > 40 | CLAY | 1/64" (0.4mm) | Hard | > 30 | > 4.0 tsf |

## BURMISTER SOIL CLASSIFICATION (ORGANIC)

Fibrous PEAT - Light weight, spongy, mostly visible organic matter, water squeezes readily from sample. Typically near top of deposit.
Fine Grained PEAT - Light weight, spongy, little visible organic matter, water squeezes readily from sample. Typically below fibrous PEAT.
Organic SILT - Typically gray to dark gray, often has strong H2S odor. Typically contains shells or shell fragment. Light weight. Usually found near coastal regions. May contain wide range of sand fractions.

## MASSDOT VISUAL IDENTIFICATION OF SOILS

| COMPONENT | NAME | PROPORTIONAL TERM | PERCENT BY WEIGHT |
|---|---|---|---|
| MAJOR | GRAVEL<br>SAND<br>FINES | n/a | > 50 |
| Minor | Gravel<br>Sand<br>Fines | and<br>some<br>trace | 40 - 50<br>10 - 40<br>< 10 |

| PARTICLE SIZE DEFINITIONS | | | |
|---|---|---|---|
| *SOIL* | *FRACTION* | *SIEVE NO.* | *SIEVE SIZE* |
| Boulders | n/a | > 12 in | > 305mm |
| Cobbles | n/a | 12 in to 3 in | 305mm - 75mm |
| Gravel | coarse<br>medium<br>fine | 3 to 1 in<br>1 in to 3/8 in<br>3/8 in to No.10 | 75mm - 25mm<br>25mm - 9.5mm<br>9.5mm - 2.0mm |
| Sand | coarse<br>fine | No.10 to No.40<br>No.40 to No.200 | 2.0mm - 0.425mm<br>0.425mm - 0.075mm |
| Silt | n/a | < No.200 | < 0.075mm |

| GRANULAR SOILS | |
|---|---|
| *DENSITY* | *SPT N-VALUE* |
| Very Loose | < 4 |
| Loose | 4 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | > 50 |

| FINE SOILS | |
|---|---|
| *CONSISTENCY* | *SPT N-VALUE* |
| Very Soft | < 2 |
| Soft | 2 - 4 |
| Medium Stiff | 4 - 8 |
| Stiff | 8 - 15 |
| Very Stiff | 15 - 30 |
| Hard | > 30 |

## GRAPHIC SYMBOLS


Split-Spoon Sample (SS) and Blow Counts per 6" REC (in)


Rock Core (RC) and RQD (%) REC (%)


Undisturbed (U) Shelby Tube (P) Piston


Auger Sample (AS)


Jar Sample (JS)


Bag Sample (B)

## ABBREVIATIONS

SS = Split Spoon Sampler
U = Undisturbed Sample (Shelby Tube)
P = Piston Sample
WOR = Weight of Rods
WOH = Weight of Hammer
SPT = Stadard Penetration Test (ASTM D2487)
PP = Pocket Penetrometer
PI = Plasticity Index
UC STRENGTH = Unconfined Compressive Strength
PID = Photoionization Detector
ppm = Part Per Million
REC = Recovery
RQD = Rock Quality Designation
Water Level

# LOG OF TEST BORING

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jacobs | PROJECT | Lighting Vault Expansion Project | | | BORING NO. | JB-1(OW) | |
| | LOCATION | Manchester, New Hampshire | | | | SHEET 1 OF 3 | |
| | OWNER | Manchester Boston Regional Airport | | | | | |
| | JOB NUMBER | E2X97905 | | | | | |
| INSPECTOR: X. Zhou | CONTRACTOR | Geologic Earth Exploration Inc | DRILLER | J. Mientkiewicz | ELEVATION | 231.7 | |
| METHOD OF DRILLING | GROUNDWATER READINGS | | DRILL RIG | D-6 ATV | DATUM | NAVD 88 | |
| 0.0 Wash Boring w/Casing | DATE/TIME | DEPTH(ft) REMARKS | SPT HAMMER | 140 lb Auto | GRID | N | 157708.17 |
| 74.0 NX Rock Core | 09-26-2024 / 10:00 | 13.0 Monitoring Well Reading | | | COORD | E | 1047593.89 |
| 84.0 Terminated | | | | | DATE START | | 9/24/24 |
| | | | | | DATE END | | 9/26/24 |

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 0 | 5 4 9 12 | 13 | S1 | 0 - 2 | 24/16 | | FILL | S1: Dry, medium dense, grayish brown, fine to medium SAND, little fine Gravel, trace Silt, trace grass roots observed. | 1 |
| | | 9 7 9 13 | 16 | S2 | 2 - 4 | 24/14 | | | S2: Dry, medium dense, olive brown, fine to medium SAND, little Silt, trace fine Gravel. [Laboratory Testing Performed - Particle Size Analysis (Sieve Only): Gravel = 2.5%, Sand = 84.8%, Silt & Clay = 12.7%] | 2 |
| | 5 | 4 2 4 8 | 6 | S3 | 4 - 6 | 24/12 | | | S3: Dry, loose, olive brown, fine to medium SAND, little Silt, trace fine Gravel. [Laboratory Testing Performed - Particle Size Analysis (Sieve Only): Gravel = 4.1%, Sand = 83.1%, Silt & Clay = 12.8%] | 3 |
| 225 | | 12 10 15 19 | 25 | S4 | 6 - 8 | 24/8 | | 6 | S4: Wet, medium dense, light brown/dark brown, fine to medium SAND, little Silt. | |
| | | 11 16 16 20 | 32 | S5 | 8 - 10 | 24/13 | | | S5: Wet, dense, light brown, fine to medium SAND, little Silt. | |
| | 10 | 18 20 23 20 | 43 | S6 | 10 - 12 | 24/16 | | | S6: Wet, dense, light brown, gray, fine to medium SAND, little Silt. | |
| 220 | | 26 28 31 24 | 59 | S7 | 12 - 14 | 24/14 | | SAND | S7: Wet, very dense, brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| | 15 | 26 25 34 20 | 59 | S8 | 14 - 16 | 24/11 | | | S8: Wet, very dense, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| 215 | | 12 14 17 15 | 31 | S9 | 16 - 18 | 24/11 | | | S9: Wet, dense, light brown, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| | | 18 80 66 40/3" | 146 | S10 | 18 - 19.75 | 21/13 | | 18 | S10: Wet, very dense, brown, fine to medim SAND, trace fine Gravel, trace Silt. | |
| 210 | 20 | | | | | | | | | |
| 205 | 25 | 24 26 57 100/4" | 83 | S11 | 24 - 25.8 | 22/10 | | | S11: Wet, very dense, dark gray, fine to medium SAND, trace coarse Gravel, trace Silt. | |
| | 30 | 100/6" | 100/6" | S12 | 29 - 29.5 | 6/6 | | | S12: Wet, very dense, dark gray, fine to coarse SAND, trace fine Gravel, trace Silt. | |
| 200 | | 100/6" | 100/6" | S13 | 34 - 34.5 | 6/6 | | | S13: Wet, very dense, dark gray, fine to coarse SAND, trace fine Gravel, | |
| | 35 | | | | | | | | | |

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Elevation obtained from plans provided by Doucet Survey LLC under the direction of Jacobs, entitled,"Topographic Plan", sheets 1 of 1, dated October 4, 2024.
2. JB-1(OW) offset approximately 3 feet south of the proposed location for overhead utility clearance.
3. Composite sample collected from JB-1(OW) and JB-2 from 0 to 6 feet bgs. [Laboratory Testing Performed - Chlorides = 15 ppm, Sulfates = 1.0 ppm, pH = 7.62, Electrical Resistivity = 12,578 ohm-cm]

# LOG OF TEST BORING

| | | | |
|---|---|---|---|
| Jacobs | PROJECT: Lighting Vault Expansion Project | BORING NO. | JB-1(OW) |
| | LOCATION: Manchester, New Hampshire | | |
| | OWNER: Manchester Boston Regional Airport | | SHEET 2 OF 3 |
| | JOB NUMBER: E2X97905 | | |

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | trace Silt. | |
| 195 | | | | | | | | | | |
| | 40 | 100/4" | 100/4" | S14 | 39 - 39.3 | 4/4 | | | S14: Wet, very dense, dark gray, fine to medium SAND, trace Silt. | |
| 190 | | | | | | | | | | |
| | 45 | 100/2.5" | 100/2.5" | S15 | 44 - 44.2 | 3/3 | | TILL | S15: Wet, very dense, dark gray, fine to coarse SAND, trace Silt. | |
| 185 | | | | | | | | | | |
| | 50 | 100/4" | 100/4" | S16 | 49 - 49.3 | 4/4 | | | S16: Wet, very dense, dark gray, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| 180 | | | | | | | | | | |
| | 55 | 100/5" | 100/5" | S17 | 54 - 54.4 | 5/5 | | | S17: Wet, very dense, dark gray, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| 175 | | | | | | | | | | |
| | 60 | 36 40 37 75 | 77 | S18 | 59 - 61 | 24/24 | | | S18: Wet, very dense, dark gray, fine to coarse SAND, trace fine Gravel, trace Silt. | |
| 170 | | | | | | | | | | |
| | 65 | 36 52 59 63 | 111 | S19 | 64 - 66 | 24/22 | | | S19: Wet, very dense, dark gray, fine to coarse SAND, trace fine Gravel, trace Silt. | |
| 165 | | | | | | | | | | |
| | 70 | 31 37 50 50/3" | 87 | S20 | 69 - 70.8 | 21/20 | | | S20: Wet, very dense, dark gray, fine to coarse SAND, trace fine Gravel, trace Silt. | |
| | | | | | | | | 70.8 | | |
| 160 | | | | | | | | W/R | | 4 |
| | | | | | | | | 74 | | |
| | | | | C1 | 74 - 79 | 60/60 | | | | |



NOTES

4. Driller noted increasing drilling resistance at appximately 70.8 feet due to possible weathered rock layer. Driller advanced roller bit to 74 feet and began drilling rock core run C-1.

# LOG OF TEST BORING

| | | | |
|---|---|---|---|
| Jacobs | PROJECT: Lighting Vault Expansion Project | BORING NO. | JB-1(OW) |
| | LOCATION: Manchester, New Hampshire | | SHEET 3 OF 3 |
| | OWNER: Manchester Boston Regional Airport | | |
| | JOB NUMBER: E2X97905 | | |

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 155 | 75 | RQD=78 | | | | | | BEDROCK | C1: GNEISS, dark bluish gray, fine to coarse grained, moderately hard, medium strong, fresh to slightly weathered, massive; close to moderate spaced, horizontal joints, fresh, extremely to slightly fractured.<br><br>Drilling Rates (mins/ft): 4 - 3 - 3 - 3 - 4. | |
| | | | | C2 | 79 - 84 | 60/54 | | | C2: GNEISS, dark bluish gray, fine to coarse grained, moderately hard, medium strong, fresh, massive; close to moderate spacing, horizontal joints, fresh, extremely to slightly fractured. | 5 |
| 150 | 80 | RQD=78 | | | | | | | Drilling Rates (mins/ft): 2.5 - 2.5 - 3 - 2 - 2. | |
| | 84 | | | | | | | | Bottom of Borehole at 84 feet. | |
| 145 | 85 | | | | | | | | | |
| | 90 | | | | | | | | | |
| 140 | | | | | | | | | | |
| | 95 | | | | | | | | | |
| 135 | | | | | | | | | | |
| | 100 | | | | | | | | | |
| 130 | | | | | | | | | | |
| | 105 | | | | | | | | | |
| 125 | | | | | | | | | | |
| | 110 | | | | | | | | | |
| 120 | | | | | | | | | | |

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

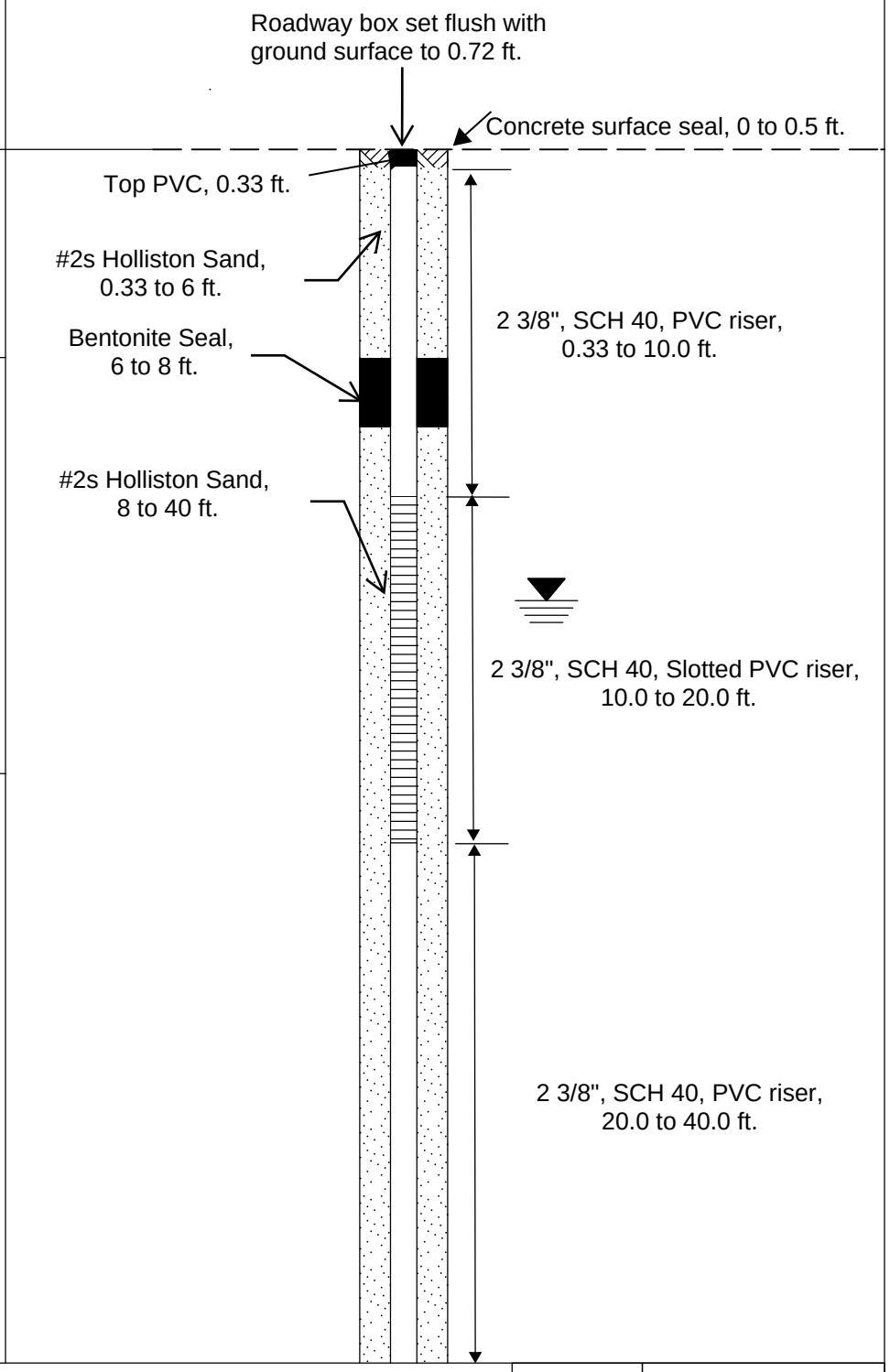
5. Upon completion, an observation well was installed with a flush mount roadbox to existing grade.

# LOG OF MONITORING WELL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Jacobs | PROJECT | Lighting Vault Expansion Project | | | | BORING NO. | JB-1(OW) | | |
| | LOCATION | Manchester, New Hampshire | | | | | SHEET 1 OF 3 | | |
| | OWNER | Manchester Boston Regional Airport | | | | | | | |
| | JOB NUMBER | E2X97905 | | | | | | | |
| INSPECTOR X. Zhou | CONTRACTOR | Geologic Earth Exploration Inc | | DRILLER | J. Mientkiewicz | | ELEVATION | | 231.7 |
| METHOD OF DRILLING | GROUNDWATER READINGS | | | DRILL RIG | D-6 ATV | | DATUM | | NAVD88 |
| 0.0 Wash Boring w/Casing | DATE/TIME | DEPTH(ft) | REMARKS | SPT HAMMER | 140 lb Auto | | GRID | N | 157708.17 |
| 74.0 NX Rock Core | 09-26-2024 / 10:00 | 13.0 | Monitoring Well Reading | | | | COORD | E | 1047593.89 |
| 84.0 Terminated | | | | | | | DATE START | | 9/24/24 |
| | | | | | | | DATE END | | 9/26/24 |

| DEPTH (FEET) | STRATA SYMBOL | ELEVATION (FEET) | MATERIAL DESCRIPTION |
|---|---|---|---|
| 0 | | | FILL |
| 5 | | | SAND |
| 10 | | | |
| 15 | | | |
| 20 | | | TILL |
| 25 | | | |
| 30 | | | |
| 35 | | | |

WELL DIAGRAM




| BORING NO. | JB-1(OW) |
|---|---|

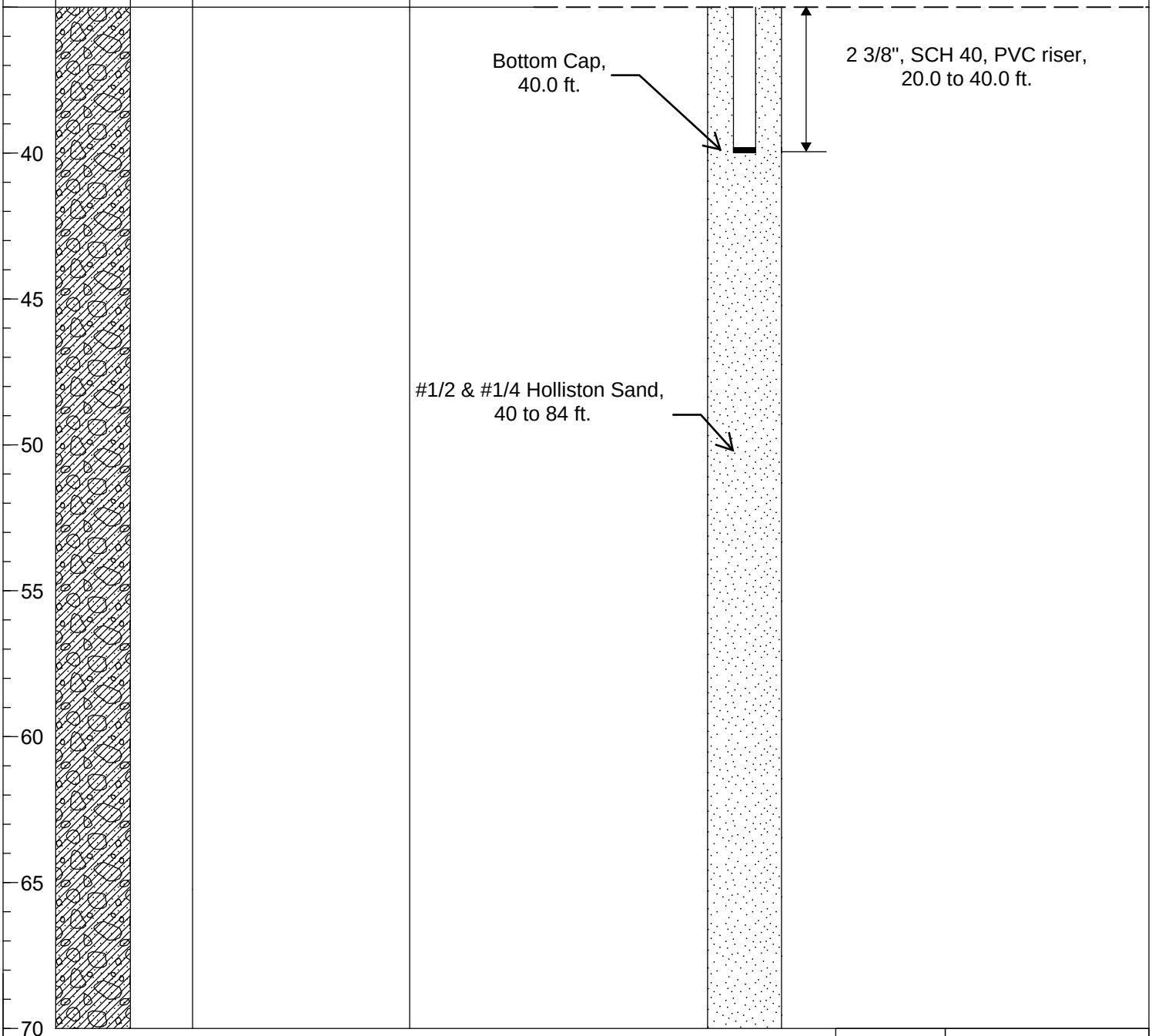
# LOG OF MONITORING WELL

Jacobs

| | | | |
|---|---|---|---|
| PROJECT | Lighting Vault Expansion Project | BORING NO. | JB-1(OW) |
| LOCATION | Manchester, New Hampshire | | |
| OWNER | Manchester Boston Regional Airport | | SHEET 2 OF 3 |
| JOB NUMBER | E2X97905 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| INSPECTOR | X. Zhou | CONTRACTOR | Geologic Earth Exploration Inc | | DRILLER | J. Mientkiewicz | ELEVATION | | 231.7 |
| METHOD OF DRILLING | | GROUNDWATER READINGS | | | DRILL RIG | D-6 ATV | DATUM | | NAVD88 |
| 0.0 | Wash Boring w/Casing | DATE/TIME | DEPTH(ft) | REMARKS | SPT HAMMER | 140 lb Auto | GRID | N | 157708.17 |
| 74.0 | NX Rock Core | 09-26-2024 / 10:00 | 13.0 | Monitoring Well Reading | | | COORD | E | 1047593.89 |
| 84.0 | Terminated | | | | | | DATE START | | 9/24/24 |
| | | | | | | | DATE END | | 9/26/24 |

| DEPTH (FEET) | STRATA SYMBOL | ELEVATION (FEET) | MATERIAL DESCRIPTION | WELL DIAGRAM |
|---|---|---|---|---|




| | |
|---|---|
| BORING NO. | JB-1(OW) |

# LOG OF MONITORING WELL

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Jacobs | PROJECT | Lighting Vault Expansion Project | | | | BORING NO. | JB-1(OW) | | |
| | LOCATION | Manchester, New Hampshire | | | | | SHEET 3 OF 3 | | |
| | OWNER | Manchester Boston Regional Airport | | | | | | | |
| | JOB NUMBER | E2X97905 | | | | | | | |
| INSPECTOR X. Zhou | CONTRACTOR | Geologic Earth Exploration Inc | | DRILLER | J. Mientkiewicz | | ELEVATION | | 231.7 |
| METHOD OF DRILLING | GROUNDWATER READINGS | | | DRILL RIG | D-6 ATV | | DATUM | | NAVD88 |
| 0.0 Wash Boring w/Casing | DATE/TIME | DEPTH(ft) | REMARKS | SPT HAMMER | 140 lb Auto | | GRID | N | 157708.17 |
| 74.0 NX Rock Core | 09-26-2024 / 10:00 | 13.0 | Monitoring Well Reading | | | | COORD | E | 1047593.89 |
| 84.0 Terminated | | | | | | | DATE START | | 9/24/24 |
| | | | | | | | DATE END | | 9/26/24 |

| DEPTH (FEET) | STRATA SYMBOL | ELEVATION (FEET) | MATERIAL DESCRIPTION | WELL DIAGRAM |
|---|---|---|---|---|
| | | | W/R | |
| 75 | | | BEDROCK | #1/2 & #1/4 Holliston Sand, 40 to 84 ft. |
| 80 | | | | |
| 85 | | | | |
| 90 | | | | |
| 95 | | | | |
| 100 | | | | |
| 105 | | | | |

BORING NO. JB-1(OW)

# LOG OF TEST BORING

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Jacobs | PROJECT | Lighting Vault Expansion Project | | | BORING NO. | JB-2 | |
| | LOCATION | Manchester, New Hampshire | | | | SHEET 1 OF 2 | |
| | OWNER | Manchester Boston Regional Airport | | | | | |
| | JOB NUMBER | E2X97905 | | | | | |
| INSPECTOR: X. Zhou | CONTRACTOR | Geologic Earth Exploration Inc | DRILLER | J. Mientkiewicz | ELEVATION | 232.7 | |
| METHOD OF DRILLING | GROUNDWATER READINGS | | DRILL RIG | D-6 ATV | DATUM | NAVD 88 | |
| 0.0 Wash Boring w/Casing | DATE/TIME | DEPTH(ft) REMARKS | SPT HAMMER | 140 lb Auto | GRID | N | 157734.7 |
| 34.8 Terminated | 09-23-2024 / 1437 | 9.0 Upon Completion (In Casing) | | | COORD | E | 1047551.8 |
| | | | | | DATE START | | 9/23/24 |
| | | | | | DATE END | | 9/23/24 |

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0.5 | ASPHALT. | 1 |
| | | 12 13 28 | 41 | S1 | 0.5 - 2 | 18/12 | | FILL | S1; Dry, dense, brown, fine to coarse SAND, little fine Gravel, trace Silt. | |
| 230 | | 18 7 7 7 | 14 | S2 | 2 - 4 | 24/9 | | | S2: Dry, medium dense, black, fine to coarse SAND, trace fine Gravel, trace Silt. | |
| | 5 | 5 4 3 5 | 7 | S3 | 4 - 6 | 24/0 | | | S3: No recovery. | 2 |
| | | 6 8 7 9 | 15 | S4 | 6 - 8 | 24/0 | | 6 SAND | S4: No recovery. | |
| 225 | | 4 8 11 13 | 19 | S5 | 8 - 10 | 24/14 | | | S5: Dry, medium dense, light olive brown, fine to medium SAND, trace Silt. [Laboratory Testing Performed - Particle Size Analysis (Sieve Only): Gravel = 0%, Sand = 90.7%, Silt & Clay = 9.3%] | |
| | 10 | 13 20 18 20 | 38 | S6 | 10 - 12 | 24/18 | | | S6: Wet, dense, light olive brown, fine to medium SAND, trace Silt. | |
| 220 | | 20 16 19 20 | 35 | S7 | 12 - 14 | 24/20 | | 12 Sandy SILT | S7: Wet, dense, light olive brown, fine to medium SAND, little Silt. | |
| | 15 | 8 10 12 18 | 22 | S8 | 14 - 16 | 24/19 | | 16 | S8: Wet, medium dense, light olive brown to reddish brown, SILT, some fine Sand. [Laboratory Testing Performed - Particle Size Analysis (Sieve Only): Gravel = 0%, Sand = 47.9%, Silt & Clay = 52.1%] | |
| | | 17 25 34 46 | 59 | S9 | 16 - 18 | 24/24 | | TILL | S9: Wet, very dense, light olive brown to reddish brown, fine SAND, little Silt. | |
| 215 | | 18 23 28 26 | 51 | S10 | 18 - 20 | 24/12 | | | S10: Wet, very dense, light brown, fine to coarse SAND, trace fine Gravel, little Silt. | |
| | 20 | | | | | | | | | |
| 210 | | | | | | | | | | |
| | 25 | 19 37 41 69 | 78 | S11 | 24 - 26 | 24/9 | | | S11: Wet, very dense, light brown to reddish brown, fine to coarse SAND, trace Silt. | |
| | | | | | | | | 26.5 | | |
| | | | | | | | | 27.5 | BOULDERS. | 3 |
| 205 | | | | | | | | TILL | | |
| | 30 | 15 47 53/1.5" | 100/7.5" | S12 | 29 - 30.1 | 14/9 | | | S12: Wet, very dense, brownish gray, fine to coarse SAND, little fine to coarse Gravel, trace Silt. | |
| 200 | | | | | | | | | | |
| | | 44 | 100/9" | S13 | 34 - 34.8 | 9/3 | | 34.8 | S13: Wet, very dense, brownish gray, fine to coarse SAND, trace Silt. | 4 |
| | 35 | | | | | | | | | |

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

1. Elevation obtained from plans provided by Doucet Survey LLC under the direction of Jacobs, entitled,"Topographic Plan", sheets 1 of 1, dated October 4, 2024.
2. Soil sample collected from approximately 4 to 6 feet with casing for the corrosive testing. Composite sample collected from JB-1(OW) and JB-2 from 0 to 6 feet bgs. [Laboratory Testing Performed - Chlorides = 15 ppm, Sulfates = 1.0 ppm, pH = 7.62,
3. Diller noted increasing drilling resistance at 26.5 feet and advanced roller bit through a boulder to 27.5 feet bgs.
4. Upon completion, borehole backfilled with soil cuttings and ashalt cold patch to match existing grade.

# LOG OF TEST BORING

| | | | |
|---|---|---|---|
| Jacobs | PROJECT | Lighting Vault Expansion Project | BORING NO. JB-2 |
| | LOCATION | Manchester, New Hampshire | |
| | OWNER | Manchester Boston Regional Airport | |
| | JOB NUMBER | E2X97905 | SHEET 2 OF 2 |

| ELEV. (ft) | DEPTH (ft) | SAMPLE DATA | N-VALUE | SAMPLE NO. | DEPTH INTERVAL (ft) | PEN/REC (in)/(in) | PID (ppm) | LAYER NAME | SOIL AND ROCK DESCRIPTION | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 56/3" | | | | | | | Bottom of Borehole at 34.8 feet. | |
| 195 | 40 | | | | | | | | | |
| 190 | 45 | | | | | | | | | |
| 185 | 50 | | | | | | | | | |
| 180 | 55 | | | | | | | | | |
| 175 | 60 | | | | | | | | | |
| 170 | 65 | | | | | | | | | |
| 165 | 70 | | | | | | | | | |
| 160 | | | | | | | | | | |

Page 1: 0-35 feet. Each subsequent page displays 40 feet.

NOTES

# Appendix C. Laboratory Testing

| | |
|---|---|
| Client: | Jacobs Engineering Group |
| Project Name: | MAN-BOS Airport Lighting Vault Expan. |
| Project Location: | Boston, MA |
| GTX #: | 319877 |
| Test Date: | 09/27/24 |
| Tested By: | NMK |
| Checked By: | ank |

# Laboratory pH of Soil by ASTM G51

| Boring ID | Sample ID | Depth, ft | Description | Soil Temperature, ° C | Average pH Reading |
|---|---|---|---|---|---|
| JB-1 (OW) & JB-2 | S-1, S-2 & S-3 | 0-6 ft | Moist, dark brown sand with silt | 19.9° | 7. 62 |

Notes:

| | |
|---|---|
| Client: | Jacobs Engineering Group |
| Project: | MAN-BOS Airport Lighting Vault Expan. |
| Location: | Boston, MA |
| GTX#: | 319877 |
| Test Date: | 10/07/24 |
| Due Date: | 10/09/24 |
| Tested By: | NMK |
| Checked By: | ank |

# Laboratory Measurement of Soil Resistivity Using the Wenner Four-Electrode Method by ASTM G57 (Laboratory Measurement)

| Boring ID | Sample ID | Depth, ft. | Sample Description | Electrical Resistivity, ohm-cm | Electrical Conductivity, $(ohm\text{-}cm)^{-1}$ |
|---|---|---|---|---|---|
| JB-1 (OW) & JB-2 | S-1, S-2, S-3 | 0-6 ft | Moist, dark brown sand with silt | 12,578 | 7.95E-05 |

Notes: Test Equipment: Nilsson Model 400 Soil Resistance Meter, MC Miller Soil Box
Water added to sample to create a thick slurry prior to testing (saturated condition).
Electrical Conductivity is calculated as inverse of Electrical Resistivity (per ASTM G57)
Test conducted in standard laboratory atmosphere: 68-73 F



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ACTON MA 01720-3451
USA

| | |
|---|---|
| Analysis No. | TS-A2412185 |
| Report Date | 03 October 2024 |
| Date Sampled | 27 September 2024 |
| Date Received | 01 October 2024 |
| Where Sampled | Acton, MA USA |
| Sampled By | Client |

This is to attest that we have examined: Soil for Project Name: Man-Bos Airport Lighting Vault Expansion; Site Location: - — -; Job Number: GTX-319877

When examined to the applicable requirements of:

ASTM D 4327-17 "Standard Test Method for Anions in Water by Suppressed Ion Chromatography" Chloride and Sulfate Anion

Results:

ASTM D 4327 – Chloride Anion

| Sample | | Results | | Detection Limit |
|---|---|---|---|---|
| | | ppm (mg/kg) | %[1] | |
| JB-1 (OW) & JB-2 | | 15. | 0.0015 | 1.0 |
| S1, S2, & S3 | 0 – 6' | | | |

NOTE: [1]Percent by weight after drying.

ASTM D 4327 - Sulfate Anion

| Sample | | Results | | Detection Limit |
|---|---|---|---|---|
| | | ppm (mg/kg) | %[1] | |
| JB-1 (OW) & JB-2 | | 1. | 0.0001 | 1.0 |
| S1, S2, & S3 | 0 – 6' | | | |

NOTE: [1]Percent by weight after drying.

END OF ANALYSIS

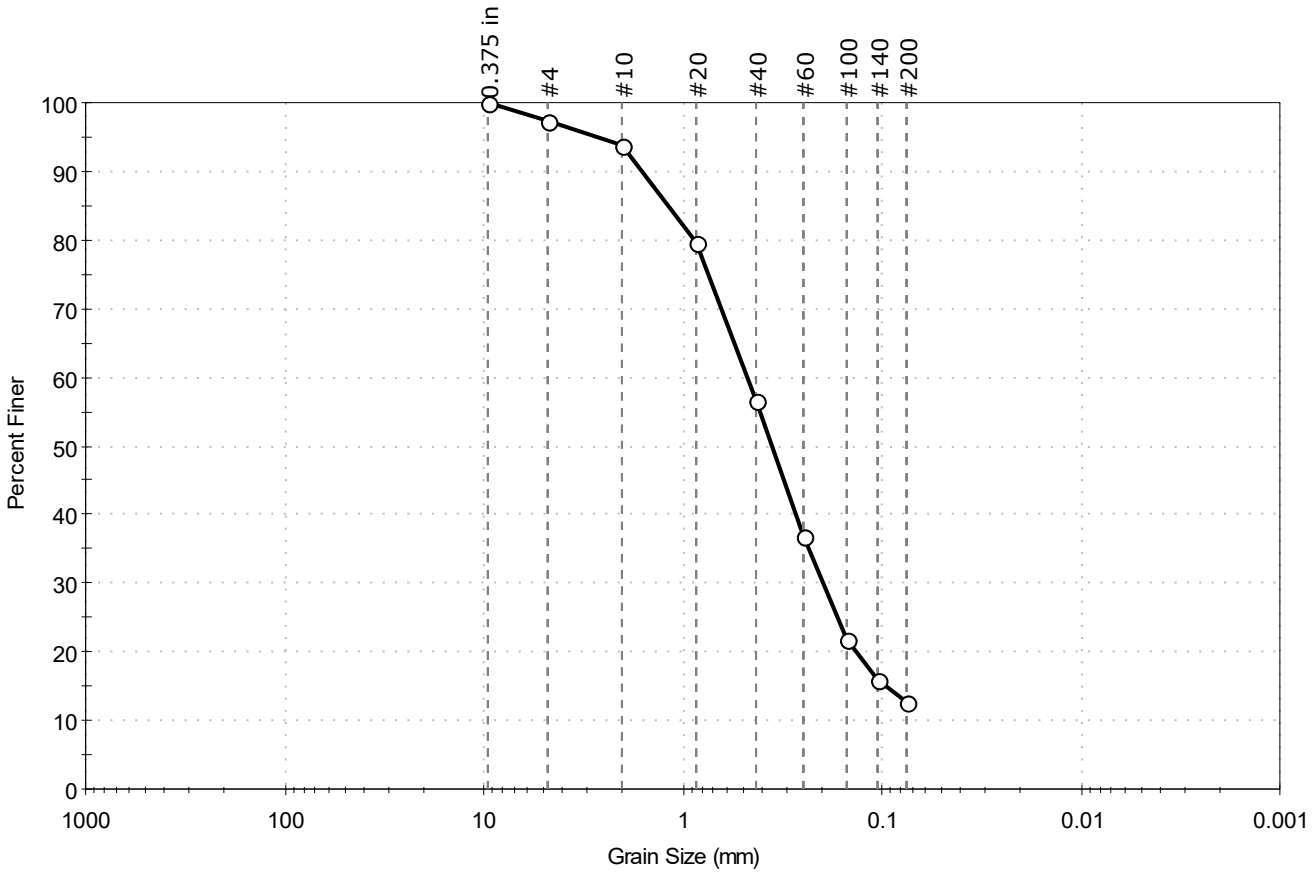
USEPA Laboratory ID UT00930

Merrill Gee P.E. – Engineer in Charge

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| | | | | | |
|---|---|---|---|---|---|
| Client: | Jacobs Engineering Group | | | | |
| Project: | MAN-BOS Airport Lighting Vault Expan. | | | | |
| Location: | Boston, MA | | | Project No: | GTX-319877 |
| Boring ID: | JB-1 (OW) | Sample Type: | Jar | Tested By: | ajl |
| Sample ID: | S-2 | Test Date: | 10/01/24 | Checked By: | ank |
| Depth : | 2-4 ft | Test Id: | 787261 | | |
| Test Comment: | --- | | | | |
| Visual Description: | Moist, olive brown silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D6913




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 2.5 | 84.8 | 12.7 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 0.375 in | 9.50 | 100 | | |
| #4 | 4.75 | 97 | | |
| #10 | 2.00 | 94 | | |
| #20 | 0.85 | 80 | | |
| #40 | 0.42 | 57 | | |
| #60 | 0.25 | 37 | | |
| #100 | 0.15 | 22 | | |
| #140 | 0.11 | 16 | | |
| #200 | 0.075 | 13 | | |
| | | | | |
| | | | | |

**Coefficients**

$D_{85}$ = 1.1710 mm
$D_{30}$ = 0.1980 mm
$D_{60}$ = 0.4713 mm
$D_{15}$ = 0.0966 mm
$D_{50}$ = 0.3560 mm
$D_{10}$ = N/A
$C_u$ = N/A
$C_c$ = N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

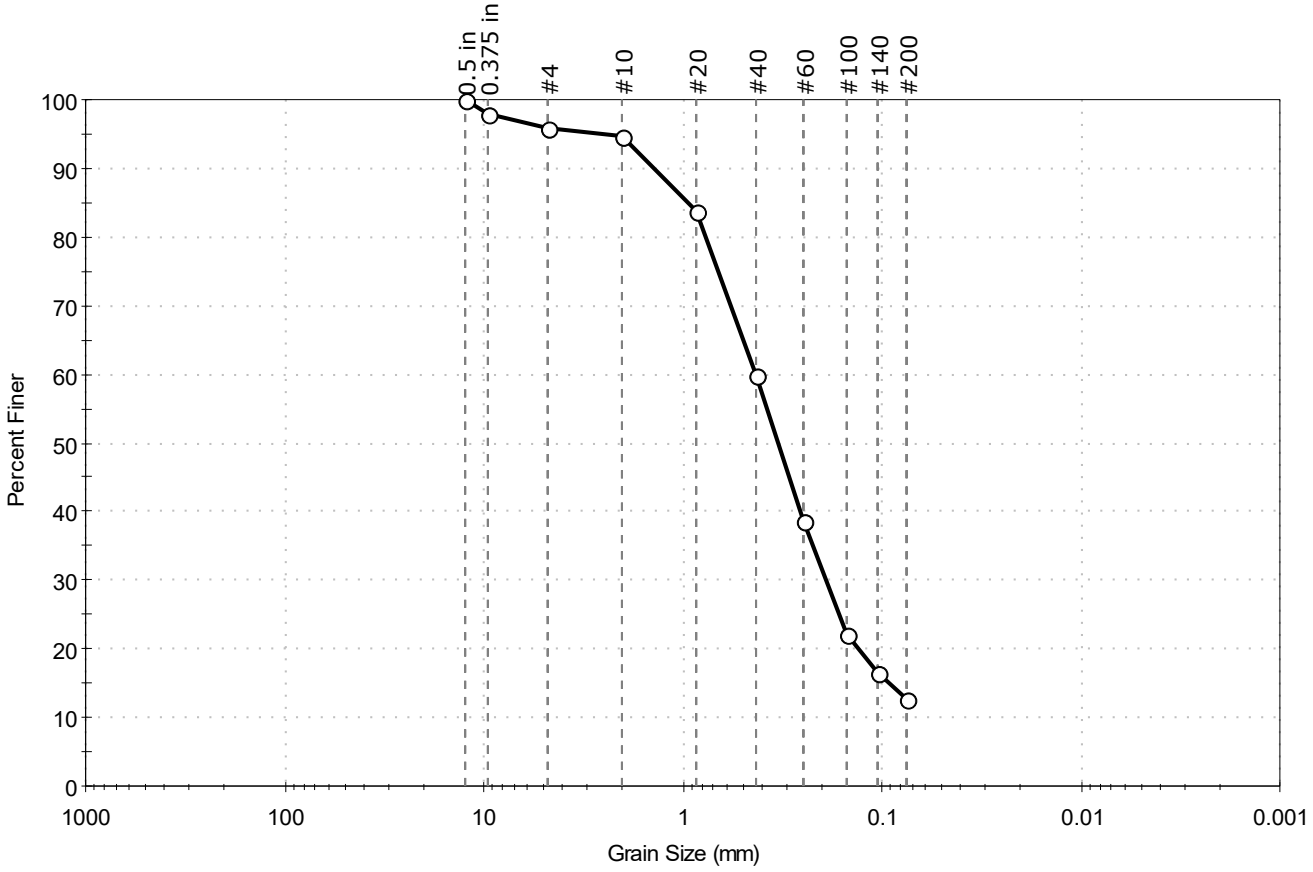
**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

| | | | | | |
|---|---|---|---|---|---|
| Client: | Jacobs Engineering Group | | | | |
| Project: | MAN-BOS Airport Lighting Vault Expan. | | | | |
| Location: | Boston, MA | | | Project No: | GTX-319877 |
| Boring ID: | JB-1 (OW) | Sample Type: | Jar | Tested By: | ajl |
| Sample ID: | S-3 | Test Date: | 10/01/24 | Checked By: | ank |
| Depth : | 4-6 | Test Id: | 787262 | | |
| Test Comment: | --- | | | | |
| Visual Description: | Moist, olive brown silty sand | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D6913




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 4.1 | 83.1 | 12.8 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| 0.5 in | 12.50 | 100 | | |
| 0.375 in | 9.50 | 98 | | |
| #4 | 4.75 | 96 | | |
| #10 | 2.00 | 95 | | |
| #20 | 0.85 | 84 | | |
| #40 | 0.42 | 60 | | |
| #60 | 0.25 | 39 | | |
| #100 | 0.15 | 22 | | |
| #140 | 0.11 | 16 | | |
| #200 | 0.075 | 13 | | |
| | | | | |
| | | | | |

**Coefficients**

$D_{85}$ = 0.9292 mm
$D_{30}$ = 0.1913 mm
$D_{60}$ = 0.4276 mm
$D_{15}$ = 0.0927 mm
$D_{50}$ = 0.3322 mm
$D_{10}$ = N/A
$C_u$ = N/A
$C_c$ = N/A

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

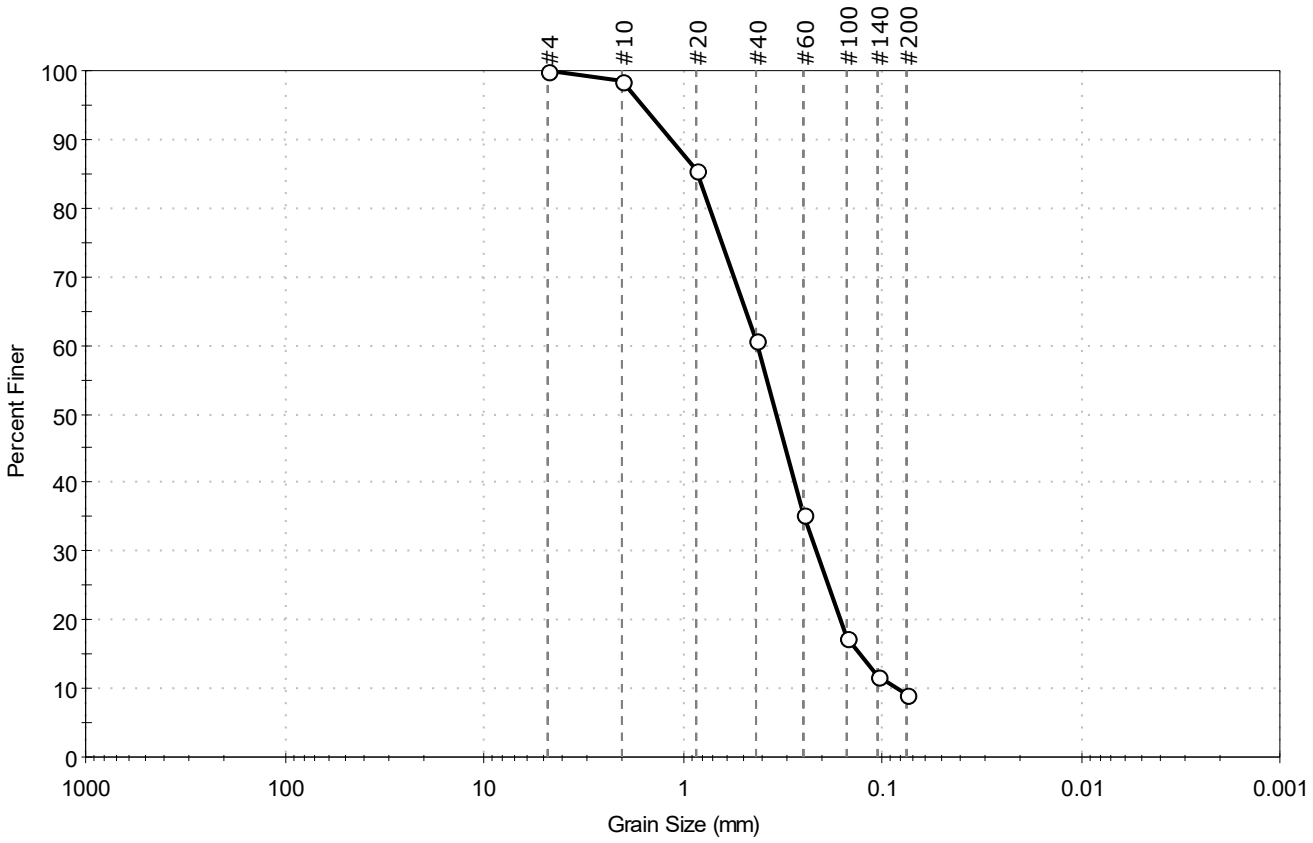
**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

| | | | | | |
|---|---|---|---|---|---|
| Client: | Jacobs Engineering Group | | | | |
| Project: | MAN-BOS Airport Lighting Vault Expan. | | | | |
| Location: | Boston, MA | | | Project No: | GTX-319877 |
| Boring ID: | JB-2 | Sample Type: | Jar | Tested By: | ajl |
| Sample ID: | S5 | Test Date: | 10/01/24 | Checked By: | ank |
| Depth : | 8-10 | Test Id: | 787263 | | |
| Test Comment: | --- | | | | |
| Visual Description: | Moist, light olive brown sand with silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D6913




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 0.0 | 90.7 | 9.3 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| #4 | 4.75 | 100 | | |
| #10 | 2.00 | 98 | | |
| #20 | 0.85 | 86 | | |
| #40 | 0.42 | 61 | | |
| #60 | 0.25 | 35 | | |
| #100 | 0.15 | 17 | | |
| #140 | 0.11 | 12 | | |
| #200 | 0.075 | 9.3 | | |
| | | | | |
| | | | | |

**Coefficients**

$D_{85}$ = 0.8339 mm
$D_{30}$ = 0.2150 mm
$D_{60}$ = 0.4194 mm
$D_{15}$ = 0.1295 mm
$D_{50}$ = 0.3402 mm
$D_{10}$ = 0.0827 mm
$C_u$ = 5.071
$C_c$ = 1.333

**Classification**

ASTM N/A

AASHTO Fine Sand (A-3 (1))

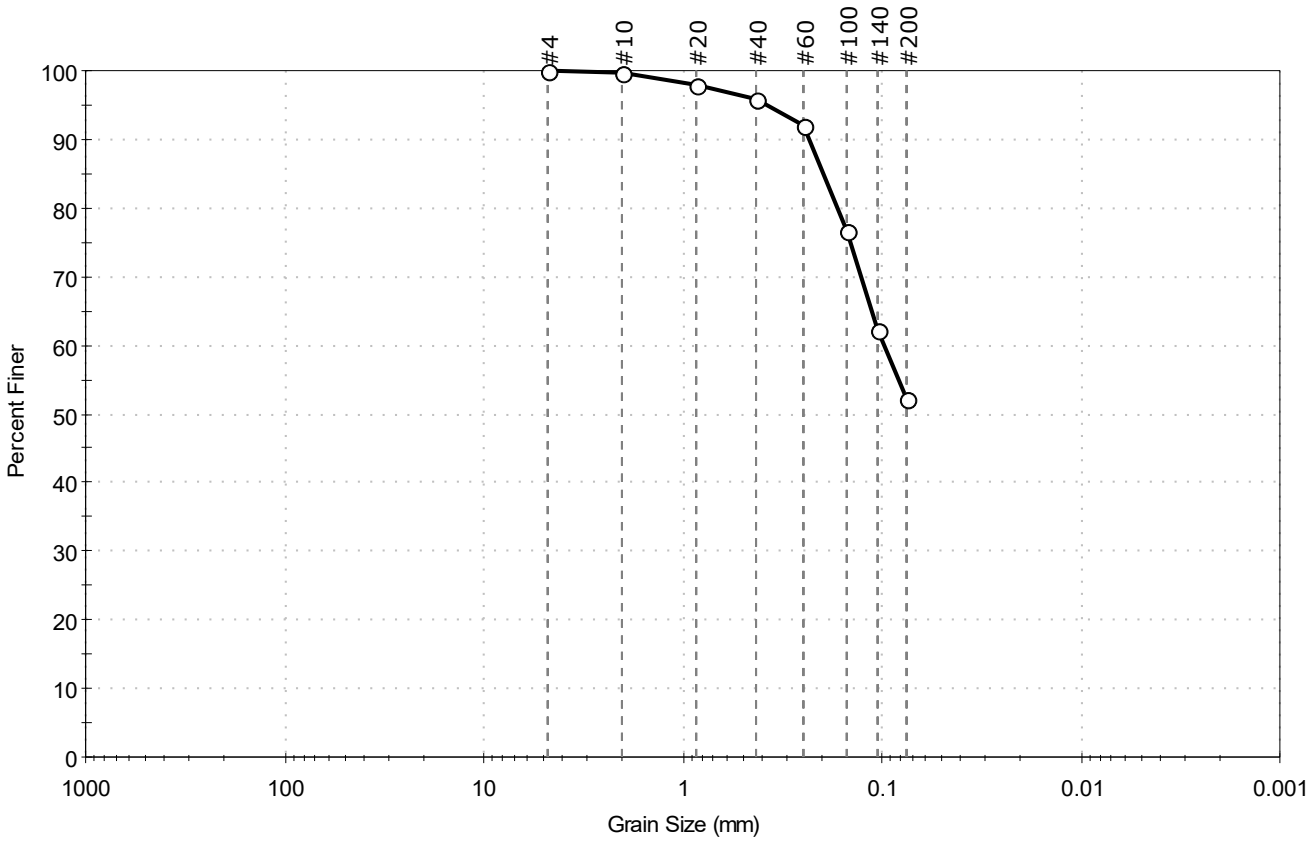
**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

| | | | | | |
|---|---|---|---|---|---|
| Client: | Jacobs Engineering Group | | | | |
| Project: | MAN-BOS Airport Lighting Vault Expan. | | | | |
| Location: | Boston, MA | | | Project No: | GTX-319877 |
| Boring ID: | JB-2 | Sample Type: | Jar | Tested By: | ajl |
| Sample ID: | S8 | Test Date: | 10/01/24 | Checked By: | ank |
| Depth : | 14-16 ft | Test Id: | 787264 | | |
| Test Comment: | --- | | | | |
| Visual Description: | Moist, light olive brown sandy silt | | | | |
| Sample Comment: | --- | | | | |

# Particle Size Analysis - ASTM D6913




| % Cobble | % Gravel | % Sand | % Silt & Clay Size |
|---|---|---|---|
| — | 0.0 | 47.9 | 52.1 |

| Sieve Name | Sieve Size, mm | Percent Finer | Spec. Percent | Complies |
|---|---|---|---|---|
| #4 | 4.75 | 100 | | |
| #10 | 2.00 | 100 | | |
| #20 | 0.85 | 98 | | |
| #40 | 0.42 | 96 | | |
| #60 | 0.25 | 92 | | |
| #100 | 0.15 | 77 | | |
| #140 | 0.11 | 62 | | |
| #200 | 0.075 | 52 | | |
| | | | | |
| | | | | |

**Coefficients**

| | |
|---|---|
| $D_{85}$ = 0.1977 mm | $D_{30}$ = N/A |
| $D_{60}$ = 0.0984 mm | $D_{15}$ = N/A |
| $D_{50}$ = N/A | $D_{10}$ = N/A |
| $C_u$ = N/A | $C_c$ = N/A |

**Classification**

ASTM N/A

AASHTO Silty Soils (A-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

# Appendix D. Rock Core Photographs

| BORING NO. | RUN | APPROX. DEPTHS | | RECOVERY | | RQD |
|---|---|---|---|---|---|---|
| | | TOP | BOTTOM | REC. | PERCENT | |
| | | (FT) | (FT) | (IN.) | (%) | (%) |
| JB-1(OW) | C-1 | 74.0 | 79.0 | 60.0 | 100 | 78 |
| JB-1(OW) | C-2 | 79.0 | 84.0 | 54.0 | 90 | 78 |
| - | - | - | - | - | - | - |
| - | - | - | - | - | - | - |




**Wet Condition**

| | | |
|---|---|---|
| Jacobs | MANCHESTER BOSTON REGIONAL AIRPORT<br>LIGHTING VAULT EXPANSION PROJECT<br>MANCHESTER, NEW HAMPSHIRE | **BORING:** |
| | ROCK CORE PHOTOGRAPHS | JB-1(OW) |

# Appendix E. Inferred Friction Angle and Corrected N-Value

Jacobs

**CALCULATION SHEET**

Sheet No. 1

| | | | | | |
|---|---|---|---|---|---|
| Project: | Manchester Boston Airport Lighting Vault Expansion | Authored by: | XZ | Date | 10/1/2024 |
| Job No. | E2X97905 | Checked by: | GL | Date | 10/3/2024 |
| | | Revised by: | GL | Date | 10/11/2024 |

# Corrected N Value for Estimation of Soil Strength Parameters

**Boring No.** JB-1(OW)
**Ground Surface Elevation** 232 ft (NAVD 88)
**Ground Water Depth during Drilling** 13.0 ft
**Hammer Efficiency** 73 %

**Hammer Type** Auto
**Sampler Type** Standard
**SPT Rod Stickup** 5.0 ft

References:
1. FHWA-IF-02-034 (2002)
2. FHWA-NHI-10-0.16 (May 2010)
3. NAVFAC DM-7 (March 1971)
4. IDOT AGMU Memo 10.2
5. Valiquette, Robinson, and Borden (2009)

| Elevation of Sample | Boring Data | | | | | SPT Correction Factor | | | | | Corrected SPT N Value, $N_{60}$ | Vertical Effective Stress | Corrected SPT N Value, $N_{1,60}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample No. | Sample Depth | SPT N Value | Material | Borehole Diameter | | | | | | | | |
| (ft) | - | (ft) | (blows/ft) | - | (in) | $C_N$ | $C_E$ | $C_R$ | $C_B$ | $C_S$ | (blows/ft) | (psf) | (blows/ft) |
| 231.0 | S1 | 1 | 13 | FILL | 4 | 1.94 | 1.22 | 0.84 | 1.00 | 1.00 | **13** | 121 | **25.7** |
| 229.0 | S2 | 3 | 16 | FILL | 4 | 1.57 | 1.22 | 0.85 | 1.00 | 1.00 | **17** | 370 | **26.0** |
| 227.0 | S3 | 5 | 6 | FILL | 4 | 1.41 | 1.22 | 0.87 | 1.00 | 1.00 | **6** | 596 | **8.9** |
| 225.0 | S4 | 7 | 25 | SAND | 4 | 1.29 | 1.22 | 0.88 | 1.00 | 1.00 | **27** | 856 | **34.4** |
| 223.0 | S5 | 9 | 32 | SAND | 4 | 1.20 | 1.22 | 0.89 | 1.00 | 1.00 | **35** | 1,116 | **41.6** |
| 221.0 | S6 | 11 | 43 | SAND | 4 | 1.13 | 1.22 | 0.90 | 1.00 | 1.00 | **47** | 1,376 | **53.3** |
| 219.0 | S7 | 13 | 59 | SAND | 4 | 1.07 | 1.22 | 0.92 | 1.00 | 1.00 | **66** | 1,636 | **70.3** |
| 217.0 | S8 | 15 | 59 | SAND | 4 | 1.04 | 1.22 | 0.93 | 1.00 | 1.00 | **66** | 1,771 | **69.3** |
| 215.0 | S9 | 17 | 31 | SAND | 4 | 1.02 | 1.22 | 0.94 | 1.00 | 1.00 | **35** | 1,906 | **35.9** |
| 213.0 | S10 | 19 | 146 | TILL | 4 | 0.99 | 1.22 | 0.95 | 1.00 | 1.00 | **168** | 2,041 | **167.1** |
| 207.1 | S11 | 24.9 | 83 | TILL | 4 | 0.94 | 1.22 | 0.97 | 1.00 | 1.00 | **98** | 2,440 | **91.5** |
| 202.7 | S12 | 29.3 | 100 | TILL | 4 | 0.90 | 1.22 | 0.98 | 1.00 | 1.00 | **120** | 2,738 | **107.2** |
| 197.7 | S13 | 34.3 | 100 | TILL | 4 | 0.86 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 3,076 | **104.4** |
| 192.8 | S14 | 39.2 | 100 | TILL | 4 | 0.82 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 3,407 | **100.2** |
| 187.9 | S15 | 44.1 | 100 | TILL | 4 | 0.79 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 3,738 | **96.4** |
| 182.8 | S16 | 49.2 | 100 | TILL | 4 | 0.76 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 4,083 | **92.9** |
| 177.8 | S17 | 54.2 | 100 | TILL | 4 | 0.74 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 4,421 | **89.6** |
| 172.0 | S18 | 60 | 77 | TILL | 4 | 0.71 | 1.22 | 1.00 | 1.00 | 1.00 | **94** | 4,813 | **66.3** |
| 167.0 | S19 | 65 | 111 | TILL | 4 | 0.69 | 1.22 | 1.00 | 1.00 | 1.00 | **135** | 5,151 | **92.6** |
| 162.1 | S20 | 69.9 | 87 | TILL | 4 | 0.66 | 1.22 | 1.00 | 1.00 | 1.00 | **106** | 5,482 | **70.3** |

Notation:
$N_{60}$ = SPT blow count corrected for hammer efficiency (blows/ft)
$N_{1,60}$ = SPT blow count corrected for hammer efficiency and overburden pressure.
$C_N$ = SPT correction factor for overburden pressure, $C_N$ = min[0.77*log(40/σ'v),2]
$C_E$ = SPT correction factor for hammer energy, $C_E$ = 60/ER
$C_R$ = SPT Correction factor for rod length, $C_R$ = -8E-5*L^2+0.0083*L+0.7922
$C_B$ = SPT Correction factor for borehole diameter, $C_B$ = 1.0 if D < 4.5", 1.05 if 4.5" < D < 6", 1.15 if D > 6"
$C_S$ = SPT Correction factor for sampler type, $C_S$ = 1.0 if standard sampler, 1.2 if liner space without liners

Notes:
1) Overburden pressure calculated using a unit weight based on IDOT AGMU Memo 10.2
2) Rod length assumes 5' stickup during SPTs, L = depth + 5'

IDOT AGMU Memo 10.2 Unit Weights
Max Unit Weight: $\gamma_{granular,\ dry}$ (pcf)= 130
$\gamma_{granular,\ submerged}$ (pcf)= 67.6
Above Water Table: $\gamma_{granular} = 95*(N_{60})^{0.095}$ [pcf]
Below Water Table: $\gamma_{granular} = 105*(N_{60})^{0.07} - 62.4$ [pcf]
Above Water Table: $\gamma_{cohesive} = 121.5*(Qu)^{0.095}$ [pcf]
Below Water Table: $\gamma_{cohesive} = 121.5*(Qu)^{0.095} - 62.4$ [pcf]

Jacobs

**CALCULATION SHEET**

Sheet No. 2

| | | | | | |
|---|---|---|---|---|---|
| Project: | Manchester Boston Aiport Lighting Vault Expansion | Authored by: | XZ | Date | 10/1/2024 |
| Job No. | E2X97905 | Checked by: | GL | Date | 10/3/2024 |
| | | Revised by: | GL | Date | 10/11/2024 |

# Corrected N Value for Estimation of Soil Strength Parameters

**Boring No.** JB-2
**Ground Surface Elevation** 232 ft (NAVD 88)
**Ground Water Depth during Drilling** 9.0 ft
**Hammer Efficiency** 73 %

**Hammer Type** Auto
**Sampler Type** Standard
**SPT Rod Stickup** 5.0 ft

References:
1. FHWA-IF-02-034 (2002)
2. FHWA-NHI-10-0.16 (May 2010)
3. NAVFAC DM-7 (March 1971)
4. IDOT AGMU Memo 10.2
5. Valiquette, Robinson, and Borden (2009)

| Elevation of Sample | Boring Data | | | | | SPT Correction Factor | | | | | Corrected SPT N Value, $N_{60}$ | Vertical Effective Stress | Corrected SPT N Value, $N_{1,60}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample No. | Sample Depth | SPT N Value | Material | Borehole Diameter | | | | | | | | |
| (ft) | - | (ft) | (blows/ft) | - | (in) | $C_N$ | $C_E$ | $C_R$ | $C_B$ | $C_S$ | (blows/ft) | (psf) | (blows/ft) |
| 230.7 | S1 | 1.3 | 41 | FILL | 4 | 1.83 | 1.22 | 0.84 | 1.00 | 1.00 | **42** | 169 | **76.7** |
| 229.0 | S2 | 3 | 14 | FILL | 4 | 1.56 | 1.22 | 0.85 | 1.00 | 1.00 | **15** | 377 | **22.7** |
| 227.0 | S3 | 5 | 7 | FILL | 4 | 1.40 | 1.22 | 0.87 | 1.00 | 1.00 | **7** | 607 | **10.3** |
| 225.0 | S4 | 7 | 15 | SAND | 4 | 1.29 | 1.22 | 0.88 | 1.00 | 1.00 | **16** | 854 | **20.7** |
| 223.0 | S5 | 9 | 19 | SAND | 4 | 1.20 | 1.22 | 0.89 | 1.00 | 1.00 | **21** | 1,108 | **24.8** |
| 221.0 | S6 | 11 | 38 | SAND | 4 | 1.16 | 1.22 | 0.90 | 1.00 | 1.00 | **42** | 1,243 | **48.5** |
| 219.0 | S7 | 13 | 35 | Silty SAND | 4 | 1.13 | 1.22 | 0.92 | 1.00 | 1.00 | **39** | 1,378 | **43.9** |
| 217.0 | S8 | 15 | 22 | Silty SAND | 4 | 1.10 | 1.22 | 0.93 | 1.00 | 1.00 | **25** | 1,513 | **27.1** |
| 215.0 | S9 | 17 | 59 | TILL | 4 | 1.07 | 1.22 | 0.94 | 1.00 | 1.00 | **67** | 1,648 | **71.7** |
| 213.0 | S10 | 19 | 51 | TILL | 4 | 1.04 | 1.22 | 0.95 | 1.00 | 1.00 | **59** | 1,784 | **61.0** |
| 207.0 | S11 | 25 | 78 | TILL | 4 | 0.97 | 1.22 | 0.97 | 1.00 | 1.00 | **92** | 2,189 | **89.4** |
| 202.4 | S12 | 29.6 | 100 | TILL | 4 | 0.93 | 1.22 | 0.98 | 1.00 | 1.00 | **120** | 2,500 | **111.0** |
| 197.6 | S13 | 34.4 | 100 | TILL | 4 | 0.89 | 1.22 | 1.00 | 1.00 | 1.00 | **122** | 2,825 | **107.8** |

Notation:
$N_{60}$ = SPT blow count corrected for hammer efficiency (blows/ft)
$N_{1,60}$ = SPT blow count corrected for hammer efficiency and overburden pressure.
$C_N$ = SPT correction factor for overburden pressure, $C_N$ = min[0.77*log(40/σ'v),2]
$C_E$ = SPT correction factor for hammer energy, $C_E$ = 60/ER
$C_R$ = SPT Correction factor for rod length, $C_R$ = -8E-5*L^2+0.0083*L+0.7922
$C_B$ = SPT Correction factor for borehole diameter, $C_B$ = 1.0 if D < 4.5", 1.05 if 4.5" < D < 6", 1.15 if D > 6"
$C_S$ = SPT Correction factor for sampler type, $C_S$ = 1.0 if standard sampler, 1.2 if liner space without liners

Notes:
1) Overburden pressure calculated using a unit weight based on IDOT AGMU Memo 10.2
2) Rod length assumes 5' stickup during SPTs, L = depth + 5'

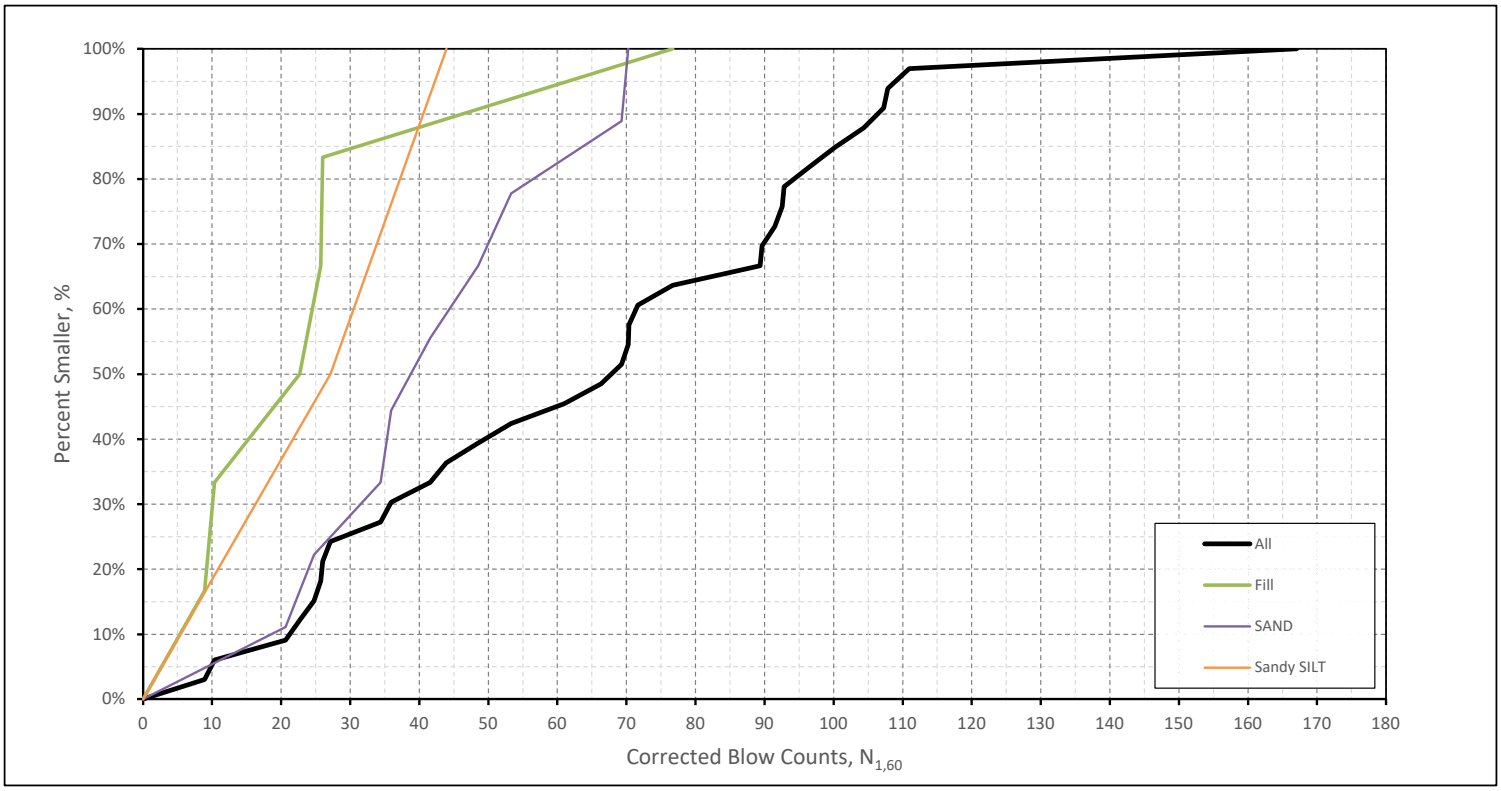
IDOT AGMU Memo 10.2 Unit Weights
Max Unit Weight: $\gamma_{granular,\ dry}$ (pcf)= 130
$\gamma_{granular,\ submerged}$ (pcf)= 67.6
Above Water Table: $\gamma_{granular} = 95*(N_{60})^{0.095}$ [pcf]
Below Water Table: $\gamma_{granular} = 105*(N_{60})^{0.07} - 62.4$ [pcf]
Above Water Table: $\gamma_{cohesive} = 121.5*(Qu)^{0.095}$ [pcf]
Below Water Table: $\gamma_{cohesive} = 121.5*(Qu)^{0.095} - 62.4$ [pcf]

| | | | | | |
|---|---|---|---|---|---|
| | | | | Sheet No. | 1 |
| Project: | Manchester Boston Aiport Lighting Vault Expansion | Authored by: | XZ | Date: | 10/1/2024 |
| Job No. | E2X97905 | Checked by: | GL | Date: | 10/11/2024 |

# N Value Distribution and Inferred Friction Angle

**NOTE:**
1. N-values and inferred friction angles from information found on borings JB-1(OW) and JB-2.
2. Representative value of 11.0 for "FILL" was used due to the inconsistent nature of fill soils at the Project site.
3. Representative value of 30.0 for "SAND" was used because the boring values did not accurately represent commonly accepted values for this strata.
4. Representative value of 45.0 for "TILL" were used because the boring values did not accurately represent commonly accepted values for this strata.

| Material | N Values | | | | | Representative Value | Inferred ϕ (deg) |
|---|---|---|---|---|---|---|---|
| | 35th % | Median | 65th % | Geomean | Arithmean | | |
| All | 42.9 | 67.8 | 82.4 | 53.6 | 65.4 | | |
| Fill | 11.6 | 22.7 | 25.4 | 21.8 | 28.4 | 11.0 | 30 |
| SAND | 34.7 | 38.8 | 47.5 | 41.1 | 44.3 | 30.0 | 36 |
| Sandy SILT | 19.0 | 27.1 | 32.2 | 34.5 | 35.5 | 19.0 | 33 |
| TILL | 89.5 | 92.6 | 97.9 | 92.3 | 95.0 | 45.0 | 40 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |



# Appendix F. Seismic Site Class and Design Category Calculation

Jacobs
120 St James Avenue
Boston, MA 02116



| | | | |
|---|---|---|---|
| JOB | Lighting Vault Expansion Project | | |
| SUBJECT | Seismic Site Class | | |
| CALCULATED BY | XZ | DATE | 10/2/2024 |
| CHECKED BY | GL | DATE | 10/3/2024 |
| RE-CHECK | | DATE | |

**Codes and Standards:**

[1] American Society of Civil Engineers (ASCE 7-22) - Minimum Design Loads and Associated Criteria for Buildings and Other Structures
[2] American Society of Civil Engineers (ASCE 7-16) - Guide to the Seismic Load Provisions of ASCE 7-16.

**PURPOSE:**

[1] Determine seismic site class in accordance with ASCE 7-16 and the International Building Code (2018).

**APPROACH:**

[1] Check for Site Class F soils requiring site-specific evaluation (see Table G4-1 developed from Table 20.3-1 of ASCE 7-16)

***Table G4-1.*** **Site Classification**

| *Site class* | $\overline{v}_s$ *(ft/s)* | $\overline{N}$ *or* $\overline{N}_{ch}$ *(blows/ft)* | $\overline{s}_u$ *(lb/ft²)* |
|---|---|---|---|
| A. Hard rock | >5,000 | NA | NA |
| B. Rock | 2,500 to 5,000 | NA | NA |
| C. Very dense soil and soft rock | 1,200 to 2,500 | >50 | >2,000 |
| D. Stiff soil | 600 to 1,200 | 15 to 50 | 1,000 to 2,000 |
| E. Soft clay soil | <600 | <15 | <1,000 |
| | Any profile with more than 10 ft of soil that has the following characteristics:<br>• Plasticity index PI > 20,<br>• Moisture content $w \geq 40\%$, and<br>• Undrained shear strength $\overline{s}_u < 500$ lb/ft². | | |
| F. Soils requiring site response analysis in accordance with Section 21.1. | See Section 20.3.1. | | |

*Source*: Table 20.3-1 of ASCE 7-16.

[2] Categorize the site using one of the $V_s$, N and $s_u$ methods.
[3] Determine the appropriate Site Class based on the boring-specific results.

**SITE CLASS RESULTS PER BORING:**

| Boring | N_bar | Site Class |
|---|---|---|
| JB-1(OW) | 59 | C |
| JB-2 | 57 | C |
| | | |

**SITE CLASS:**

Per Table G4-1 developed from Table 20.3-1 of ASCE 7-16, the two explorations performed indicate Site Class C based on N-values.

Therefore, we recommend the site be classified as **Site Class C**.

*Approx. Project Coordinates*

Latitude = 42.932637
Longitude = -71.430204

*Seismic Coefficients:*

| | | |
|---|---|---|
| $PGA_M$ = | 0.25 | ASCE Hazard Tool using ASCE 7-22 |
| $S_S$ = | 0.39 | ASCE Hazard Tool using ASCE 7-22 |
| $S_1$ = | 0.069 | ASCE Hazard Tool using ASCE 7-22 |

*Design Spectral Response Parameters:*

| | | |
|---|---|---|
| $S_{MS}$ = | 0.380 | ASCE Hazard Tool using ASCE 7-22 |
| $S_{M1}$ = | 0.088 | ASCE Hazard Tool using ASCE 7-22 |
| $S_{DS} = 2/3 S_{MS}$ = | 0.260 | Equ. 11.4-1 and ASCE Hazard Tool using ASCE 7-22 |
| $S_{D1} = 2/3 M_1$ = | 0.059 | Equ. 11.4-2 and ASCE Hazard Tool using ASCE 7-22 |

**Seismic Design Category:** **B** (ASCE 7-22 Table 11.6.2-1 and 11.6.2-2)

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Boston, MA 02116



**Table 11.6-1. Seismic Design Category Based on Short-Period Response Acceleration Parameter.**

| | Risk Category | |
|---|---|---|
| Value of $S_{DS}$ | I or II or III | IV |
| $S_{DS} < 0.167$ | A | A |
| $0.167 \leq S_{DS} < 0.33$ | B | C |
| $0.33 \leq S_{DS} < 0.50$ | C | D |
| $0.50 \leq S_{DS}$ | D | D |

**Table 11.6-2. Seismic Design Category Based on 1 s Period Response Acceleration Parameter.**

| | Risk Category | |
|---|---|---|
| Value of $S_{D1}$ | I or II or III | IV |
| $S_{D1} < 0.067$ | A | A |
| $0.067 \leq S_{D1} < 0.133$ | B | C |
| $0.133 \leq S_{D1} < 0.20$ | C | D |
| $0.20 \leq S_{D1}$. | D | |

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Boston, MA 02116
617/242-9222



| | | | |
|---|---|---|---|
| **JOB** | Manchester Boston Aiport Lighting Vault Expansion | | |
| **SUBJECT** | Seismic Site Class | | |
| **CALCULATED BY** | XZ | **DATE** | 10/2/2024 |
| **CHECKED BY** | GL | **DATE** | 10/3/2024 |
| **RE-CHECK** | | **DATE** | |

***Seismic Site Class Evaluation***

| Boring No. | Sample No. | $N_{60}$ Value | Di | $Di/N_i$ | $\bar{N}$ |
|---|---|---|---|---|---|
| JB-1(OW) | S-1 | 13 | 2.0 | 0.15 | 59 |
| | S-2 | 17 | 2.0 | 0.12 | |
| | S-3 | 6 | 2.0 | 0.32 | |
| | S-4 | 27 | 2.0 | 0.07 | |
| | S-5 | 35 | 2.0 | 0.06 | |
| | S-6 | 47 | 2.0 | 0.04 | |
| | S-7 | 66 | 2.0 | 0.03 | |
| | S-8 | 66 | 2.0 | 0.03 | |
| | S-9 | 35 | 2.0 | 0.06 | |
| | S-10 | 100 | 6.0 | 0.06 | |
| | S-11 | 98 | 5.0 | 0.05 | |
| | S-12 | 100 | 5.0 | 0.05 | |
| | S-13 | 100 | 5.0 | 0.05 | |
| | S-14 | 100 | 5.0 | 0.05 | |
| | S-15 | 100 | 5.0 | 0.05 | |
| | S-16 | 100 | 5.0 | 0.05 | |
| | S-17 | 100 | 5.0 | 0.05 | |
| | S-18 | 94 | 5.0 | 0.05 | |
| | S-19 | 100 | 5.0 | 0.05 | |
| | S-20 | 100 | 5.0 | 0.05 | |
| | Bedrock | 100 | 26.0 | 0.26 | |
| | | | | | |
| | | | | | |
| | | | | | |
| | Total Depth = | 100.0 | | | |
| | Depth to Bedrock = | 74 | SUM | 1.70 | |

$\bar{N} = \Sigma Di / \Sigma Di/Ni =$ 59

**Per AASHTO Table 3.4.2.1-1, $\bar{N}$ > 50 Site Class C**

| Boring No. | Sample No. | $N_{60}$ Value | Di | $Di/N_i$ | $\bar{N}$ |
|---|---|---|---|---|---|
| JB-2 | S-1 | 42 | 2.0 | 0.05 | 57 |
| | S-2 | 15 | 2.0 | 0.14 | |
| | S-3 | 7 | 2.0 | 0.27 | |
| | S-4 | 16 | 2.0 | 0.12 | |
| | S-5 | 21 | 2.0 | 0.10 | |
| | S-6 | 42 | 2.0 | 0.05 | |
| | S-7 | 39 | 2.0 | 0.05 | |
| | S-8 | 25 | 2.0 | 0.08 | |
| | S-9 | 67 | 2.0 | 0.03 | |
| | S-10 | 59 | 6.0 | 0.10 | |
| | S-11 | 92 | 5.0 | 0.05 | |
| | S-12 | 100 | 5.0 | 0.05 | |
| | S-13 | 100 | 0.8 | 0.01 | |
| | Bedrock | 100 | 65.2 | 0.65 | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | Total Depth = | 100 | | | |
| | Depth to Bedrock = | Note 1 | SUM | 1.75 | |

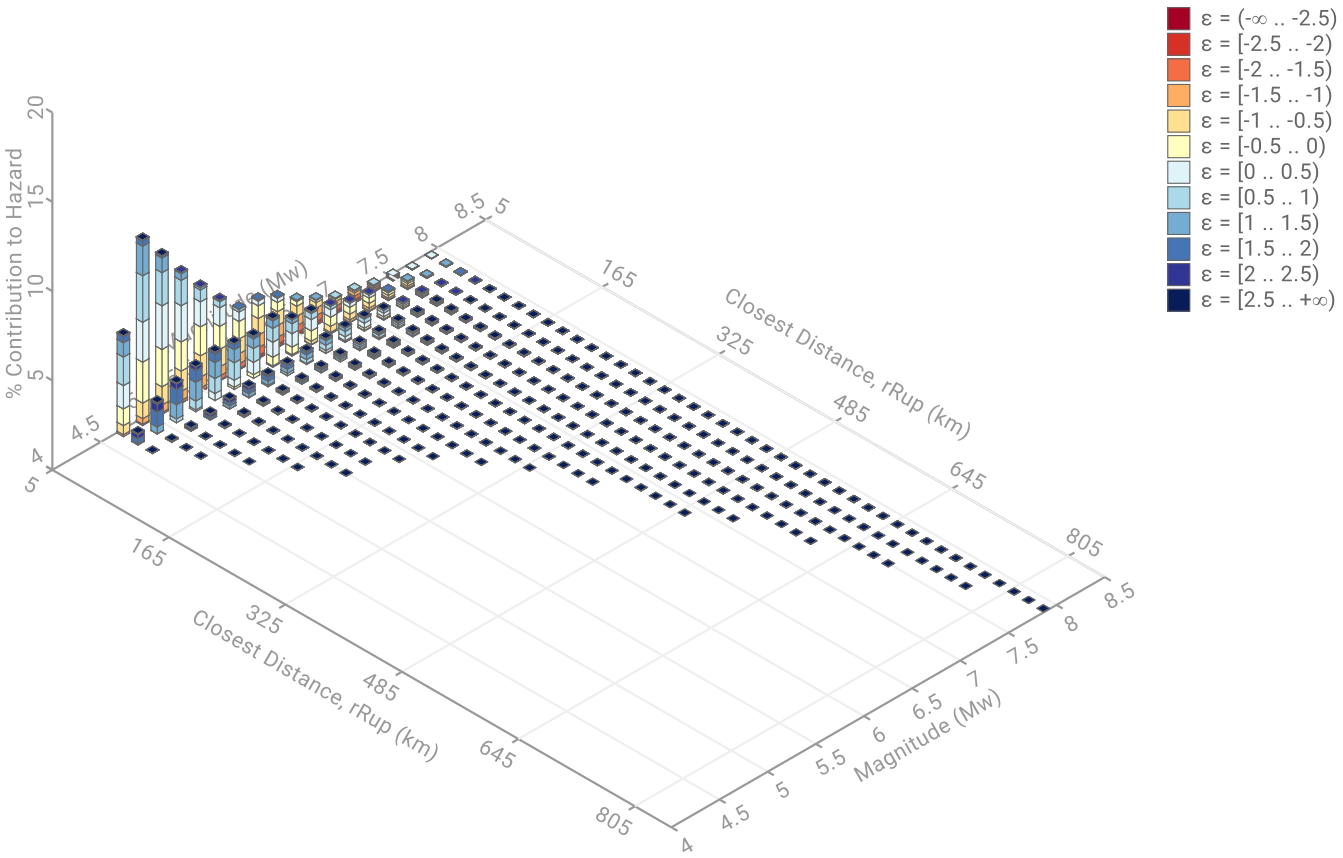
Note 1: Bedrock not encountered at boring JB-2.

$\bar{N} = \Sigma Di / \Sigma Di/Ni =$ 57

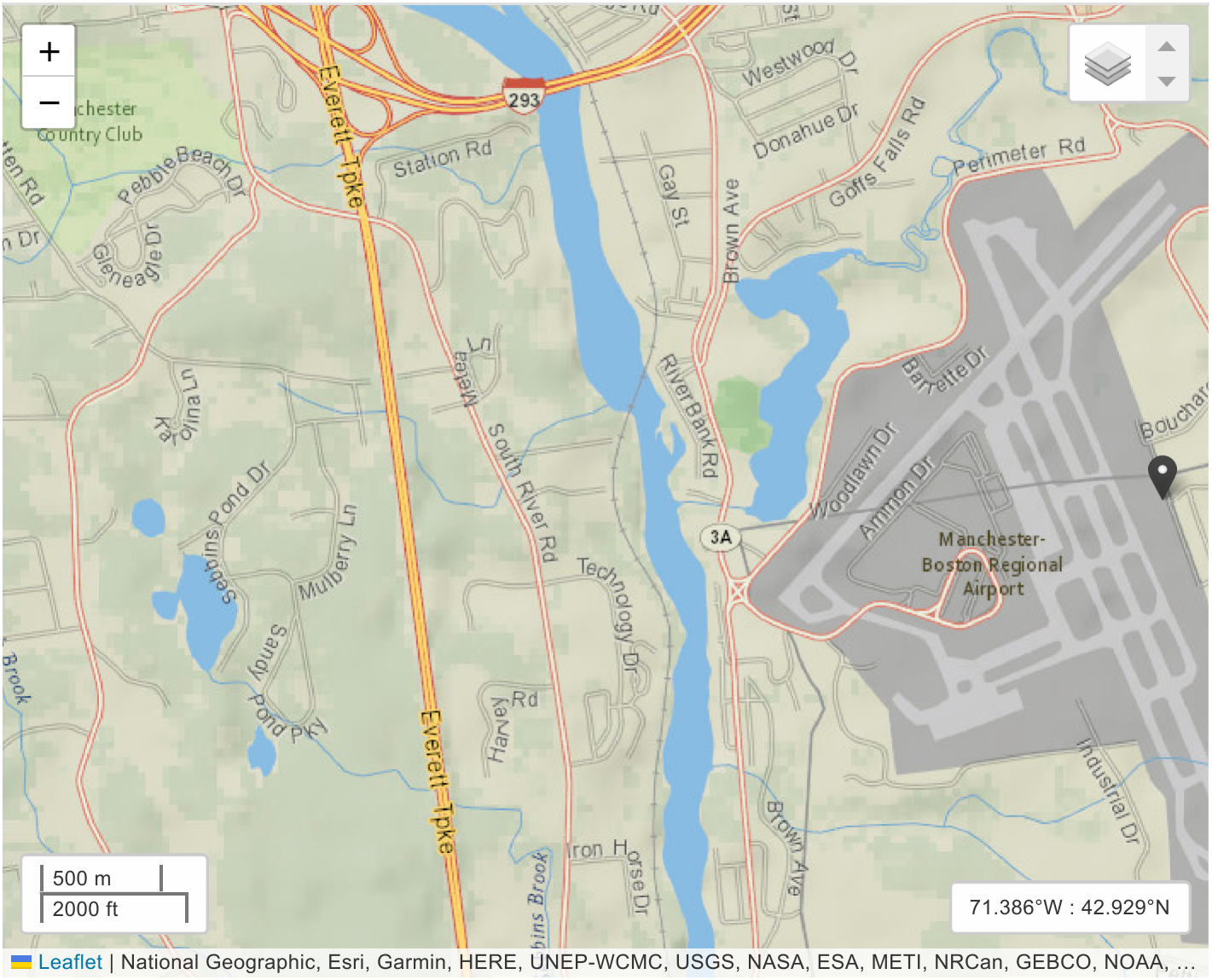
**Per AASHTO Table 3.4.2.1-1, `N > 50 Site Class C**

# Disaggregation Report

## Disaggregation



## Geographical Disaggregation




## Parameter Summary

**Model**: NSHM Conterminous U.S. 2023

**Latitude**: 42.932 °

**Longitude**: -71.43 °

**Site Class**: C (Vs30 530)

**Intensity Measure Type**: PGA

**Return Period**: 2475 (2% in 50)

**Component**: Total

## Disaggregation Summary: Total

## Disaggregation targets

**Return period** : 2475 yrs
**Exceedance rate** : 4.040e-4 $yr^{-1}$
**PGA ground motion** : 3.055e-1 g

## Recovered targets

**Return period** : 2473.0927 yrs
**Exceedance rate** : 4.044e-4 $yr^{-1}$

## Totals

**Binned** : 100 %
**Residual** : 0 %
**Trace** : 1.77 %

## Mean (over all sources)

**m** : 5.77
**r** : 27.77 km
**$\varepsilon_0$** : 0.26 σ

## Mode (largest m-r bin)

**m** : 4.9
**r** : 11.41 km
**$\varepsilon_0$** : 0.32 σ
**Contribution** : 10.37 %

## Mode (largest m-r-$\varepsilon_0$ bin)

**m** : 4.9
**r** : 13.29 km
**$\varepsilon_0$** : 0.71 σ
**Contribution** : 2.6 %

## Discretization

**r** : min = 0.0, max = 1000.0, Δ = 20.0 km
**m** : min = 4.4, max = 9.4, Δ = 0.2
**ε** : min = -3.0, max = 3.0, Δ = 0.5 σ

## Epsilon keys

**ε0** : [-∞ .. -2.5)
**ε1** : [-2.5 .. -2.0)
**ε2** : [-2.0 .. -1.5)
**ε3** : [-1.5 .. -1.0)
**ε4** : [-1.0 .. -0.5)
**ε5** : [-0.5 .. 0.0)
**ε6** : [0.0 .. 0.5)
**ε7** : [0.5 .. 1.0)
**ε8** : [1.0 .. 1.5)
**ε9** : [1.5 .. 2.0)
**ε10** : [2.0 .. 2.5)
**ε11** : [2.5 .. +∞]

## Disaggregation Contributions: Total

| Source Set ↳ Source | Type | r | m | $\varepsilon_0$ | lon | lat | az | % |
|---|---|---|---|---|---|---|---|---|
| USGS Extended Margin [2] (nn, adaptive) (opt) | Grid | | | | | | | 12.85 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 2.32 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 2.13 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.84 |
| PointSourceFinite: -71.430, 43.134 | | 21.53 | 5.73 | 0.48 | 71.430°W | 43.134°N | 0.00 | 1.34 |
| SSCn Mesozoic [4,5] (nn, adaptive) (opt) | Grid | | | | | | | 12.84 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 2.32 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 2.13 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.84 |
| PointSourceFinite: -71.430, 43.134 | | 21.53 | 5.73 | 0.48 | 71.430°W | 43.134°N | 0.00 | 1.34 |
| SSCn Mesozoic [4,5] (gk, adaptive) (opt) | Grid | | | | | | | 10.51 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.86 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.71 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.48 |
| PointSourceFinite: -71.430, 43.134 | | 21.53 | 5.73 | 0.48 | 71.430°W | 43.134°N | 0.00 | 1.08 |
| USGS Extended Margin [2] (gk, adaptive) (opt) | Grid | | | | | | | 10.5 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.86 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.71 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.48 |
| PointSourceFinite: -71.430, 43.134 | | 21.53 | 5.73 | 0.48 | 71.430°W | 43.134°N | 0.00 | 1.08 |
| USGS Extended Margin [2] (gk, fixed) (opt) | Grid | | | | | | | 9.57 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.63 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.52 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.31 |
| SSCn Mesozoic [4,5] (gk, fixed) (opt) | Grid | | | | | | | 9.56 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.63 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.52 |
| PointSourceFinite: -71.430, 43.089 | | 17.23 | 5.57 | 0.29 | 71.430°W | 43.089°N | 0.00 | 1.31 |
| USGS Extended Margin [2] (nn, fixed) (opt) | Grid | | | | | | | 7.5 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.22 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.14 |
| SSCn Mesozoic [4,5] (nn, fixed) (opt) | Grid | | | | | | | 7.49 |
| PointSourceFinite: -71.430, 43.044 | | 12.91 | 5.42 | -0.01 | 71.430°W | 43.044°N | 0.00 | 1.22 |
| PointSourceFinite: -71.430, 42.999 | | 8.77 | 5.31 | -0.41 | 71.430°W | 42.999°N | 0.00 | 1.14 |
| SSCn Mesozoic [4,5] (r85, adaptive) (opt) | Grid | | | | | | | 4.82 |
| USGS Extended Margin [2] (r85, adaptive) (opt) | Grid | | | | | | | 4.82 |
| USGS Extended Margin [2] (r85, fixed) (opt) | Grid | | | | | | | 4.66 |
| SSCn Mesozoic [4,5] (r85, fixed) (opt) | Grid | | | | | | | 4.66 |

## Application Metadata

**Application**: Disaggregation
**URL**: https://earthquake.usgs.gov/nshmp/hazard/disagg

**Repository**: nshmp-apps
**Version**: 4.5.1
**URL**: https://code.usgs.gov/ghsc/nshmp/nshmp-apps

**Repository** : nshmp-haz
**Version**: 2.4.15
**URL:** https://code.usgs.gov/ghsc/nshmp/nshmp-haz

**Repository** : nshmp-lib
**Version**: 1.4.27
**URL:** https://code.usgs.gov/ghsc/nshmp/nshmp-lib

**Repository** : nshmp-utils-java
**Version**: 0.4.0
**URL:** https://code.usgs.gov/ghsc/nshmp/nshmp-utils-java

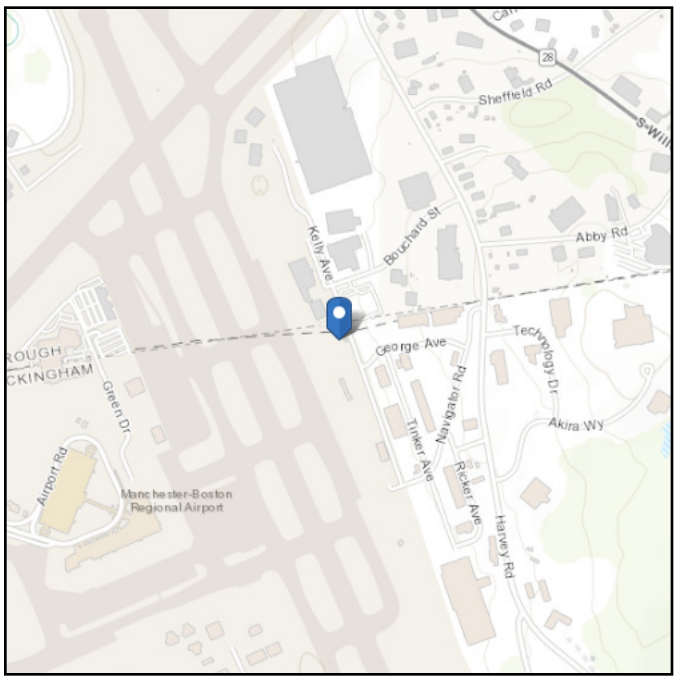
**Repository** : nshm-conus
**Version**: 6.0.0
**URL:** https://code.usgs.gov/ghsc/nshmp/nshms/nshm-conus

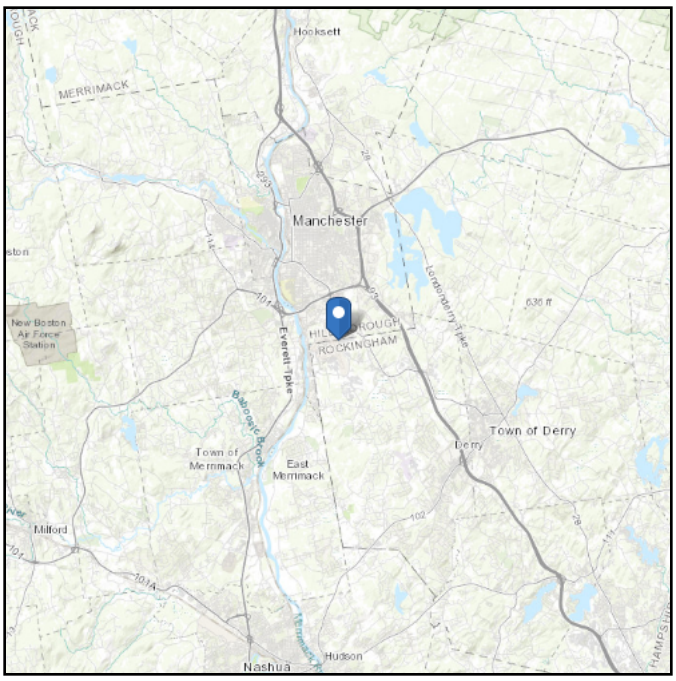
October 08, 2024, 08:09 PM

# ASCE Hazards Report

**Address:**
No Address at This Location

| | | | |
|---|---|---|---|
| **Standard:** | ASCE/SEI 7-22 | **Latitude:** | 42.932617 |
| **Risk Category:** | I | **Longitude:** | -71.430432 |
| **Soil Class:** | C - Very Dense Soil and Soft Rock | **Elevation:** | 230.8383775213423 ft (NAVD 88) |



# Seismic

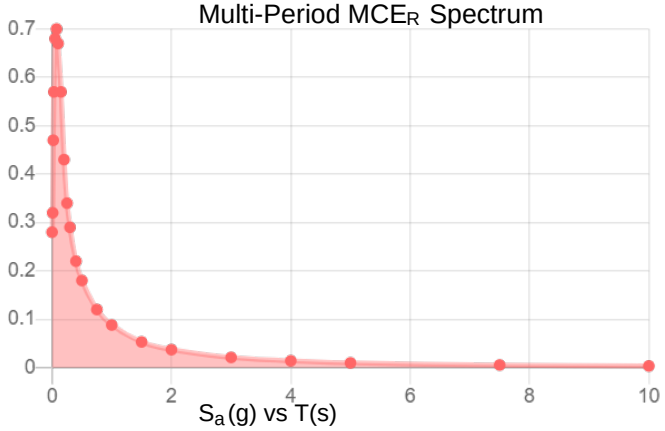
**Site Soil Class:** C - Very Dense Soil and Soft Rock

**Results:**

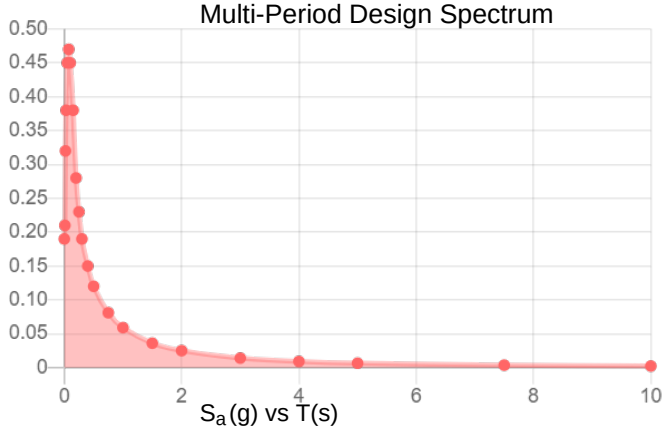
| | | | |
|---|---|---|---|
| $PGA_M$ : | 0.26 | $T_L$ : | 6 |
| $S_{MS}$ : | 0.38 | $S_S$ : | 0.39 |
| $S_{M1}$ : | 0.088 | $S_1$ : | 0.069 |
| $S_{DS}$ : | 0.26 | $V_{S30}$ : | 530 |
| $S_{D1}$ : | 0.059 | | |

**Seismic Design Category: B**

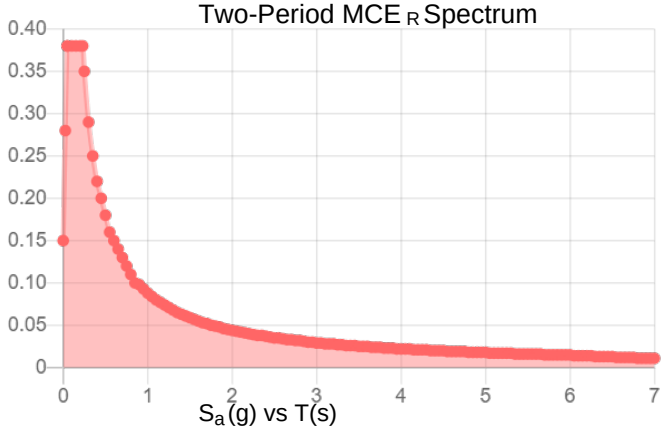
Multi-Period $MCE_R$ Spectrum



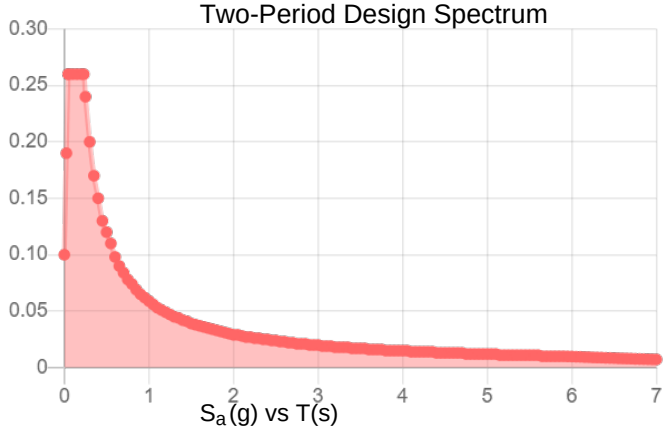

Multi-Period Design Spectrum




Two-Period $MCE_R$ Spectrum




Two-Period Design Spectrum




$MCE_R$ Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

Design Vertical Response Spectrum

Vertical ground motion data has not yet been made available by USGS.

**Data Accessed:** Tue Oct 08 2024

**Date Source:**
**USGS Seismic Design Maps based on ASCE/SEI 7-22 and ASCE/SEI 7-22 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-22 Ch. 21 are available from USGS.**

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# LIQUEFACTION ANALYSIS

Modified 11/7/14

REFERENCE BORING NUMBER ========== JB-1(OW)
ELEVATION OF BORING GROUND SURFACE ========== 231.7 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 13.0 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 13.0 FT. (Below Finished Grade Cut or Fill Surface)
SITE COEFFICIENT (S) ========== 1.2
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ====== 0.14 g
EARTHQUAKE MOMENT MAGNITUDE ========== 5.77
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 % automatic
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

**EQ MAGNITUDE SCALING FACTOR**
(MSF) = **1.797**

**AVG. SHEAR WAVE VELOCITY (top 40')**
$V_{s,40'}$ = **1223** FT./SEC.

**2014 USGS DEAGGREGATION MAPS DATA**
Earthquake Moment Magnitude = 5.77
Source-To-Site Distance, R (km) = 27.77
*A* = 0.11 g

| | BORING DATA | | | | | | | CONDITIONS DURING DRILLING | | | | | CONDITIONS DURING EARTHQUAKE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV. OF SAMPLE (FT.) | BORING SAMPLE DEPTH (FT.) | SPT N VALUE (BLOWS) | UNCONF. COMPR. STR., $Q_u$ (TSF.) | % FINES < #200 (%) | PLAST. INDEX PI | LIQUID LIMIT LL | MOIST. CONTENT $w_c$ (%) | EFFECTIVE UNIT WT. (KCF.) | EFFECTIVE VERT. STRESS (KSF.) | CORR. SPT N VALUE $(N_1)_{60}$ | EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$ | CRR RESIST. MAG 7.5 $CRR_{7.5}$ | EFFECTIVE UNIT WT. (KCF.) | EFFECTIVE VERT. STRESS (KSF.) | TOTAL VERT. STRESS (KSF.) | OVER-BURDEN CORR. FACT. (Ks) | CORR. RESIST. $CRR_{7.5}$ CRR | SOIL MASS PART. FACTOR $(r_d)$ | EQ INDUCED CSR | FACTOR OF SAFETY * CRR/CSR |
| 230.7 | 1 | 13 | | 5 | | | | 0.121 | 0.121 | 24.623 | 24.623 | 0.285 | 0.121 | 0.121 | 0.121 | 1.500 | **0.767** | 1.000 | **0.089** | **N.L. (1)** |
| 228.7 | 3 | 16 | | 12.7 | | | | 0.124 | 0.369 | 29.364 | 32.189 | 0.786 | 0.124 | 0.369 | 0.369 | 1.500 | **2.119** | 1.000 | **0.089** | **N.L. (1)** |
| 226.7 | 5 | 6 | | 12.7 | | | | 0.113 | 0.595 | 8.948 | 11.053 | 0.123 | 0.113 | 0.595 | 0.595 | 1.353 | **0.298** | 1.000 | **0.089** | **N.L. (1)** |
| 224.7 | 7 | 25 | | 10 | | | | 0.129 | 0.853 | 40.717 | 42.467 | 0.192 | 0.129 | 0.853 | 0.853 | 1.439 | **0.496** | 1.000 | **0.089** | **N.L. (1)** |
| 222.7 | 9 | 32 | | 10 | | | | 0.132 | 1.117 | 51.130 | 53.105 | 0.336 | 0.132 | 1.117 | 1.117 | 1.292 | **0.781** | 1.000 | **0.089** | **N.L. (1)** |
| 220.7 | 11 | 43 | | 5 | | | | 0.136 | 1.389 | 67.311 | 67.311 | 0.464 | 0.136 | 1.389 | 1.389 | 1.184 | **0.987** | 1.000 | **0.089** | **N.L. (1)** |
| 218.7 | 13 | 59 | | 5 | | | | 0.140 | 1.669 | 89.611 | 89.611 | 0.641 | 0.140 | 1.669 | 1.669 | 1.100 | **1.267** | 1.000 | **0.089** | **N.L. (1)** |
| 216.7 | 15 | 59 | | 5 | | | | 0.077 | 1.823 | 89.011 | 89.011 | 0.636 | 0.077 | 1.823 | 1.948 | 1.062 | **1.214** | 1.000 | **0.095** | **N.L. (3)** |
| 214.7 | 17 | 31 | | 5 | | | | 0.071 | 1.965 | 46.305 | 46.305 | 0.257 | 0.071 | 1.965 | 2.215 | 1.031 | **0.476** | 1.000 | **0.100** | **N.L. (3)** |
| 212.7 | 19 | 146 | | 5 | | | | 0.086 | 2.137 | 213.595 | 213.595 | 1.572 | 0.086 | 2.137 | 2.511 | 0.997 | **2.815** | 1.000 | **0.105** | **N.L. (3)** |
| 206.8 | 24.9 | 83 | | 5 | | | | 0.081 | 2.615 | 113.422 | 113.422 | 0.823 | 0.081 | 2.615 | 3.357 | 0.920 | **1.359** | 1.000 | **0.114** | **N.L. (3)** |
| 202.4 | 29.3 | 100 | | 5 | | | | 0.083 | 2.980 | 129.032 | 129.032 | 0.940 | 0.083 | 2.980 | 3.997 | 0.873 | **1.474** | 1.001 | **0.119** | **N.L. (3)** |
| 197.4 | 34.3 | 100 | | 5 | | | | 0.083 | 3.395 | 120.991 | 120.991 | 0.880 | 0.083 | 3.395 | 4.724 | 0.828 | **1.309** | 1.001 | **0.124** | **N.L. (3)** |
| 192.5 | 39.2 | 100 | | 5 | | | | 0.083 | 3.802 | 113.950 | 113.950 | 0.827 | 0.083 | 3.802 | 5.437 | 0.792 | **1.176** | 1.002 | **0.127** | **N.L. (3)** |
| 187.6 | 44.1 | 100 | | 5 | | | | 0.083 | 4.209 | 107.689 | 107.689 | 0.779 | 0.083 | 4.209 | 6.149 | 0.760 | **1.064** | 1.003 | **0.130** | **N.L. (3)** |
| 182.5 | 49.2 | 100 | | 5 | | | | 0.083 | 4.632 | 101.848 | 101.848 | 0.735 | 0.083 | 4.632 | 6.891 | 0.732 | **0.966** | 1.005 | **0.133** | **N.L. (3)** |
| 177.5 | 54.2 | 100 | | 5 | | | | 0.083 | 5.047 | 96.634 | 96.634 | 0.695 | 0.083 | 5.047 | 7.618 | 0.707 | **0.883** | 1.009 | **0.135** | **N.L. (3)** |
| 171.7 | 60 | 77 | | 5 | | | | 0.080 | 5.511 | 70.288 | 70.288 | 0.488 | 0.080 | 5.511 | 8.444 | 0.682 | **0.599** | 1.015 | **0.138** | **N.L. (3)** |
| 166.7 | 65 | 100 | | 5 | | | | 0.083 | 5.926 | 86.868 | 86.868 | 0.620 | 0.083 | 5.926 | 9.171 | 0.663 | **0.738** | 1.117 | **0.154** | **N.L. (3)** |
| 161.8 | 69.9 | 87 | | 5 | | | | 0.081 | 6.323 | 72.201 | 72.201 | 0.504 | 0.081 | 6.323 | 9.873 | 0.646 | **0.585** | 1.111 | **0.154** | **N.L. (3)** |

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c$/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

# LIQUEFACTION ANALYSIS

Modified 11/7/14

REFERENCE BORING NUMBER ========== JB-2
ELEVATION OF BORING GROUND SURFACE ========== 232.7 FT.
DEPTH TO GROUNDWATER - DURING DRILLING ========== 9.0 FT. (Below Boring Ground Surface)
DEPTH TO GROUNDWATER - DURING EARTHQUAKE ========== 9.0 FT. (Below Finished Grade Cut or Fill Surface)
SITE COEFFICIENT (S) ========== 1.2
PEAK HORIZ. GROUND SURFACE ACCELERATION COEFFICIENT (As) ====== 0.14 g
EARTHQUAKE MOMENT MAGNITUDE ========== 5.77
FINISHED GRADE FILL OR CUT FROM BORING SURFACE ========== 0.00 FT.
HAMMER EFFICIENCY========== 73 % automatic
BOREHOLE DIAMETER========== 2.5 to 4.5 IN.
SAMPLING METHOD========== Sampler w/out Liners

**EQ MAGNITUDE SCALING FACTOR**
(MSF) = **1.797**

**AVG. SHEAR WAVE VELOCITY (top 40')**
$V_{s,40'}$ = **1089** FT./SEC.

**2014 USGS DEAGGREGATION MAPS DATA**
Earthquake Moment Magnitude = 5.77
Source-To-Site Distance, R (km) = 27.77
*A* = 0.11 g

| | BORING DATA | | | | | | | CONDITIONS DURING DRILLING | | | | | CONDITIONS DURING EARTHQUAKE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV. OF SAMPLE (FT.) | BORING SAMPLE DEPTH (FT.) | SPT N VALUE (BLOWS) | UNCONF. COMPR. STR., $Q_u$ (TSF.) | % FINES < #200 (%) | PLAST. INDEX PI | LIQUID LIMIT LL | MOIST. CONTENT $w_c$ (%) | EFFECTIVE UNIT WT. (KCF.) | EFFECTIVE VERT. STRESS (KSF.) | CORR. SPT N VALUE $(N_1)_{60}$ | EQUIV. CLN. SAND SPT N VALUE $(N_1)_{60cs}$ | CRR RESIST. MAG 7.5 $CRR_{7.5}$ | EFFECTIVE UNIT WT. (KCF.) | EFFECTIVE VERT. STRESS (KSF.) | TOTAL VERT. STRESS (KSF.) | OVER-BURDEN CORR. FACT. (Ks) | CORR. RESIST. $CRR_{7.5}$ CRR | SOIL MASS PART. FACTOR $(r_d)$ | EQ INDUCED CSR | FACTOR OF SAFETY * CRR/CSR |
| 231.4 | 1.3 | 41 | | 5 | | | | 0.135 | 0.176 | 82.682 | 82.682 | 0.587 | 0.135 | 0.176 | 0.176 | 1.500 | **1.582** | 1.000 | **0.089** | **N.L. (1)** |
| 229.7 | 3 | 14 | | 5 | | | | 0.122 | 0.383 | 24.898 | 24.898 | 0.290 | 0.122 | 0.383 | 0.383 | 1.500 | **0.781** | 1.000 | **0.089** | **N.L. (1)** |
| 227.7 | 5 | 7 | | 9.3 | | | | 0.114 | 0.611 | 10.420 | 11.257 | 0.124 | 0.114 | 0.611 | 0.611 | 1.347 | **0.301** | 1.000 | **0.089** | **N.L. (1)** |
| 225.7 | 7 | 15 | | 5 | | | | 0.123 | 0.857 | 22.632 | 22.632 | 0.251 | 0.123 | 0.857 | 0.857 | 1.325 | **0.598** | 1.000 | **0.089** | **N.L. (1)** |
| 223.7 | 9 | 19 | | 5 | | | | 0.126 | 1.109 | 29.082 | 29.082 | 0.414 | 0.126 | 1.109 | 1.109 | 1.255 | **0.934** | 1.000 | **0.089** | **N.L. (1)** |
| 221.7 | 11 | 38 | | 5 | | | | 0.073 | 1.255 | 61.584 | 61.584 | 0.415 | 0.073 | 1.255 | 1.380 | 1.233 | **0.920** | 1.000 | **0.098** | **N.L. (3)** |
| 219.7 | 13 | 35 | | 10 | | | | 0.072 | 1.399 | 56.801 | 58.898 | 0.391 | 0.072 | 1.399 | 1.649 | 1.181 | **0.830** | 1.000 | **0.105** | **N.L. (3)** |
| 217.7 | 15 | 22 | | 50 | | | | 0.068 | 1.535 | 34.211 | 46.053 | 0.253 | 0.068 | 1.535 | 1.909 | 1.138 | **0.518** | 1.000 | **0.111** | **N.L. (3)** |
| 215.7 | 17 | 59 | | 10 | | | | 0.077 | 1.689 | 93.878 | 96.777 | 0.696 | 0.077 | 1.689 | 2.188 | 1.095 | **1.370** | 1.000 | **0.115** | **N.L. (3)** |
| 213.7 | 19 | 51 | | 10 | | | | 0.076 | 1.841 | 79.650 | 82.242 | 0.584 | 0.076 | 1.841 | 2.465 | 1.058 | **1.109** | 1.000 | **0.119** | **N.L. (3)** |
| 207.7 | 25 | 78 | | 5 | | | | 0.080 | 2.321 | 113.067 | 113.067 | 0.820 | 0.080 | 2.321 | 3.319 | 0.964 | **1.421** | 1.000 | **0.127** | **N.L. (3)** |
| 203.1 | 29.6 | 100 | | 5 | | | | 0.083 | 2.703 | 135.932 | 135.932 | 0.992 | 0.083 | 2.703 | 3.988 | 0.907 | **1.618** | 1.000 | **0.131** | **N.L. (3)** |
| 198.3 | 34.4 | 100 | | 5 | | | | 0.083 | 3.101 | 127.310 | 127.310 | 0.927 | 0.083 | 3.101 | 4.686 | 0.859 | **1.431** | 1.000 | **0.134** | **N.L. (3)** |

* FACTOR OF SAFETY DESCRIPTIONS

N.L. (1) = NOT LIQUEFIABLE, ABOVE EQ GROUND WATER ELEVATION
N.L. (2) = NOT LIQUEFIABLE, PI $\geq$ 12 OR $w_c$/LL $\leq$ 0.85
N.L. (3) = NOT LIQUEFIABLE, $(N_1)_{60} > 25$
(C) = CONTRACTIVE SOIL TYPES
(D) = DILATIVE SOIL TYPES

# Appendix G. Bearing Capacity Analyses

| | | | | | |
|---|---|---|---|---|---|
| Project: | Lighting Vault Expansion Project | Prepared by | XZ | Date | 10/3/2024 |
| Job No.: | E2X97905 | Checked by | GL | Date | 10/7/2024 |
| Subject: | Shallow Foundation Design | Revised by | GL | Date | 10/11/2024 |
| | | Rechecked by | CD | Date | 10/17/2024 |

**Reference:**

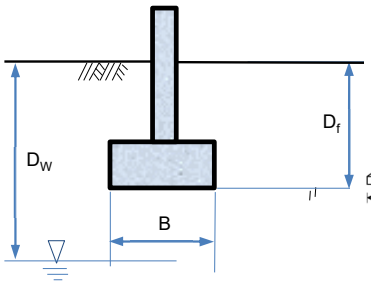
- AASHTO LRFD Bridge Design Specifications 2020.

**Assumptions:**

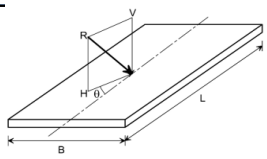
- e = B/3 is assumed for preliminary design
- embedment depth is assumed to be 4.0 ft sitting on the natural sand and gravel layer
- GS El. = 232.7 ft (assumed using topographic map), FFE = 234 ft, BOF El. = 227.5 ft, GW El. = 219 ft (Based on JB-1(OW) & JB-2)
- 1 ksf service load (structural)

**Input:**

Footing Shape: Continuous Foundation
Footing Rigidity: Flexible




If applicable




Service Load (Vertical Uniform Pressure)

| | | |
|---|---|---|
| $p_o = \sigma_v$ = | 1.0 | ksf (Structural) |
| H = | 0 | |
| V = | 0 | |
| q = | 0 | |

*Dimension:*

| | | |
|---|---|---|
| Footing Width, B = | 4.0 | ft |
| Length, L = | 47.0 | ft |
| Eccentricity, e = | 1.33 | ft (B/3 is assumed for preliminary design) |
| Effective Width, B' = | 1.3 | ft |
| Slope Angle, β = | 0 | degrees |
| Embedment Depth, $D_f$ = | 4 | ft |
| Height of Slope, Hs= | 0 | ft |
| Distance to Slope, b= | 0 | ft |

*Groundwater:*

| | | |
|---|---|---|
| $D_w$ = | 13.00 | ft |
| $\gamma_w$ = | 62.40 | pcf |

*Soil Above Footing:*

| | | | |
|---|---|---|---|
| Unit Weight | $\gamma_q$ = | 125 | pcf |

*Foundation Soil:* Sand - Med to Dense

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Unit Weight | $\gamma_f$ = | 120 | pcf | | | | Cohesion, c = | 0 psf |
| | | | | | | | Friction angle ,φ = | 30 degrees |
| Young's mod. | Es = | 4.17 | ksi | [ | 4.17 | to 6.94 | ]ksi | AASHTO Table C10.4.6.3-1 |
| Poisson's Ratio | v = | 0.3 | | [ | 0.2 | to 0.36 | ] | |

**Assume bearing on existing granular fill.

***Munfakh et al. (2001)***

$q_n = cN_{cm}\, x\, \gamma_q D_f N_{qm} C_{wq} + 0.5\gamma_f B N_{\gamma m} C_{w\gamma}$ 10.6.3.1.2a-1 = 11122 psf

$N_{cm} = N_c s_c i_c$ 10.6.3.1.2a-2 = 30.62 dim

$N_{qm} = N_q s_q d_q i_q$ 10.6.3.1.2a-3 = 18.70 dim

$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$ 10.6.3.1.2a-4 = 22.15 dim

**Load inclination Factors - From Eqn. 10.6.3.1.2a-5 to 10.6.3.1.2a-9**

$$n = \left[\frac{2+\frac{L}{B}}{1+\frac{L}{B}}\right]\cos^2\theta + \left[\frac{2+\frac{B}{L}}{1+\frac{B}{L}}\right] sin^2\theta$$ n = 1.08

$$i_c = \begin{cases} 1-(nH/(cBLN_c)) & \text{for } Ø=0 \\ i_q - ((1-i_q)/(N_q-1)) & \text{for } Ø>0 \end{cases}$$ $i_c$ = 1

$$i_q = \left[1 - \frac{H}{V + cBLcot(\phi_f)}\right]^n$$ $i_q$ = 1

$$i_\gamma = \left[1 - \frac{H}{V + cBLcot(\phi_f)}\right]^{(n+1)}$$ $i_\gamma$ = 1

**Bearing Capacity Factors - Table 10.6.3.1.2a-1**

| | |
|---|---|
| $N_c$ = | 30.1 |
| $N_q$ = | 18.4 |
| $N_\gamma$ = | 22.4 |

**Groundwater Coefficients - Table 10.6.3.1.2a-2**

| | $D_w$ | $C_{wq}$ | $C_{wg}$ | | |
|---|---|---|---|---|---|
| G.S | 0 | 0.5 | 0.5 | $C_{wq}$ = | 1.00 |
| Df = | 4 | 1 | 0.5 | $C_{wg}$ = | 1.00 |
| 1.5B'+Df= | 6 | 1 | 1 | | |

**Depth Correction Factor - Eqn 10.6.3.1.2a-3**

$$d_q = 1 + 2tan\phi_f(1 - sin\phi_f)^2 \arctan(\frac{D_f}{B})$$

$d_q$ = 1

Note that $d_q$ should not exceed 1.4

$\phi$ should be in between 32° to 42° and range of $D_f/B$ of 1 to 8

**Shape Correction Factors - Table 10.6.3.1.2a-3**

$$S_c = \begin{cases} 1 + [B'/(5L)] & \text{for Ø=0} \\ 1 + (B'/L)(N_q/N_c) & \text{for Ø>0} \end{cases} \quad = \quad 1.02$$

$$S_\gamma = \begin{cases} 1.0 & \text{for Ø=0} \\ 1 - 0.4(B'/L) & \text{for Ø>0} \end{cases} \quad = \quad 0.99$$

$$S_q = \begin{cases} 1.0 \\ 1 + \left(\frac{B'}{L}\tan\phi\right) \end{cases} \begin{matrix} \text{for Ø=0} \\ \text{for Ø>0} \end{matrix} \quad = \quad 1.02$$

**Footings on Slope - Table 10.6.3.1.2c-2**

| | |
|---|---|
| Ns = | c=0 |
| b/B = | 0.00 |
| B/H = | 0.3 |
| $RC_{BC}$ = | 1.00 |

Note that $RC_{BC}$ = 1 for no-slope condition

| | β | | |
|---|---|---|---|
| **b/B** | 20 | 30 | 0 |
| 0.5 | 0.51 | 0.35 | 0.83 |
| 1.25 | 0.72 | 0.58 | 1.00 |
| 0.00 | 0.37 | 0.20 | 0.72 |

$q_{n\text{-sloping ground}} = q_{ult} \times RC_{BC}$ = 11122 psf

**Factored Bearing Resistance - Eqn 10.6.3.1.1-1**

$resistance\ factor, \phi_b$ = 0.45

$q_R = \phi_b q_n = \phi_b \times q_n$ = 5005 psf

**Results:** **1. Factored Bearing Resistance**

| Method | Factored Bearing Capacity (psf) | Note |
|---|---|---|
| AASHTO 2020<br>Munfakh et al. (2001) | **5,005** | Strength Limit State |

****Use 4ksf to match the recommended bearing pressure from the existing adjacent structure.**

**2. Estimated Settlement under Service Load:**

| Method | $S_e$ | |
|---|---|---|
| Hough method | 0.19 | in |
| Half-space method | 0.05 | in |

Hough Method $S_e = \sum_{i=1}^{n} \Delta H_i \quad \Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_o + \Delta\sigma_v}{\sigma'_o}\right)$ (10.6.2.4.2b-2)

Half-space Method $S_e = \frac{q_o(1-\nu^2)\sqrt{A'}}{144 E_S \beta_Z}$

| | | | | | |
|---|---|---|---|---|---|
| Project: | Lighting Vault Expansion Project | Prepared by | XZ | Date | 10/4/2024 |
| Job No.: | E2X97905 | Checked by | GL | Date | 10/7/2024 |
| Subject: | Shallow Foundation Design | Revised by | GL | Date | 10/7/2024 |
| | | Rechecked by | CD | Date | 10/17/2024 |

# Settlement Estimation under Service Loading Case

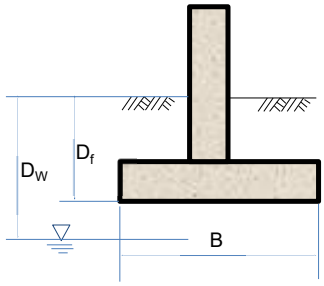
***Reference:*** - AASHTO LRFD Bridge Design Specifications 2014.

***Assumptions:***

Loading Condition: Service

Footing:

| | | | | |
|---|---|---|---|---|
| Footing Rigidity | Flexible | | | |
| Footing Length | L = | 47 | ft | |
| Footing Width | B = | 4.00 | ft | |
| | L/B = | 35.25 | | |
| Eccentricity | e = | 1.33 | ft | |
| Effective footing width | B' = | 1.33 | ft | |
| Effective area of footing | A'=LB'= | 17.78 | $ft^2$ | |
| Vertical uniform pressure | $p_o = \sigma_v$ = | 1.0 | ksf | |




Foundation Soil: Cohesionless soil

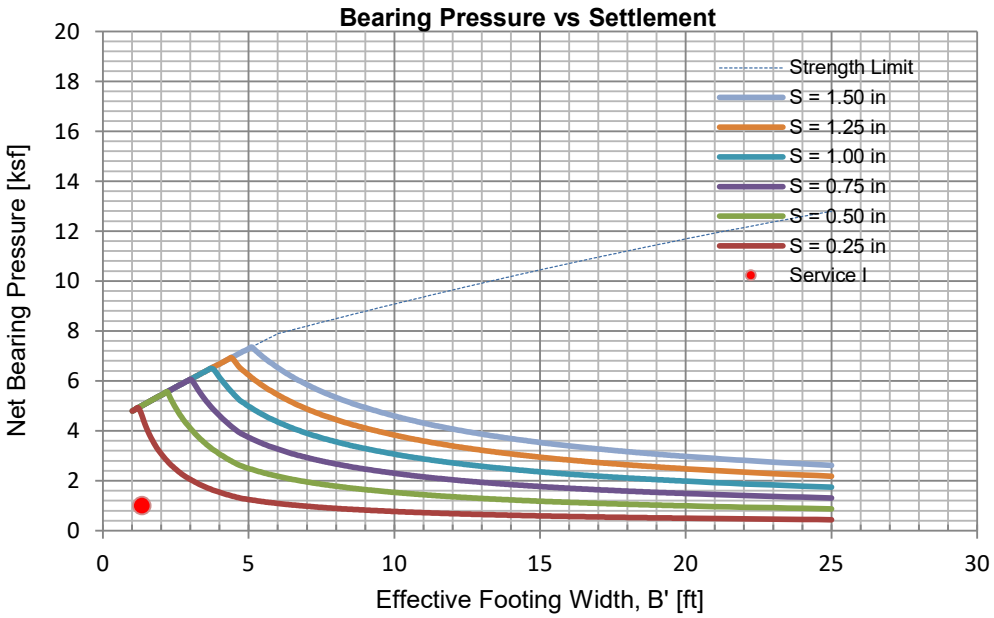
| | | | | | | |
|---|---|---|---|---|---|---|
| Unit weight | $\gamma_f$ = | 0.120 | kcf | $D_w$ = | 13.00 | ft |
| Friction Angle | φ = | 30 | deg. | $D_f$ = | 4 | ft |
| Cohesion | c = | 0 | ksf | $\gamma_w$ = | 0.06 | kcf |
| Young's modulus | Es = | 4.17 | ksi | AASHTO 10.4.6.3 | | |
| Poisson's Ratio | ν = | 0.3 | | AASHTO 10.4.6.3 | | |

***Elastic Settlement Estimation***

Shape Factor $\beta z$ = 1.41 AASHTO Table 10.6.2.4.2-1

The elastic settlement of spread footing, in feet, is estimated by the elastic half-space method:

$$S_e = \frac{q_o(1-\nu^2)\sqrt{A'}}{144 E_S \beta_Z}$$ = **0.05** inches AASHTO 10.6.2.4.2-1



| | | | | | |
|---|---|---|---|---|---|
| Project: | Lighting Vault Expansion Project | Prepared by | XZ | Date | 10/4/2024 |
| Job No.: | E2X97905 | Checked by | GL | Date | 10/7/2024 |
| Subject: | Shallow Foundation Design | Revised by | GL | Date | 10/7/2024 |
| | | Rechecked by | CD | Date | 10/17/2024 |

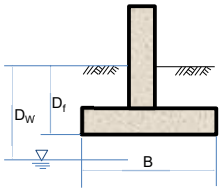
## Settlement Estimation under Service Loading Case

***Reference:*** - AASHTO LRFD Bridge Design Specifications 2020

***Assumptions:*** Based on borings JB-1(OW) and JB-2.

Footing:

| | | | |
|---|---|---|---|
| Footing Bottom El. | = | 227.5 | ft |
| Footing Length | L = | 47.0 | ft |
| Effective Footing Width | B' = | 1.3 | ft |
| Vertical uniform pressure | $p_o = \sigma_v$ = | 1.00 | ksf |




Foundation Soil: Sand - Dense

| | | |
|---|---|---|
| Unit Weight, $\gamma_f$ = | 0.120 | kcf |
| Groundwater Depth, $D_w$ = | 13.00 | ft |
| Groundwater El. = | 219.70 | ft |
| Embedment depth, $D_f$ = | 4 | ft |

Include the effect of overburden pressure above the bottom of foundation = Yes — Effective vertical stresses will be calculated starting from GS.

| Soil Layer | Soil Type | Top El, ft | Bottom El, ft | Thickness ft | How many sub-layers (max = 5) | Total Unit Weight, pcf | $(N_1)_{60}$ (more than 10) | C |
|---|---|---|---|---|---|---|---|---|
| Fill | Clean Well Graded Fine to Coarse Sand | 232.7 | 226.7 | 6.0 | 2 | 120 | 11 | 51.8 |
| Sand | Clean Well Graded Fine to Coarse Sand | 226.7 | 220.7 | 6.0 | 2 | 125 | 30 | 90 |
| sandy SILT | Inorganic Silt | 220.7 | 216.7 | 4.0 | 2 | 115 | 19 | 39 |
| | | | | | | | | |
| | | | | | | | | |

***Elastic Settlement Estimation***

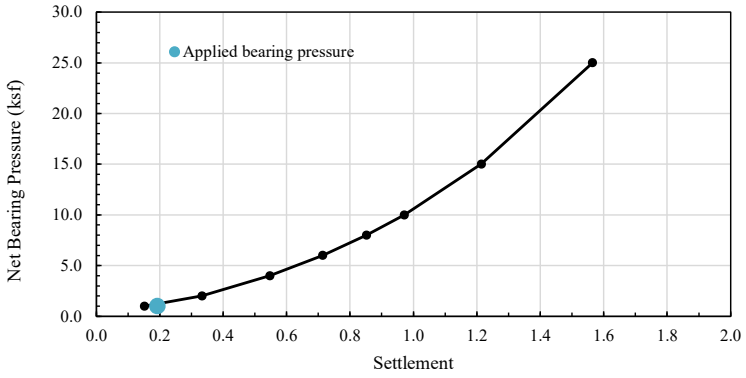
$$S_e = \sum_{i=1}^{n} \Delta H_i \qquad (10.6.2.4.2b\text{-}1)$$

in which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_o + \Delta\sigma_v}{\sigma'_o}\right) \qquad (10.6.2.4.2b\text{-}2)$$

| Soil Layer | Top El, ft | Bottom El, ft | Elastic Settlement, ft |
|---|---|---|---|
| Fill | 232.7 | 226.7 | 0.00568 |
| Sandy SILT | 226.7 | 220.7 | 0.00685 |
| sandy SILT | 220.7 | 216.7 | 0.00354 |
| | | | |
| | | | |

**Total Settlement, $S_e$ =** 0.016 ft / 0.19 inches




| q, applied vertical stress (ksf) | $S_e$ (in) |
|---|---|
| 1.0 | 0.15 |
| 2.0 | 0.33 |
| 4.0 | 0.55 |
| 6.0 | 0.71 |
| 8.0 | 0.85 |
| 10.0 | 0.97 |
| 15.0 | 1.21 |
| 25.0 | 1.56 |

| q (ksf) | $S_e$ (in) |
|---|---|
| 10.6 | 1.00 |

Settlement is not anticipated to reach 1 inch until extremely high net bearing pressures.

# Appendix H. Existing Building As-Builts

## GENERAL NOTES

### FOUNDATIONS

1. NO CONCRETE SHALL BE PLACED IN WATER OR ON FROZEN GROUND.
2. IN GENERAL, EXTERIOR CONSTRUCTION SHALL BE CARRIED DOWN A MINIMUM OF 4'–0" BELOW FINISHED EXTERIOR GRADE.
3. ALL FOUNDATIONS SHALL BEAR ON UNDISTURBED SOIL WITH A BEARING CAPACITY OF NOT LESS THAN 2 TONS PER SQUARE FOOT.
4. ALL FINISHED EXCAVATIONS SHALL BE INSPECTED AND APPROVED BY THE ENGINEER OR HIS DESIGNEE BEFORE ANY CONCRETE IS PLACED.
5. ALL BACKFILL UNDER OR ADJACENT TO ANY PORTION OF THE STRUCTURES SHALL BE COMPACTED IN 12" LIFTS. SEE SPECIFICATIONS.
6. PROVIDE 12" GRAVEL, COMPACTED TO 90% MODIFIED PROCTOR DENSITY, UNDER ALL SLABS ON GRADE AND WHERE INDICATED ON THE DRAWINGS AND WELL COMPACTED STRUCTURAL FILL TO THAT POINT.

### CONCRETE

1. ALL CONCRETE WORK SHALL CONFORM TO THE REQUIREMENTS OF THE SPECIFICATIONS, THE LATEST EDITION OF THE ACI BUILDING CODE (ACI 318) AND ACI 301, SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS, AND TO THE BOCA NATIONAL BUILDING CODE. IN CASE OF CONFLICT, THE MORE STRINGENT REQUIREMENTS SHALL GOVERN.
2. ALL CONCRETE SHALL BE READY–MIXED IN ACCORDANCE WITH ASTM C94.
3. VERTICAL CONSTRUCTION JOINTS AND STOPS IN THE CONCRETE WORK SHALL BE MADE AT MIDSPAN. PROVIDE DOWELS AT CONSTRUCTION JOINTS OF AREA EQUAL TO .5% OF THE VERTICAL CONCRETE AREA. SEE SPECIFICATIONS. PROVIDE BEVELED KEYWAYS AT ALL CONSTRUCTION JOINTS.
4. AT LEAST 48 HOURS SHALL ELAPSE BEFORE DEPOSITING OF NEW CONCRETE AGAINST PREVIOUSLY PLACED CONCRETE.
5. ALL CONCRETE SHALL ATTAIN 4,000 PSI MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS.
6. ALL SLABS ON GRADE SHALL BE PLACED IN ALTERNATE PANELS NOT EXCEEDING 900 S.F.

### REINFORCING

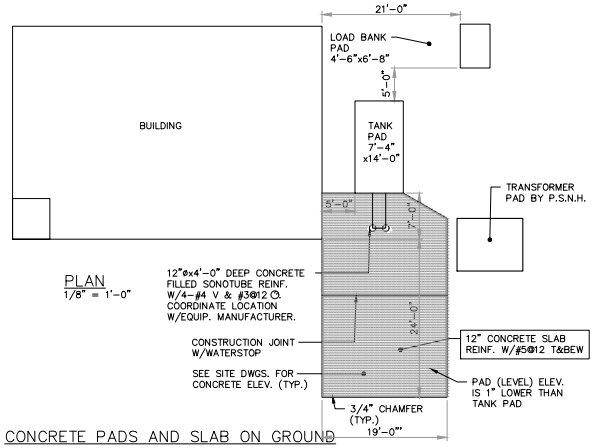
1. ALL REINFORCING BAR DETAILS SHALL CONFORM TO THE LATEST ACI CODE AND DETAILING MANUAL, EXCEPT AS OTHERWISE SPECIFIED.
2. ALL REINFORCING BARS SHALL CONFORM TO ASTM A615 GRADE 60 EXCEPT TIES AND STIRRUPS GRADE 40. ALL WELDED WIRE FABRIC SHALL CONFORM TO ASTM A185 AND SHALL BE PROVIDED IN FLAT SHEETS. LAPS SHALL BE STAGGERED AND SHALL BE 1–1/2 FULL MESH MINIMUM.
3. SCHEDULE WITH THE SHOP DRAWINGS ALL NECESSARY ACCESSORIES TO HOLD REINFORCING SECURELY IN POSITION. MINIMUM REQUIREMENTS SHALL BE: HIGH CHAIRS – 4 FEET ON CENTERS; SLAB BOLSTERS – 3'–6" ON CENTERS; SUPPORT BARS FOR HIGH CHAIRS – #5.
4. ALL BARS, EXCEPT AS OTHERWISE NOTED, SHALL BE CONTINUOUS AND SHALL BE RUN CONTINUOUSLY AROUND CORNERS, LAPPED AT NECESSARY SPLICES, AND HOOKED AT DISCONTINUOUS ENDS. LAPS SHALL BE 30–BAR DIAMETER MINIMUM, UNLESS OTHERWISE NOTED.
5. THE CONCRETE PROTECTIVE COVERING FOR MAIN REINFORCEMENT SHALL BE, UNLESS SHOWN OTHERWISE:
   A. FOOTING BOTTOMS...3 INCHES.
   B. COLUMNS, BEAMS AND FORMED SURFACES IN DIRECT CONTACT WITH SOIL OR EXPOSED TO THE WEATHER (EXCEPT SLABS)...2 INCHES.
   C. INTERIOR FACES OF WALLS AND SLABS EXPOSED TO WEATHER...1 INCH.
   D. INTERIOR SLABS...3/4 INCH.
6. ALL CONCRETE, UNLESS SPECIFICALLY NOTED TO BE PLAIN CONCRETE, SHALL BE REINFORCED.
7. ALL REINFORCING SHALL BE INSPECTED AND APPROVED BY THE ENGINEER OR HIS DESIGNEE BEFORE CONCRETE IS PLACED.

### MASONRY

1. CONCRETE MASONRY SHALL COMPLY WITH THE APPLICABLE SECTIONS OF THE NATIONAL CONCRETE MASONRY ASSOCIATION, PORTLAND CEMENT ASSOCIATION AND AMERICAN CONCRETE INSTITUTE CODES.
2. CONCRETE MASONRY UNITS SHALL BE NORMAL WEIGHT CONFORMING TO ASTM C90; HOLLOW LOAD–BEARING, GRADE N, TYPE 1, WITH A MINIMUM COMPRESSIVE STRENGTH OF 1000 PSI, TWO CELLS.
3. MORTAR SHALL CONFORM TO ASTM C270, TYPE S, WITH A MINIMUM COMPRESSIVE STRENGTH OF 1800 PSI AT 28 DAYS.
4. GROUT SHALL CONFORM TO ASTM C476, FINE OR COARSE TYPE AS APPROPRIATE, WITH A MINIMUM COMPRESSIVE STRENGTH OF 2000 PSI AT 28 DAYS. LOW–LIFT GROUTING SHALL BE USED IN HEIGHTS OF LESS THAN FOUR FEET.
5. HORIZONTAL AND VERTICAL REINFORCING SHALL COMPLY WITH THE ABOVE CODES AND BE OF TYPE, SIZE AND SPACING INDICATED ON THE DRAWINGS. DEFORMED BARS SHALL COMPLY WITH ASTM A615, GRADE 60; COLD–DRAWN STEEL WIRE SHALL CONFORM TO ASTM A82, AND DEFORMED STEEL WIRE SHALL CONFORM TO ASTM A496.
6. A DESIGN MIX FOR THE MORTAR AND GROUT SHALL BE SUBMITTED BY THE CONTRACTOR TO THE ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION. THEY SHALL BE IN ACCORDANCE WITH THE APPROPRIATE ASTM SPECIFICATIONS AND INCLUDE ACTUAL 28–DAY COMPRESSIVE STRENGTH TESTS.
7. TEST DATA ON THE PROPOSED MASONRY UNITS SHALL BE SUBMITTED BY THE CONTRACTOR TO THE ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION. THEY SHALL BE IN ACCORDANCE WITH THE APPROPRIATE ASTM SPECIFICATIONS AND INCLUDE ACTUAL COMPRESSIVE STRENGTH, ABSORPTION, WEIGHT, MOISTURE CONTENT AND DIMENSIONS.
8. THE OWNER SHALL EMPLOY AN INDEPENDENT ENGINEERING FIRM TO PERFORM FIELD TESTING DURING CONSTRUCTION ON THE MORTAR, GROUT, AND MASONRY UNITS.
9. NORMAL MASONRY CONSTRUCTION WEATHER CONDITIONS ASSUME THE AIR TEMPERATURE TO BE BETWEEN 40 AND 90 DEGREES FAHRENHEIT WITH MINIMUM WIND AND RAIN, PLUS AVERAGE RELATIVE HUMIDITY. IF CONDITIONS OTHER THAN THESE OCCUR, THE CONTRACTOR SHALL MODIFY CONSTRUCTION PROCEDURES IN ACCORDANCE WITH GOOD CONSTRUCTION PRACTICES AND THE ABOVE NOTED CODES.
10. EXTERIOR WALLS SHALL BE CONSTRUCTED IN A WEATHERTIGHT MANNER WITH ALL NECESSARY FLASHING AND WEEPS.

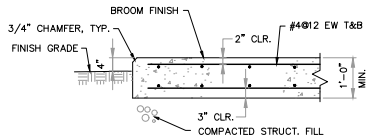
### PRECAST, PRESTRESSED CONCRETE SLABS

1. ALL PRECAST PLANK SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI AT 28 DAYS.
2. PRESTRESSING SHALL BE UNCOATED SEVEN–WIRE STRESS RELIEVED STRAND IN ACCORDANCE WITH ASTM A416.
3. PLANKS SHALL BE COMPLETELY CURED PRIOR TO DELIVERY AND SHALL BE CLEAN, SMOOTH AND FREE OF DEFECTS. DEFECTIVE UNITS WILL BE REJECTED.
4. WELD PLATES INDICATED ON THE DRAWINGS SHALL BE INCORPORATED INTO THE MEMBER AT THE TIME OF MANUFACTURE.
5. SUBMIT SIX COPIES OF SHOP DRAWINGS AND CALCULATIONS FOR APPROVAL. SHOP DRAWINGS SHALL SHOW POSITION, SPAN, FABRICATION DIMENSIONS, DETAILS AND ERECTION SEQUENCE.
6. ERECTION OF PLANK MAY TAKE PLACE AFTER CONCRETE AND SUPPORTING STEELWORK IS IN PLACE.

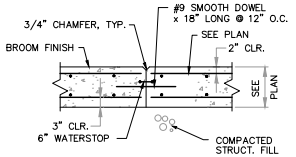



PLAN
1/8" = 1'–0"

CONCRETE PADS AND SLAB ON GROUND




TYPICAL SECTION
3/4" = 1'–0"




CONSTRUCTION JOINT DETAIL
3/4" = 1'–0"

### MISCELLANEOUS

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AT THE JOB SITE.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL SHORING AND BRACING AND SHALL DISCUSS HIS METHODS WITH THE ENGINEER PRIOR TO THE START OF WORK.
3. CONSULT THE ARCHITECTURAL, MECHANICAL, PROCESS AND ELECTRICAL DRAWINGS FOR VERIFICATION OF LOCATION AND DIMENSIONS OF CHASES, INSERTS, OPENINGS, SLEEVES, WASHES, REVEALS, DEPRESSIONS AND OTHER PROJECT REQUIREMENTS.
4. ALL EQUIPMENT PENETRATIONS TO BE VERIFIED BY CONTRACTOR.
5. DO NOT SCALE FROM DRAWINGS.

### STEEL LINTEL SCHEDULE

UNLESS OTHERWISE SPECIFIED ON THE DRAWINGS, PROVIDE AND INSTALL LINTEL ANGLES FOR MASONRY OPENINGS IN ACCORDANCE WITH THE FOLLOWING SCHEDULE:

| MAX. MAS. OPENING | WALL THICKNESS | | | | SIZE |
|---|---|---|---|---|---|
| | 4 IN. | 6 IN.* | 8 IN. | 12 IN. | |
| 3'–0" | 1 | 2 | 2 | 3 | 3 1/2x3 1/2x1/4 |
| 4'–0" | DO | DO | DO | DO | 4x3 1/2x1/4 |
| 5'–0" | DO | DO | DO | DO | 4x3 1/2x1/4 |
| 6'–0" | DO | DO | DO | DO | 5x3 1/2x1/4 |
| 8'–0" | – | DO | DO | DO | 6x3 1/2x1/4 |

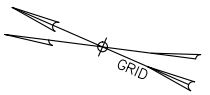
1. INSTALL LONG LEG VERTICAL.
2. *FOR 6" WALLS HORIZONTAL LEG IS 2–1/2".
3. PROVIDE 6" MINIMUM BEARING AT EACH END, BUT NOT LESS THAN 1" PER FOOT OF SPAN. FILL TWO COURSES OF MASONRY BELOW BEARING WITH MORTAR.
4. WHERE WALL THICKNESS EXCEEDS 12", PROVIDE ONE ADDITIONAL ANGLE FOR EACH ADDITIONAL 4" OF WALL.
5. ALL EXTERIOR LINTELS TO BE GALVANIZED.

### LIST OF ABBREVIATIONS

| | | | | | |
|---|---|---|---|---|---|
| AL | ALUMINUM | FNDN | FOUNDATION | T | TOP |
| B | BOTTOM | H | HORIZONTAL | TOC | TOP OF CONCRETE |
| BM | BEAM | HP | HIGH POINT | TOS | TOP OF SLAB |
| CJ | CONSTRUCTION JOINT | LP | LOW POINT | TOS | TOP OF STEEL |
| CMU | CONCRETE MASONRY UNIT | MAS | MASONRY | TOW | TOP OF WALL |
| EF | EACH FACE | OC | ON CENTER | V | VERTICAL |
| EL | ELEVATION | SOG | SLAB ON GRADE | WS | WATER STOP |
| EW | EACH WAY | | | | |

**RECORD DRAWING**

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3/4" = 1'–0"




1/8" = 1'–0"

| REVISION NO. | DATE | DESCRIPTION |
|---|---|---|
| | | |

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MANCHESTER, NEW HAMPSHIRE

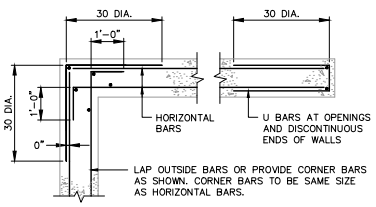
EDWARDS AND KELCEY, INC.
ONE RADIAL AVENUE SUITE 402 SARATOGA, NY 12053
PROGRAM MANAGER

# NEW AIRFIELD LIGHTING VAULT
# GENERAL NOTES & TYPICAL DETAILS

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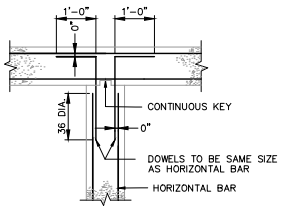
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PREPARED BY: DUFRESNE–HENRY, INC.
DRAWN BY: O.R.P. | CHECKED BY: P.R.D. | APPROVED BY:
SCALE: AS SHOWN | DRAWING NAME: VLTS001 | SHEET NO. VLT–S–001

dufresne-Henry, Inc.



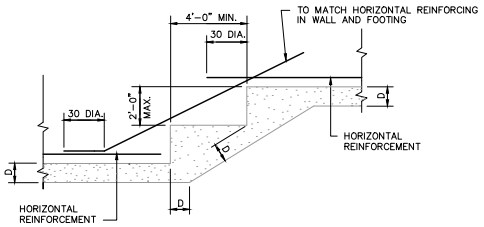

PLAN OF HORIZONTAL REINFORCING AT CORNERS

NOT TO SCALE



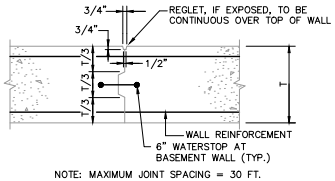

PLAN OF HORIZONTAL REINFORCING AT INTERSECTIONS

NOT TO SCALE




TYPICAL ELEVATION OF CONTINUOUS STEPPED WALL FOOTING

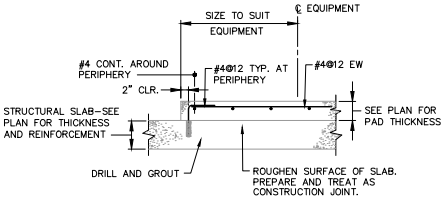
NOT TO SCALE




NOTE: MAXIMUM JOINT SPACING = 30 FT.

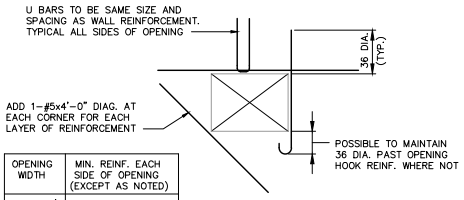
WALL AND SLAB CONSTRUCTION JOINT

NOT TO SCALE




TYPICAL EQUIPMENT PAD DETAIL

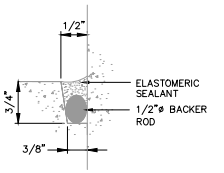
NOT TO SCALE




| OPENING WIDTH | MIN. REINF. EACH SIDE OF OPENING (EXCEPT AS NOTED) |
|---|---|
| UNDER 4' | 1-#5 E.F. |
| 4' TO 6' | 1-#6 E.F. |
| 6' TO 8' | 1-#7 E.F. |
| OVER 8' | 1-#8 E.F. |

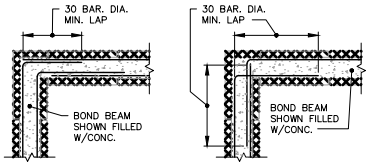
TYPICAL REINFORCING AT OPENING IN WALLS

NOT TO SCALE

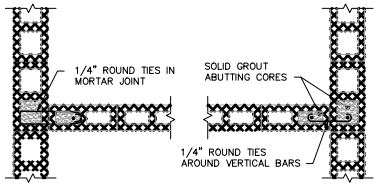



REGLET DETAIL

NOT TO SCALE



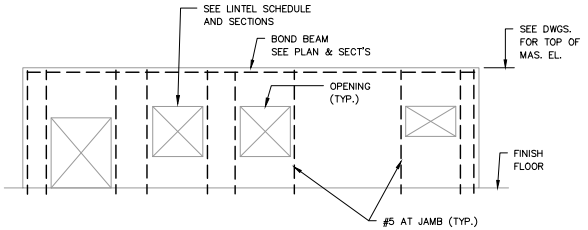

EXTERIOR BOND BEAMS, ALTERNATE DETAILS




INTERSECTING WALLS

TYPICAL HORIZONTAL MASONRY WALL REINFORCING AT BOND BEAMS AND INTERSECTING WALLS

NOT TO SCALE




TYPICAL MASONRY WALL REINFORCING DETAIL

NOT TO SCALE

**RECORD DRAWING**

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| REVISION NO. | DATE | DESCRIPTION |
|---|---|---|
| | | |

CITY OF MANCHESTER – DEPARTMENT OF AVIATION
MANCHESTER, NEW HAMPSHIRE

EDWARDS AND KELCEY, INC.
PROGRAM MANAGER

NEW AIRFIELD LIGHTING VAULT
TYPICAL DETAILS

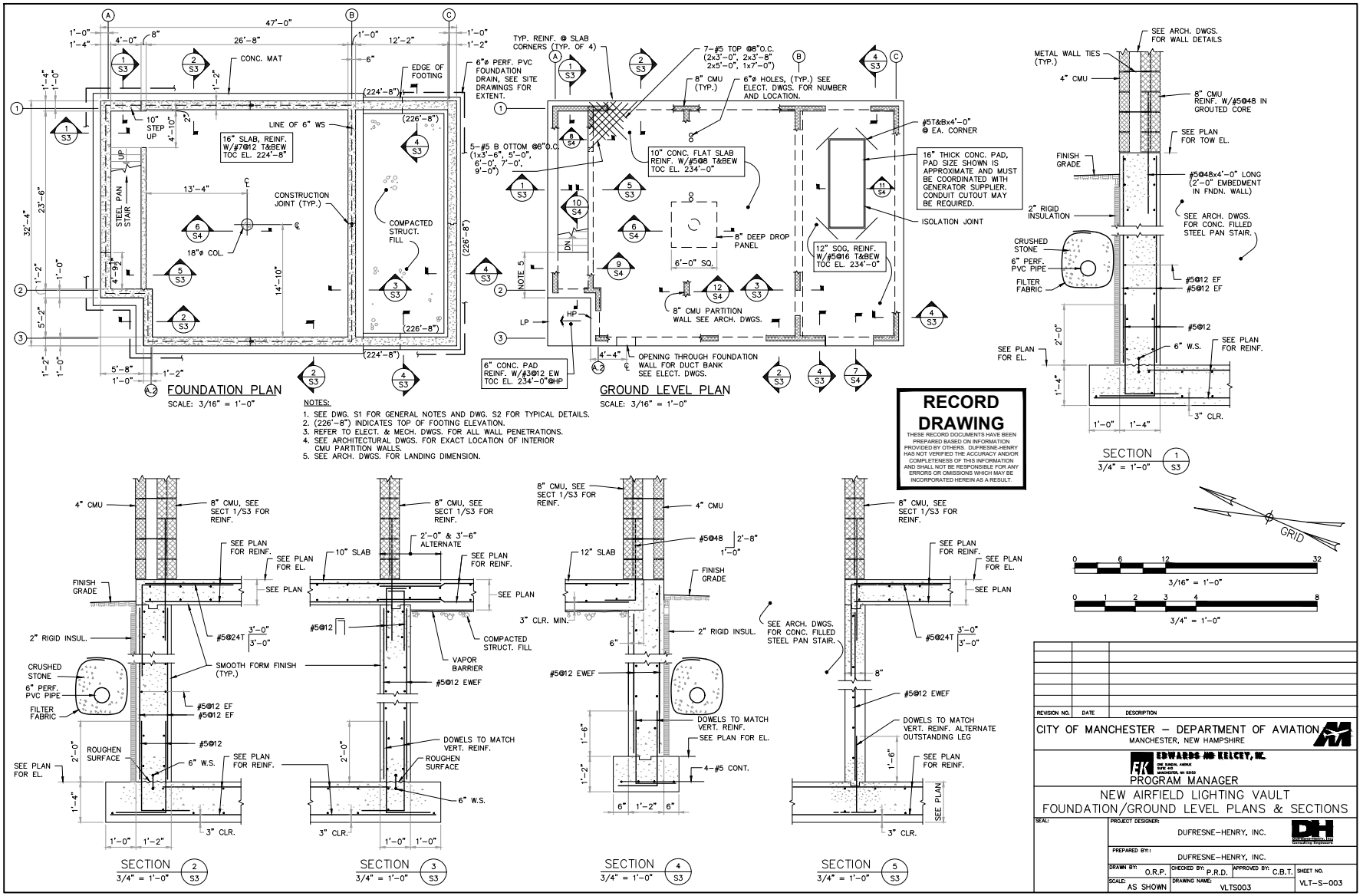
SEAL:

PROJECT DESIGNER: DUFRESNE-HENRY, INC.

PREPARED BY: DUFRESNE-HENRY, INC.

DRAWN BY: O.R.P. | CHECKED BY: P.R.D. | APPROVED BY: | SHEET NO.

SCALE: AS SHOWN | DRAWING NAME: VLTSDT002 | VLT-S-002




NOTES:

1. SEE DWG. S1 FOR GENERAL NOTES AND DWG. S2 FOR TYPICAL DETAILS.
2. (226'-8") INDICATES TOP OF FOOTING ELEVATION.
3. REFER TO ELECT. & MECH. DWGS. FOR ALL WALL PENETRATIONS.
4. SEE ARCHITECTURAL DWGS. FOR EXACT LOCATION OF INTERIOR CMU PARTITION WALLS.
5. SEE ARCH. DWGS. FOR LANDING DIMENSION.

**RECORD DRAWING**

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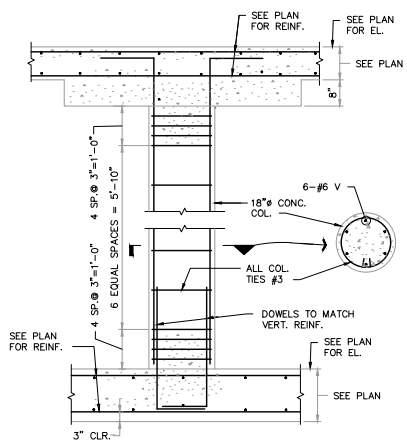
| REVISION NO. | DATE | DESCRIPTION |
|---|---|---|
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CITY OF MANCHESTER – DEPARTMENT OF AVIATION
MANCHESTER, NEW HAMPSHIRE

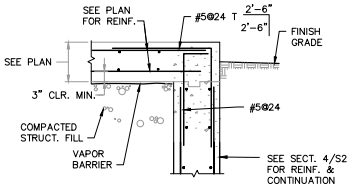
EDWARDS AND KELCEY, INC.
PROGRAM MANAGER

# NEW AIRFIELD LIGHTING VAULT
# FOUNDATION/GROUND LEVEL PLANS & SECTIONS

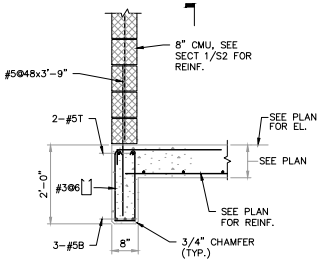
| | |
|---|---|
| SEAL: | |
| PROJECT DESIGNER: | DUFRESNE-HENRY, INC. |
| PREPARED BY: | DUFRESNE-HENRY, INC. |
| DRAWN BY: O.R.P. | CHECKED BY: P.R.D. APPROVED BY: C.B.T. SHEET NO. |
| SCALE: AS SHOWN | DRAWING NAME: VLTS003 VLT-S-003 |



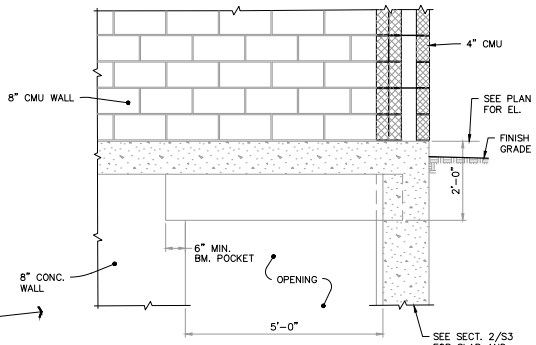

SECTION 6 / S3
3/4" = 1'-0"



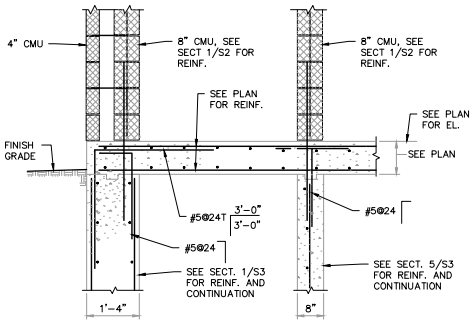

SECTION 7 / S3
3/4" = 1'-0"



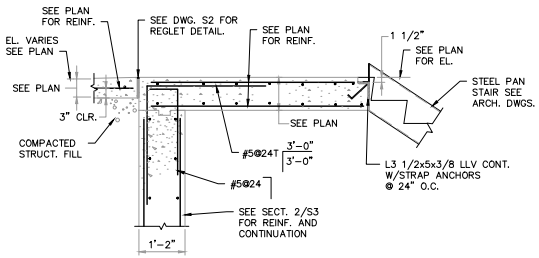

SECTION 8 / S3
3/4" = 1'-0"



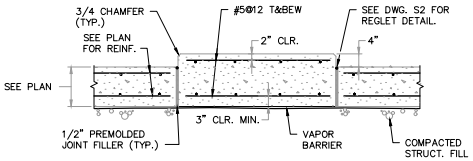

ELEVATION
3/4" = 1'-0"



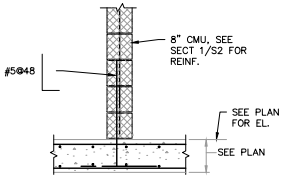

SECTION 9 / S3
3/4" = 1'-0"




SECTION 10 / S3
3/4" = 1'-0"




SECTION 11 / S3
3/4" = 1'-0"




SECTION 12 / S3
3/4" = 1'-0"




3/4" = 1'-0"

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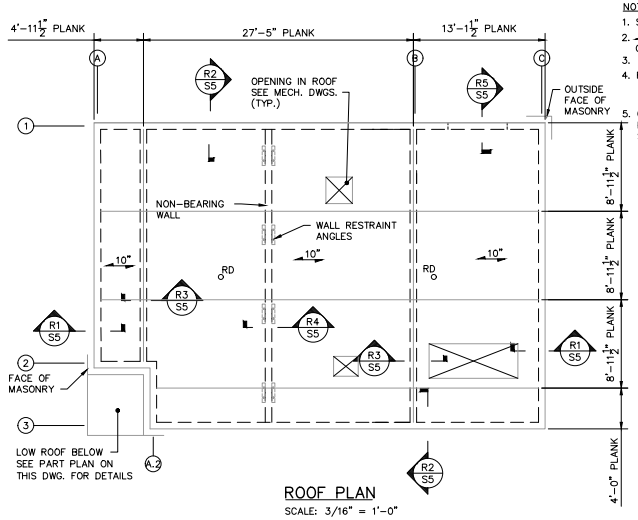
CITY OF MANCHESTER – DEPARTMENT OF AVIATION
MANCHESTER, NEW HAMPSHIRE

EDWARDS AND KELCEY, INC.
PROGRAM MANAGER

NEW AIRFIELD LIGHTING VAULT
SECTIONS

SEAL:

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| PROJECT DESIGNER: | DUFRESNE–HENRY, INC. |
| PREPARED BY: | DUFRESNE–HENRY, INC. |
| DRAWN BY: O.R.P. | CHECKED BY: P.R.D. |
| APPROVED BY: | SHEET NO. VLT–S–004 |
| SCALE: AS SHOWN | DRAWING NAME: VLTSDT004 |

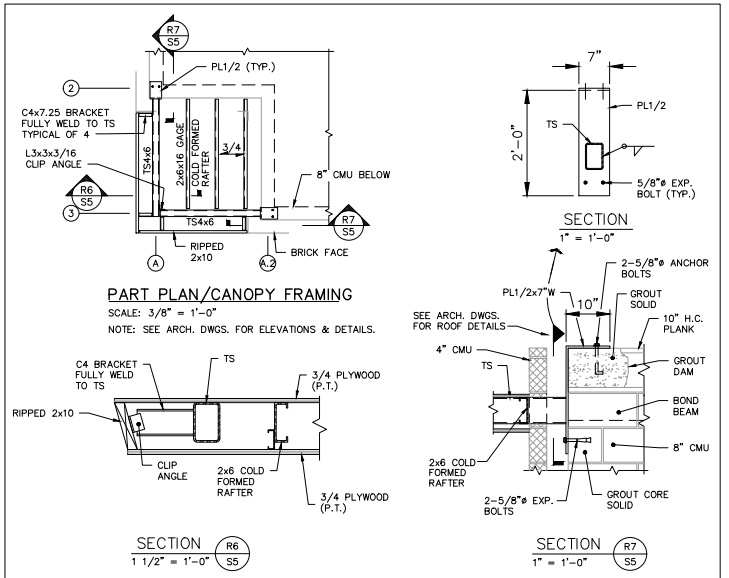



ROOF PLAN

SCALE: 3/16" = 1'-0"

NOTES:

1. SEE DWG. S1 FOR GENERAL NOTES AND DWG. S2 FOR TYPICAL DETAILS.
2. 10" INDICATES DIRECTION OF SPAN OF 10" HOLLOW PRECAST CONCRETE PLANK.
3. ○ RD INDICATES A ROOF DRAIN, SEE MECHANICAL DWGS. FOR LOCATION.
4. ROOF DESIGN LOADS (SUPERIMPOSED): DEAD LOADS..... 20 PSF
   SNOW LOAD..... 50 PSF
   HUNG LOAD..... 10 PSF
5. GALVANIZED STEEL HEADERS ARE REQUIRED AT OPENINGS THROUGH PLANKS. SEE THIS DWG. FOR DETAIL. G.C. TO COORDINATE WITH MECH. SUBCONTRACTOR.




PART PLAN/CANOPY FRAMING

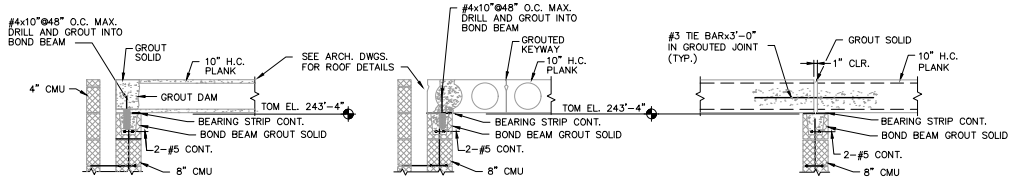
SCALE: 3/8" = 1'-0"

NOTE: SEE ARCH. DWGS. FOR ELEVATIONS & DETAILS.

SECTION 1 1/2" = 1'-0" (R6 S5)

SECTION 1" = 1'-0" (R7 S5)

CANOPY DETAILS



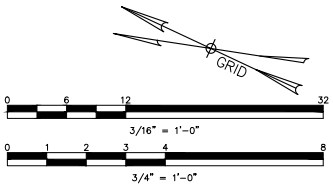

SECTION 3/4" = 1'-0" (R1 S5)

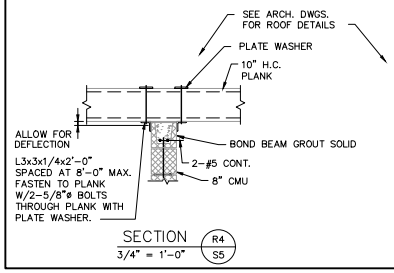
SECTION 3/4" = 1'-0" (R2 S5)

SECTION 3/4" = 1'-0" (R3 S5)

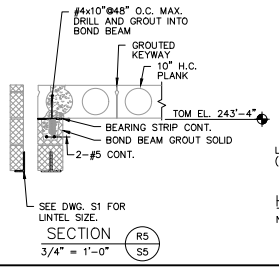
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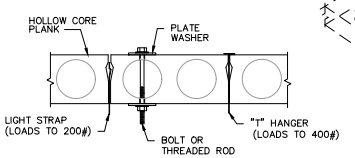



SECTION 3/4" = 1'-0" (R4 S5)



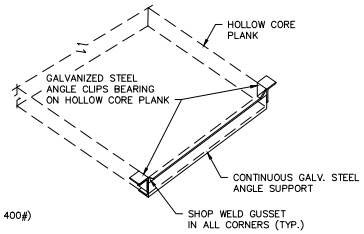

SECTION 3/4" = 1'-0" (R5 S5)




HANGER DETAILS FROM HOLLOW CORE PLANK

NOT TO SCALE

NOTE: SEE MECHANICAL, PROCESS AND ELECTRICAL DRAWINGS FOR LOCATIONS OF EQUIPMENT TO BE HUNG FROM PLANK.




HEADER DETAIL

NOT TO SCALE

NOTE: PROVIDE SHOP DWGS. AND CALCULATIONS WITH HOLLOW CORE PLANK SUBMITTAL.

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PROGRAM MANAGER

NEW AIRFIELD LIGHTING VAULT
ROOF FRAMING PLAN & SECTIONS

SEAL:

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| PROJECT DESIGNER: | DUFRESNE-HENRY, INC. |
| PREPARED BY: | DUFRESNE-HENRY, INC. |
| DRAWN BY: O.R.P. | CHECKED BY: P.R.D. |
| APPROVED BY: | SHEET NO. VLT-S-005 |
| SCALE: AS SHOWN | DRAWING NAME: VLTS005 |