

**Issued for Bid**

**NRO Wells 118N and 120N Improvements  
Collier County, Florida**

**Contract Documents and  
Technical Specifications**

**Prepared for:**

***Collier County***

**Issue Date:**

***May 2025***

***REVISED July 2025***

***REVISED August 2025***

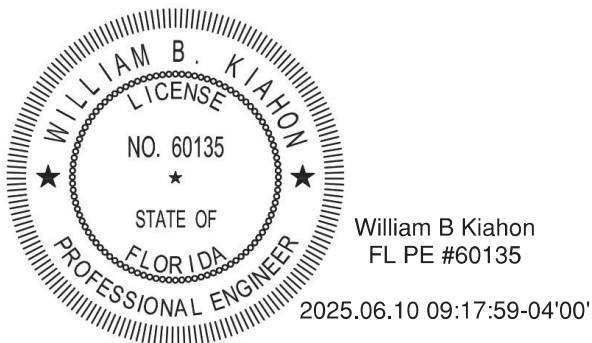


DOCUMENT 000107 - SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Structural Engineer:

1. William B. Kiahon
2. License #60135.
3. Responsible for  
Division 03 and Division 13.

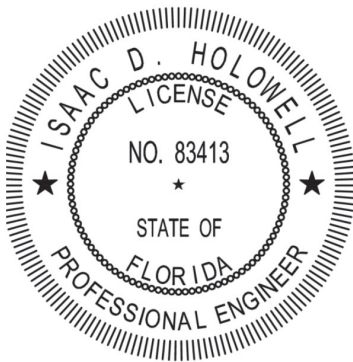


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B. Process Mechanical Engineer:

1. Isaac David Holowell.
2. License #83413.
3. Responsible for  
Division 40, Sections 400506 to 400578.19  
and Division 43



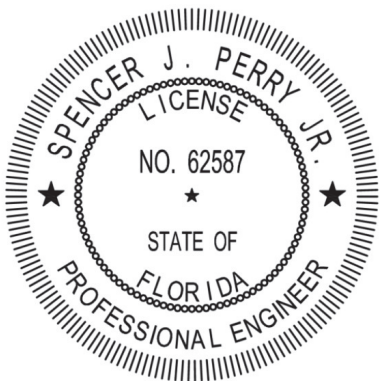
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FL PE# 83413  
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on the date adjacent to the seal.

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C. Electrical Engineer:

1. Spencer Perry.
2. License #62587.
3. Responsible for  
Division 26.



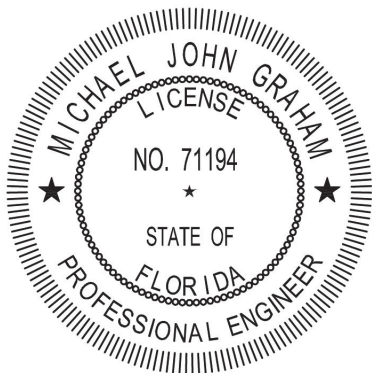
Spencer J Perry  
FL PE 62587  
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D. Instrumentation and Controls Engineer:

1. Michael Graham.
2. License #71194.
3. Responsible for  
Division 40, Sections 406100 to 407856.



Digitally signed by Michael J  
Graham  
Location: Florida PE 71194  
Date: 2025.08.06  
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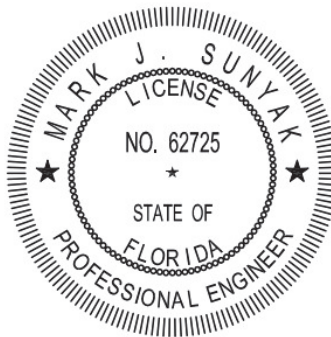
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E. Civil Engineer:

1. Mark J. Sunyak.
2. License #62725.
3. Responsible for  
Division 31 and Division 01, Section 012000.

Mark J Sunyak  
CN=Mark J Sunyak,  
dnQualifier=A01410C0000019405261F870018F2F3,  
O=CDM SMITH, C=US  
2025.07.28 23:14:25-04'00'



This item has been digitally signed and sealed by Mark J. Sunyak on the date adjacent to the seal.

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## TABLE OF CONTENTS

### PROCUREMENT AND CONTRACTING DOCUMENTS GROUP

#### DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

000107      Seals Page

#### DIVISION 01 - GENERAL

012000      Measurement and Payment

### SPECIFICATIONS GROUP

#### *Facility Construction Subgroup*

#### DIVISION 03 - CONCRETE

033000      Cast-in-Place Concrete

036000      Grouting

#### DIVISION 13 - SPECIAL CONSTRUCTION

133419      Metal Building Systems

#### *Facility Services Subgroup*

#### DIVISION 26 - ELECTRICAL

260510      Limited Electrical For Small Projects

260573      Power System Studies

262213      Low-Voltage Distribution Transformers

262505      480V Control Panels

263600      Transfer Switches

264113      Lightning Protection For Structures

264313      Surge Protective Devices for Low-Voltage Electrical Power Circuits

#### DIVISION 31 – EARTHWORK

310515      Soils and Aggregates for Earthwork

312333      Trenching and Backfilling

#### *Process Equipment Subgroup*

#### DIVISION 40 - PROCESS INTERCONNECTIONS

400506      Couplings, Adapters, and Specials For Process Piping

400507      Hangers and Supports For Process Piping

400523      Stainless Steel Process Pipe and Tubing

400551      Common Requirements For Process Valves

400553      Identification For Process Piping

400557      Actuators For Process Valves and Gates

400561      Gate Valves

400564      Butterfly Valves

400565.35      Globe Body Silent Check Valves

|           |                                                                      |
|-----------|----------------------------------------------------------------------|
| 400578.19 | Combination Air Valves For Water Service                             |
| 406100    | Process Control and Enterprise Management Systems General Provisions |
| 406121.20 | Process Control System Testing                                       |
| 406126    | Process Control System Training                                      |
| 406193    | Process Control System Input/Output List                             |
| 406196    | Process Control Descriptions                                         |
| 406733    | Panel Wiring                                                         |
| 406866    | Configuration of Controller Software                                 |
| 407000    | Instrumentation For Process Systems                                  |
| 407113    | Magnetic Flow Meters                                                 |
| 407326    | Gauge-Pressure Transmitters                                          |
| 407856    | Isolators, Intrinsically Safe Barriers, and Surge Suppressors        |

**DIVISION 43 - PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE  
EQUIPMENT**

|        |                                           |
|--------|-------------------------------------------|
| 432520 | Submersible Turbine Pump (for Water Well) |
|--------|-------------------------------------------|

## SUPPLEMENTAL SPECIFICATIONS

### COLLIER COUNTY STANDARD SPECIFICATIONS

|        |                                                                                                                                                   |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 011000 | Summary of Work                                                                                                                                   |
| 014200 | References                                                                                                                                        |
| 014500 | Quality Control                                                                                                                                   |
| 015000 | Construction Facilities and Temporary Controls                                                                                                    |
| 015526 | Traffic Regulation and Public Safety                                                                                                              |
| 015713 | Temporary Erosion and Sedimentation Control for Construction Activities Impacting Less Than One Acre, Including Construction Requiring Dewatering |
| 016100 | Material and Equipment                                                                                                                            |
| 017300 | Miscellaneous Work and Cleanup                                                                                                                    |
| 017416 | Site Clearing                                                                                                                                     |
| 017423 | Cleaning                                                                                                                                          |
| 017839 | Project Record Documents                                                                                                                          |
| 020500 | Connections to Existing Systems                                                                                                                   |
| 022100 | Lines and Grades                                                                                                                                  |
| 022200 | Pre-construction Audio-video Recording                                                                                                            |
| 022501 | Leakage Tests                                                                                                                                     |
| 024100 | Demolition                                                                                                                                        |
| 025400 | Disinfection                                                                                                                                      |
| 312316 | Excavation-Earth and Rock                                                                                                                         |
| 312319 | Groundwater Control for Open Cut Excavation                                                                                                       |
| 312323 | Backfilling                                                                                                                                       |
| 314000 | Shoring, Sheet piling and Bracing                                                                                                                 |
| 329200 | Restoration by Sodding and Seeding                                                                                                                |
| 330201 | Roadway Crossing by Open Cut                                                                                                                      |
| 330502 | High Density Polyethylene (HDPE) Pipe and Fittings                                                                                                |
| 330504 | Ductile Iron Pipe (DIP) and Fittings                                                                                                              |
| 330518 | Laying and Jointing Buried Pipelines                                                                                                              |
| 330520 | Pipe Removal and Abandonment                                                                                                                      |
| 331200 | Water Valves and Appurtenances                                                                                                                    |

### WELL CONDITIONING SPECIFICATIONS (By Water Science Associates, Inc.)

Specifications for Rehabilitation of Two Collier County Production Wells: RO-118N & RO-120N

END OF TABLE OF CONTENTS

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## SECTION 012000 MEASUREMENT AND PAYMENT

### 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 measurement and payment criteria applicable to portions of the Work performed under unit price, lump sum, or allowance payment methods.

#### 1.3 UNIT QUANTITIES SPECIFIED

- A. Quantities and measurements indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements supplied or placed in the Work and verified by the ENGINEER shall determine payment.
- B. If the actual Work requires more or fewer quantities than those quantities indicated, provide the required quantities at the unit sum/prices contracted.

#### 1.4 MEASUREMENT OF QUANTITIES

- A. Measurement Devices:
  - 1. Weigh Scales: Inspected, tested, and certified for use in the State of Florida by the applicable state Weights and Measures department within the past year.
  - 2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
  - 3. Metering Devices: Inspected, tested, and certified by the applicable State of Florida Weights and Measures department within the past year.
- B. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.
- C. Measurement of quantities expressed as volume shall be based upon a neat plan line projection to the work limits as determined by survey record drawings for each item with no additional allowances for shrinkage, swelling or creep.
  - 1. In computing volumes of excavation and fill, the average end area method or other methods, acceptable to the ENGINEER, will be used.

- D. Measurement of quantities expressed as area shall be based upon a horizontal, planimetric projection to the work limits as determined by survey record drawings for each item with no additional allowances for slopes.
- E. Measurement of linear items such as piping will be for quantities actually field installed to the specified work limits, based upon surveyed stations recorded along the straight or curved centerline of each respective item.
- F. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.

## 1.5 PAYMENT

- A. Payment for each lump sum and unit price stated in the itemized bid schedule shall constitute full compensation for all required labor, products, tools, equipment, material, plant, transportation, services and incidentals; erection, application or installation of an item of the Work required to complete all work specified under that particular item including cleanup, and all costs for doing related work as set forth in these Specifications and /or the on the Contract Drawings or implied in carrying out their intent.
  - 1. The price bid for each lump sum and unit price stated in the itemized bid schedule shall be deemed to include overhead and profit. CONTRACTOR'S Insurance is not a separate pay item and shall be included in the price for each lump sum and unit price stated in the itemized bid schedule.
  - 2. Relevant specification section references are provided to facilitate pricing. However, Contractor shall, using his own judgment, determine which sections are relevant to each pay item prior to submitting a comprehensive price that covers all Work identified in the Contract Documents.
- B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the ENGINEER multiplied by the unit sum/price for Work which is incorporated in or made necessary by the Work.
- C. Requests for payment shall be in accordance with the County's standard contract language.
- D. Payment will be made to the limits as specified in the Contract Documents. If the constructed limits are less than the specified limit, payment will be made to the actual limits of construction as shown on the As-Built Drawings. Payment for quantities that exceed the specified contract limits will only be made with the approval of the ENGINEER. The payment for quantities that exceed the contract quantities can only be obtained through an approved Change Order before contract quantities are exceeded.
- E. No partial payments shall be made for the installation of items that have not been tested and approved.
- F. Partial payment may be requested for material delivered to the site, and adequately stored and protected until installation. Materials may be paid for at direct cost plus shipping, upon presentation of valid receipt or bill with the payment request at the sole discretion of OWNER. All such requests must have material quantities verified by the ENGINEER prior to payment.

1. Qualification for partial payment for materials delivered shall be in accordance with the General Conditions and the Agreement.
- G. Upon installation, the unit cost for the item will be paid less any prior payments for stored material. Upon installation, an adjustment will be made in payment to account for the quantity of materials actually installed in the work. Final payment will be subject to the acceptance of the unit item following approval of final testing, if applicable. OWNER will not pay for material in excess of what is actually installed in the work.
- H. Payment for unit price items (all items except Lump Sum items) will be made monthly until completion of each unit price item based on quantity estimated by CONTRACTOR and verified by ENGINEER. Final payment will be based on quantity calculated from As-Built Drawings.

#### 1.6 VARIATIONS IN ESTIMATED QUANTITIES

- A. The quantities given in the Contract Documents are approximate only and are given as a basis for the uniform comparison of bids, and the OWNER does not expressly or by implication agree that the actual amount of work will correspond therewith.
- B. The CONTRACTOR must provide, for Unit Price Work, a proposed contract price determined on the basis of estimated quantities required for each item. The estimated quantities of items are not guaranteed and are solely for the purpose of comparing bids. Each such unit price will be deemed to include an amount for overhead, profit, and indirect costs for each separately defined item.
- C. An increase or decrease in quantity for any unit price item shall not be regarded as sufficient grounds for an increase or decrease in the price of the items.

#### 1.7 DEFECT ASSESSMENT

- A. Replace defective Work, or portions of defective Work, not conforming to specified requirements.
- B. If, in the opinion of the ENGINEER, it is not practical to remove and replace the Work, the ENGINEER will direct a remedy in accordance with the requirements of the Agreement.

#### 1.8 NON-PAYMENT FOR REJECTED PRODUCTS

- A. Payment will not be made for any of the following:
  1. Products wasted or disposed of in a manner that is not acceptable.
  2. Products determined as unacceptable before or after placement.
  3. Products not completely unloaded from the transporting vehicle.
  4. Products placed beyond the lines and levels of the required Work.
  5. Products remaining on hand after completion of the Work.

6. Loading, hauling, and disposing of rejected Products.
7. Submittal and approval of Schedule Update.

#### 1.9 SCHEDULE OF VALUES

- A. Approval of Schedule: Submit for approval a preliminary schedule of values, in duplicate, for all of the Work.

#### 1.10 SAVINGS PROPOSALS

- A. The CONTRACTOR may make proposals to change the Work, which result in savings in the cost to perform the Work. When such proposals are made, they will be referred to the ENGINEER and OWNER for evaluation. If it is determined by the OWNER that the proposal provides the same level of service and if the OWNER accepts the change, the CONTRACTOR shall provide an estimate of the savings resulting from the proposed change. A change order documenting the changes will be approved by the ENGINEER and issued by the OWNER to incorporate the changes including the savings through revised Unit Prices.

#### 1.11 BID ITEM DESCRIPTIONS

##### A. ITEM 1 – MOBILIZATION AND DEMOBILIZATION

1. Measurement for payment for mobilization and demobilization as described in the Specifications will be on a lump sum basis.
2. The lump sum price bid for Mobilization and Demobilization shall be a total of not more than ten percent (10%) of the total bid amount and shall be based on mobilization costs that shall not exceed fifty percent (50%) and demobilization costs that shall not exceed fifty percent (50%) of this line item.
3. Payment for mobilization will be made at the Bid Form lump sum price which shall be full compensation for the cost of bond premiums, survey layout and record drawings, preconstruction videos, maintenance of traffic, permits, erosion and sedimentation control, and contract closeout.

##### B. ITEM 2 – WELL 118N - MISCELLANEOUS STRUCTURAL

1. Measurement for payment for miscellaneous structural items shall be on a lump sum basis.
2. Payment will be made at the Bid Form lump sum price for miscellaneous structural items at Well 118N which will be full compensation for all labor, materials, and equipment necessary to install pipe supports for the aboveground wellhead piping, structural slabs and canopy structure. This item includes the delegated design of the canopy structure.

##### C. ITEM 3 – WELL 118N - MISCELLANEOUS ELECTRICAL

1. Measurement for payment for miscellaneous electrical shall be on a lump sum basis.
2. Payment will be made at the Bid Form lump sum price for Miscellaneous Electrical at Well 118N which will be full compensation for all labor, materials, and equipment necessary to install all electrical components for the well. This item will include all material and labor for the installation of conduit, wiring, electrical components, cabinets, cabinet sunshades,

Measurement and Payment

lightning protection system, modifications to existing control panels. This item includes the Delegated Design of the lightning protection system in Section 264113.

1.12 ITEM 4 – WELL 118N - INSTRUMENTATION AND CONTROLS

- A. Measurement for payment for instrumentation and controls shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Instrumentation and Controls at Well 118N which will be full compensation for all labor, materials, and equipment necessary to construct the complete Instrumentation and Controls system associated with the well. Integrator shall be selected from the County's pre-approved list of vendors.

1.13 ITEM 5 – WELL 118N - WELLHEAD, PUMP, AND MOTOR

- A. Measurement for payment for wellhead, pump and motor shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Wellhead, Pump and Motor at Well 118N which will be full compensation for all labor, materials, and equipment necessary to construct the wellhead, drop pipe and accessories, pump, and motor.

1.14 ITEM 6 – WELL 118N - MISCELLANEOUS PIPING, VALVES, AND FITTINGS

- A. Measurement for payment for miscellaneous piping, valves, and fittings shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Miscellaneous Piping, Valves, and Fittings at Well 118N which will be full compensation for all labor, materials, and equipment necessary to construct the stainless steel piping, PVC piping, appurtenances, meter, valves, air release valves, fittings, sample taps, excavation, backfill, fill material, surface restoration (gravel drive and sod), testing, chlorination, dewatering, dewatering permit, and connection to existing raw water main. Grading shall be provided around the slabs with a stepdown from the slab of no more than 8" and a grade not exceeding a 4:1 slope. There will be no additional compensation for rock excavation.

1.15 ITEM 7 – WELL 120N - MISCELLANEOUS STRUCTURAL

- A. Measurement for payment for miscellaneous structural items shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for miscellaneous structural items at Well 120N which will be full compensation for all labor, materials, and equipment necessary to install pipe supports for the aboveground wellhead piping, structural slabs, and canopy structure.

1.16 ITEM 8 – WELL 120N - MISCELLANEOUS ELECTRICAL

- A. Measurement for payment for miscellaneous electrical shall be on a lump sum basis.

- B. Payment will be made at the Bid Form lump sum price for Miscellaneous Electrical at Well 120N which will be full compensation for all labor, materials, and equipment necessary to install all electrical components for the well. This item will include all material and labor for the installation of conduit, wiring, electrical components, cabinets, cabinet sunshades, lightning protection system.

1.17 ITEM 9 – WELL 120N - INSTRUMENTATION AND CONTROLS

- A. Measurement for payment for instrumentation and controls shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Instrumentation and Controls at Well 120N which will be full compensation for all labor, materials, and equipment necessary to construct the complete Instrumentation and Controls system associated with the well. Integrator shall be selected from the County's pre-approved list of vendors.

1.18 ITEM 10 – WELL 120N - WELLHEAD, PUMP, AND MOTOR

- A. Measurement for payment for wellhead, pump and motor shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Wellhead, Pump and Motor at Well 120N which will be full compensation for all labor, materials, and equipment necessary to construct the wellhead, drop pipe and accessories, pump, and motor.

1.19 ITEM 11 – WELL 120N – MISCELLANEOUS PIPING, VALVES, AND FITTINGS

- A. Measurement for payment for miscellaneous piping, valves, and fittings shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Miscellaneous Piping, Valves, and Fittings at Well 120N which will be full compensation for all labor, materials, and equipment necessary to construct the stainless steel piping, HDPE piping, appurtenances, meter, valves, air release valves, fittings, sample taps, excavation, backfill, fill material, surface restoration (gravel drive and sod), testing, chlorination, dewatering, dewatering permit, and connection to existing raw water main. Grading shall be provided around the slabs with a stepdown from the slab of no more than 8" and a grade not exceeding a 4:1 slope. There will be no additional compensation for rock excavation.

1.20 ITEM 12 - WELL CONDITIONING

- A. Measurement for payment for well conditioning shall be as indicated on the supplemental specifications provided by WSA, Inc and included at the end of this document.
- B. Payment will be made at the Bid Form lump sum price or per hour as detailed on the bid tabulation and in the supplemental specifications for Well Conditioning at Well 118N and 120N which will be full compensation for all labor, materials, and equipment necessary to provide a permitted well.

1.21 ITEM 13 – WELL 119N – VERIFICATION OF EXISTING WIRING

- A. Measurement for payment for verification of existing wiring shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Verification of the Existing Wiring at Well 119N which will be full compensation for all labor, materials, and equipment necessary to verify the existing size and quantity of wiring from the FPL transformer to the MCC located at Well 119N. This shall include coordination with FPL and County staff to deenergize the appropriate circuit, shutdown of all affected well equipment, and documentation of wire gauge and electrical equipment compatibility.

1.22 ITEM 14 – WELL 119N – WIRING INSTALLATION

- A. Measurement for payment for wiring installation shall be on a lump sum basis.
- B. Payment will be made at the Bid Form lump sum price for Wiring Installation at Well 119N which will be full compensation for all labor, materials, and equipment necessary to remove and dispose of the existing wiring, confirmation of the suitability of reuse of the existing conduit, installation of new cabling as specified, terminations, labelling and testing at Well 119N. This shall include coordination with FPL and County staff to deenergize the appropriate circuit, shutdown of all affected well equipment, and coordination and confirmation of reenergized equipment.

1.23 ITEM 15 – WELL 119N – CONDUIT INSTALLATION

- A. Measurement for payment for conduit installation shall be on a linear foot basis.
- B. Payment will be made at the Bid Form linear foot price for Conduit Installation at Well 119N which will be full compensation for all labor, materials, and equipment necessary to remove unsuitable conduit, install new conduit as needed, make connections where required, backfill, compaction and installation of surface materials as determined in Item 14. This shall include coordination with FPL and County staff to deenergize and reenergize the appropriate circuit.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012000

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## SECTION 033000 - CAST-IN-PLACE CONCRETE

### 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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Section 036000 "Grouting" for grouting.
  - 2. Section 312000 "Earthwork" for drainage fill under slabs-on-grade.

#### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard (cubic meter), water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash or ground granulated blast furnace slag. For each concrete mixture, submit alternate design mixtures when characteristics of materials change, source of cement or aggregate change or test results do not meet specification requirements, or other circumstances warrant adjustments..
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, spacing, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Reference bars to be the same identification marks shown on the bar bending details.

- D. Construction Joint Layout: As shown on Drawings.
- E. Welding certificates.
- F. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Curing compounds.
  - 6. Bonding agents.
  - 7. Adhesives.
  - 8. Repair materials.
- G. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
  - 2. Mill Test Reports:
    - a. Cementitious materials.
    - b. Steel Reinforcing.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter that will reduce or destroy bond. Deliver, store, and handle steel reinforcement to prevent bending and damage. Store reinforcement off the ground, protect from moisture, and keep out of standing water, and free from rust, mud, dirt, grease, oil, ice, or other contaminants and deleterious films that will reduce or destroy bond.

## 1.7 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 degrees F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
1. Maintain concrete temperature below 90 degrees F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301.
  2. ACI 117.

### 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Plywood, metal, or other approved panel materials.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- D. 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.
- E. 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 to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to below grade walls.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic protected steel wire or CRSI Class 2 stainless steel bar supports.
- B. Tie wires for reinforcement: 16 gauge or heavier black annealed wire to tie uncoated reinforcing. Use zinc coated wire to tie galvanized reinforcing. Use epoxy coated wire to tie epoxy coated reinforcing.

## 2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
  1. Portland Cement: ASTM C150/C150M, Type I/II, gray.
  2. Fly Ash: ASTM C618, Class F.
  3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
  1. Maximum Coarse-Aggregate Size: ASTM C33 Size Number 57 nominal.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.
- E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

F. Water: ASTM C94/C94M and potable.

## 2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. BASF Corporation.
  - b. Dayton Superior.
  - c. Euclid Chemical Company (The); an RPM company.

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 or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Dayton Superior.
  - b. Euclid Chemical Company (The); an RPM company.
  - c. W.R. Meadows, Inc.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Dayton Superior.
  - b. Euclid Chemical Company (The); an RPM company.
  - c. W.R. Meadows, Inc.

## 2.7 REPAIR MATERIALS

A. 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.

1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

## 2.8 CONCRETE MIXTURES, GENERAL

- 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, according to ACI 301.
  1. Use a qualified independent 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 cement in concrete as follows:
  1. Fly Ash: 20-25 percent.
  2. Slag Cement: 25-50 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use water-reducing admixture in concrete, for placement and workability.
  2. High-range water-reducing admixture in concrete, may be used, for placement and workability.
  3. Plasticizing admixture in concrete, may be used, for placement and workability.
  4. Water-reducing and -retarding admixture, may be used, when required by high temperatures, low humidity, or other adverse placement conditions.
  5. Use accelerating admixtures in cold weather. Use of admixtures will not relax cold-weather placement requirements.
  6. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## 2.9 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Slabs-on-Grade: Normal-weight concrete.
  1. Minimum Compressive Strength: 4000 psi at 28 days.
  2. Maximum W/C Ratio: 0.45.
  3. Minimum Cementitious Materials Content: 520 lb/cu. yd.
  4. Slump Limit: 4 inches, plus or minus 1 inch.

5. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

## 2.10 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.11 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
  1. When air temperature is between 85 and 90 degrees F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. 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 5 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 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
  1. Class A, 1/8 inch for smooth-formed finished surfaces.
  2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight to prevent loss of concrete mortar.

- E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, ice, snow, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
  - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - 3. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
  2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose mill scale, rust, mud, dirt, grease, oil, ice, and other foreign materials that reduce or destroy the bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
1. Weld reinforcing bars according to AWS D1.4/D 1.4M, only where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing, 1.3 times the development length, or 8 inches, whichever is greater. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Splicing:
1. Lap splices in welded wire fabric in accordance with the requirements of ACI 318 but not less than 12 inches. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
  2. If not indicated on Drawings, locate reinforcement splices at point of minimum stress.

### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces. Intentionally roughen concrete surface and remove laitance prior to applying bonding agent.
5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces. Intentionally roughen concrete surface and remove laitance prior to applying epoxy-bonding adhesive.
6. At construction joints and at concrete joints indicated on Drawings to be "roughened", uniformly roughen the surface of concrete to a full amplitude (distance between high and low points and side to side) of 1/4 inch with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Coat surfaces to a depth of at least 1/8 inch thick, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.
7. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.
  1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- C. 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. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid "cold" joints.
  2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- D. 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.
  - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

### 3.7 FINISHING FORMED SURFACES

- A. Finish concrete surfaces according to ACI 301 or ACI 318.
- B. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.8 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to receive trowel finish.
- C. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.

### 3.9 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Equipment Pads:
  - 1. Coordinate sizes and locations of concrete pads with actual equipment provided.
  - 2. Minimum Compressive Strength: 4000 psi at 28 days.
  - 3. Install reinforcing dowels; to connect concrete pad to concrete floor. Unless otherwise indicated.
  - 4. For supported equipment, install anchor bolts that extend through concrete pad and anchor into structural concrete substrate.
  - 5. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 6. Cast anchor-bolt insert into pads. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.10 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

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. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
  - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
  - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
  - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
3. **Curing Compound:** Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
  - a. **Removal:** After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
4. **Curing and Sealing Compound:** Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

### 3.11 CONCRETE SURFACE REPAIRS

- A. **Defective Concrete:** Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- 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, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, 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. Limit sawcut at the perimeter of the area to a depth of 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. 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.

- Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include 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, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

### 3.12 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

- B. Notify the Owner when the reinforcing is complete and ready for inspection, at least six working hours prior to the proposed concrete placement. Do not cover reinforcing steel with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the Owner's inspection agency and the Owner's inspection agency release to proceed with the concreting has been obtained. Keep forms open until the Owner's inspection agency has completed inspection of the reinforcement.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements by the Owner's testing agency:
  - 1. Testing Frequency: One composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests will be performed when concrete consistency appears to change.
  - 3. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 degrees F and below or 80 degrees F and above, and one test for each composite sample.
  - 5. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 6. Compression Test Specimens: ASTM C31/C31M.
    - a. Cast and laboratory cure two sets of two standard 6-inch diameter cylinder specimens for each composite sample.
  - 7. Compressive-Strength Tests: ASTM C39/C39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  - 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  - 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

10. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Additional Tests: Testing and inspecting agency shall 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 Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

## SECTION 036000 - GROUTING

### 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. Nonshrink epoxy grout.
  - 2. Nonshrink cementitious grout.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete."

#### 1.3 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.
  - 1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
  - 2. Commercially manufactured nonshrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.
- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- D. Qualifications Statement:
  - 1. Submit qualifications for manufacturer.

## 1.5 QUALITY ASSURANCE

- A. Maintain one copy of each standard affecting Work of this Section on Site.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.
- D. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location.
  - 2. Provide additional protection according to manufacturer instructions.

## 1.7 AMBIENT CONDITIONS

- A. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.
- B. Minimum Conditions: Do not perform grouting if minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

## PART 2 - PRODUCTS

### 2.1 NONSHRINK EPOXY GROUT

- A. Description:
  - 1. Pre-proportioned, prepackaged, three-component, nonshrink epoxy grout, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate.
- B. Performance and Design Criteria:
  - 1. Minimum Compressive Strength:
    - a. 10,000 psi at seven days.
    - b. Comply with ASTM C579.

2. Coefficient of Expansion:
  - a.  $30 \times 10^{-6}$  inch per degree F.
  - b. Comply with ASTM C531.
3. Minimum Tensile Strength:
  - a. 1,800 psi.
  - b. Comply with ASTM C307.

C. Product: Provide one of the following or equal:

1. Masterflow 648 CP; by BASF Building Systems.
2. Five Star HP Epoxy Grout; by Five Stars Products, Inc.
3. Sikadur 42 Grout-Pak; by Sika Corp.
4. E3-G Epoxy Grout; by Euclid Chemical Co.

## 2.2 NONSHRINK CEMENTITIOUS GROUT

A. Products:

1. Sika Grout 212 by Sika Corp.
2. NS Grout by The Euclid Chemical Co.
3. Five Star Grout by Five Star Products, Inc.

B. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C827/C827M.

C. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C1107/C1107M for Grades B, C, D and CRD-C621 nonshrink grout:
  - a. Setting Time:
    - 1) Initial: Approximately two hours.
    - 2) Final: Approximately three hours.
    - 3) Comply with ASTM C191.
  - b. Maximum Expansion: 0.10 to 0.40 percent.
  - c. Minimum Compressive Strength:
    - 1) One-Day: 4,000 psi.
    - 2) Seven-Day: 7,000 psi.
    - 3) 28-Day: 10,000 to 10,800 psi.
    - 4) Comply with CRD-C621.

## 2.3 FORMWORK

- A. As specified in this Section and in Section 033000 “Cast-in-Place Concrete”.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify areas to receive grout.

### 3.2 PREPARATION

- A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by Engineer.
- B. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints, and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
  - 1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- C. Roughen concrete lightly, but not to interfere with placement of grout.
- D. Remove foreign materials from metal surfaces in contact with grout.
- E. Align, level, and maintain final positioning of components to be grouted.
- F. Wash concrete surfaces clean and then keep moist for at least 24-hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, or flooding the surface or other method acceptable to Engineer. Upon completion of the 24-hour period, remove visible water from the surface prior to grouting.
- G. Nonshrink epoxy grouts do not require saturation of concrete substrate. Do not wet concrete surfaces to receive nonshrink epoxy grout. Completely dry surfaces in contact with epoxy grout before grouting.
- H. Support equipment during alignment and installation of grout by shims, wedges, blocks, or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by Engineer. Grout voids created by the removal of shims, wedges, and blocks.

### 3.3 INSTALLATION - GENERAL

#### A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 033000 "Cast-in-Place Concrete".

#### B. Placing of Grout:

1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

#### C. Curing:

1. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

#### D. Reflect existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

### 3.4 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees F or above 90 degrees F.
- C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.3A. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Minimize 'shoulder' length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

- F. Finish grout by puddling to cover all aggregate and provide smooth finish. Break bubbles and smooth top surface of grout in conformity with manufacturer's recommendations.
- G. Epoxy grouts are self-curing and do not require the application of water. Maintain formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1,000 psi or as recommended by manufacturer, whichever is longer.
- H. Provide grout control joints as indicated on Drawings.

### 3.5 SCHEDULE

- A. Use particular types of grout as follows:
  - 1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.
  - 2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long. Use at locations indicated to receive flowable (precision) nonshrink grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.
  - 3. Nonshrink Epoxy Grout: Use at locations specifically indicated to receive nonshrink epoxy grout.

END OF SECTION 036000

## SECTION 133419 - METAL BUILDING SYSTEMS

### 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. Structural-steel framing.
  - 2. Metal roof panels.
  - 3. Accessories.
  - 4. Delegated Design.

### 1.3 DEFINITIONS

- A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in standards referenced by this Section.

### 1.4 COORDINATION

- A. Coordinate sizes and locations of concrete foundations and casting of anchor-rod inserts into foundation walls and footings. Anchor rod installation, concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of metal building system component.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Metal roof panels.
- B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and the following:
  - 1. Anchor-Rod Plans: Submit anchor-rod plans and templates before foundation work begins. Include location, diameter, and minimum required projection of anchor rods required to attach metal building to foundation. Indicate column reactions at each

- location in individual load cases and in load combinations. Foundation engineer to provide embedment into concrete after final reactions are received.
2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
  3. Metal Roof Panel Layout Drawings: Show layouts of panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, clip spacing, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
    - a. Show roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, and items mounted on roof curbs.
  4. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
    - a. Flashing and trim.
    - b. Gutters.
    - c. Downspouts.

#### 1.6 DELEGATED DESIGN SUBMITTALS

A. For metal building systems:

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.
6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure.
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.

10. Building-Use Category: Indicate category of building use and its effect on load importance factors.
  - D. Erector Certificates: For qualified erector, from manufacturer.
  - E. Material Test Reports: For each of the following products:
    1. Structural steel including chemical and physical properties.
    2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
    3. Tension-control, high-strength, bolt-nut-washer assemblies.
    4. Shop primers.
    5. Nonshrink grout.
  - F. Source quality-control reports.
  - G. Field quality-control reports.
  - H. Surveys: Show final elevations and locations of major members. Indicate discrepancies between actual installation and the Contract Documents. Have surveyor who performed surveys certify their accuracy.
  - I. Sample Warranties: For special warranties.
- 1.8 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For metal panel finishes to include in maintenance manuals.
- 1.9 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer.
    1. Accreditation: Manufacturer's facility accredited according to the International Accreditation Service's AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
    2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by professional engineer who is legally qualified to practice in jurisdiction where Project is located.
  - B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.
  - C. Welding Qualifications: Qualify procedures and personnel according to the following:
    1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
    2. AWS D1.3, "Structural Welding Code - Sheet Steel."
  - D. Land Surveyor Qualifications: A professional land surveyor who practices in jurisdiction where Project is located and who is experienced in providing surveying services of the kind indicated.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

#### 1.11 FIELD CONDITIONS

- A. Weather Limitations: Proceed with panel installation only when weather conditions permit metal panels to be installed according to manufacturers' written instructions and warranty requirements.

#### 1.12 WARRANTY

- A. Special Warranty on Metal Panel Finishes: Manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - 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 PERFORMANCE AND DESIGN CRITERIA

- A. Delegated Design: Engage a qualified professional engineer to design metal building system.
- B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
  - 1. Design Loads:
    - a. Dead Loads: Self weight of structure, roofing, and accessories, and 5 psf collateral.

- b. Roof Live Load: 20 psf.
    - c. Wind Load: Per requirements indicated on S drawings.
  - 2. Design Calculations:
    - a. Column base reactions shall be vertical and horizontal only. No bending moments shall be allowed at the base of the columns.
  - 3. Deflection and Drift Limits: Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."
  - 4. Deflection and Drift Limits: No greater than the following:
    - a. Purlins and Rafters: Vertical deflection of 1/240 of the span.
    - b. Metal Roof Panels: Vertical deflection of 1/240 of the span.
    - c. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
    - d. Lateral Drift: Maximum of 1/100 of the building height.
  - C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    - 1. Temperature Change: 120 degrees F, ambient; 180 degrees F, material surfaces.
  - D. Structural Performance for Metal Roof Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
    - 1. Wind Loads: As indicated on Drawings.
  - E. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
    - 1. Test-Pressure Difference: 2.86 lbf/sq. ft.
  - F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
    - 1. Uplift Rating: UL 90.
- 2.2 MANUFACTURERS
- A. Source Limitations: Obtain metal building system components, including primary and secondary framing and metal panel assemblies, from single source from single manufacturer.

## 2.3 SYSTEM DESCRIPTION

- A. Provide complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior.
- B. Primary-Frame Type:
  - 1. Rigid Clear Span: Solid-member, structural-framing system without interior columns.
- C. Secondary-Frame Type: Manufacturer's standard purlins.
- D. Eave Height: Manufacturer's standard height, as indicated by nominal height on Drawings.
- E. Bay Spacing: As indicated on Drawings.
- F. Roof Slope: 1/4 inch per 12 inches.
- G. Roof System: Manufacturer's standard lap-seam, tapered-rib metal roof panels.

## 2.4 STRUCTURAL-STEEL FRAMING

- A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."
- B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.
- D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters, rake, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.
  - 1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
    - a. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Engineer.
  - 2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.
  - 3. Frame Configuration: One-directional, sloped.
  - 4. Exterior Column: Uniform depth.
  - 5. Rafter: Uniform depth.
- E. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either

cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, prepainted with coil coating, to comply with the following:

1. Purlins: C- or Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.
  - a. Depth: As needed to comply with system performance requirements.
2. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
3. Flange Bracing: Minimum 2-by-2-by-1/8-inch structural-steel angles or 1-inch- diameter, cold-formed structural tubing to stiffen primary-frame flanges.
4. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
5. Purlin Clips: Manufacturer's standard clips fabricated from steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.
6. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

F. Bracing: Provide adjustable wind bracing using any method as follows:

1. Rods: ASTM A36/A36M; ASTM A572/A572M, Grade 50; or ASTM A529/A529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end.
2. Cable: ASTM A475, minimum 1/4-inch- diameter, extra-high-strength grade, Class B, zinc-coated, seven-strand steel; with threaded end anchors.
3. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.
4. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

G. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

H. Materials:

1. W-Shapes: ASTM A992/A992M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
3. Plate and Bar: ASTM A36/A36M; ASTM A572/A572M, Grade 50 or 55; or ASTM A529/A529M, Grade 50 or 55.
4. Steel Pipe: ASTM A53/A53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A500, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A1011/A1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS) or High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F), Grades 45 through 70; or cold-rolled, ASTM A1008/A1008M, Structural Steel (SS), Grades 25 through 80, or HSLAS, Grades 45 through 70.
7. Metallic-Coated Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G60 coating designation; mill phosphatized.

8. 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 A755/A755M.
  - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, SS, Grades 33 through 80, or HSLAS or HSLAS-F, Grades 50 through 80; with G90 coating designation.
  - b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, SS, Grade 50 or 80; with Class AZ50 coating.
9. Non-High-Strength Bolts, Nuts, and Washers: ASTM A307, Grade A, carbon-steel, hex-head bolts; ASTM A563 carbon-steel hex nuts; and ASTM F844 plain (flat) steel washers.
  - a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
10. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - a. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
11. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
12. Unheaded Anchor Rods: ASTM F1554, Grade 36.
  - a. Configuration: Straight.
  - b. Nuts: ASTM A563 heavy-hex carbon steel.
  - c. Plate Washers: ASTM A36/A36M carbon steel.
  - d. Washers: ASTM F436 hardened carbon steel.
  - e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
13. Headed Anchor Rods: ASTM F1554, Grade 36.
  - a. Configuration: Straight.
  - b. Nuts: ASTM A563 heavy-hex carbon steel.
  - c. Plate Washers: ASTM A36/A36M carbon steel.
  - d. Washers: ASTM F436 hardened carbon steel.
  - e. Finish: Hot-dip zinc coating, ASTM F2329, Class C.
14. Threaded Rods: ASTM A36/A36M.
  - a. Nuts: ASTM A563 heavy-hex carbon steel.
  - b. Washers: ASTM F436 hardened carbon steel.
  - c. Finish: Hot-dip zinc coating, ASTM F2329, Class C.

- I. Finish: Factory primed. Apply specified primer immediately after cleaning and pretreating.
  1. Clean and prepare in accordance with SSPC-SP2.
  2. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.
    - a. Prime secondary framing formed from uncoated steel sheet to a minimum dry film thickness of 0.5 mil on each side.

## 2.5 METAL ROOF PANELS

- A. Exposed Fastener, Tapered-Rib, Metal Roof Panels: Formed with raised, trapezoidal major ribs and intermediate stiffening ribs symmetrically spaced between major ribs; designed to be installed by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps.
  1. Material: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.024-inch nominal uncoated steel thickness. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
    - a. Exterior Finish: Two-coat fluoropolymer.
    - b. Color: As selected by Engineer from manufacturer's full range.
  2. Major-Rib Spacing: 12 inches o.c.
  3. Panel Coverage: 36 inches.
  4. Panel Height: 1.5 inches.
- B. Finishes:
  1. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

## 2.6 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
  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.

- B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same material as metal roof panels.
  2. Clips: Manufacturer's standard, formed from steel sheet, designed to withstand negative-load requirements.
  3. Cleats: Manufacturer's standard, mechanically seamed cleats formed from steel sheet.
  4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
  6. Thermal Spacer Blocks: Where metal panels attach directly to purlins, provide thermal spacer blocks of thickness required to provide 1-inch standoff; fabricated from extruded polystyrene.
- C. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.
1. 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.
  2. Opening Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.030-inch nominal uncoated steel thickness, prepainted with coil coating. Trim head and jamb of door openings, and head, jamb, and sill of other openings.
- D. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."
1. Gutter Supports: Fabricated from same material and finish as gutters.
  2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.
- E. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- long sections, complete with formed elbows and offsets.
1. Mounting Straps: Fabricated from same material and finish as gutters.
- F. Materials:
1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners

with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.

- a. Fasteners for Metal Roof Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless steel cap or zinc-aluminum-alloy head and EPDM sealing washer.
  - b. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
  - c. Blind Fasteners: High-strength aluminum or stainless steel rivets.
2. Corrosion-Resistant Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
  3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
  4. Metal Panel Sealants:
    - a. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene-compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape of manufacturer's standard size.
    - b. Joint Sealant: ASTM C920; one-part elastomeric polyurethane or polysulfide; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended by metal building system manufacturer.

## 2.7 FABRICATION

- A. General: Design components and field connections required for erection to permit easy assembly.
  1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
  2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
  1. Make shop connections by welding or by using high-strength bolts.
  2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
  3. Brace compression flange of primary framing with steel angles or cold-formed structural tubing between frame web and purlin web or girt web, so flange compressive strength is within allowable limits for any combination of loadings.
  4. Weld clips to frames for attaching secondary framing if applicable, or punch for bolts.

5. Shop Priming: Prepare surfaces for shop priming according to SSPC-SP 2. Shop prime primary framing with specified primer after fabrication.
- D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
  1. Make shop connections by welding or by using non-high-strength bolts.
  2. Shop Priming: Prepare uncoated surfaces for shop priming according to SSPC-SP 2. Shop prime uncoated secondary framing with specified primer after fabrication.
- E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
  1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

## 2.8 SOURCE QUALITY CONTROL

- A. Special Inspection: Owner will engage qualified special inspector to perform source quality control inspections and to submit reports.
  1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.
    - a. After fabrication, submit copy of certificate of compliance to authorities having jurisdiction, certifying that Work was performed according to Contract requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
  1. Engage land surveyor to perform surveying.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.
- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

### 3.3 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written instructions and drawings.
- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- F. Primary Framing: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
  - 1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.
    - a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

- G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
  - 1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
- H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
  - 1. Tighten rod and cable bracing to avoid sag.
  - 2. Locate interior end-bay bracing only where indicated.
- I. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

### 3.4 METAL PANEL INSTALLATION, GENERAL

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Examination: Examine primary and secondary framing to verify that structural-panel support members and anchorages have been installed within alignment tolerances required by manufacturer.
  - 1. Examine roughing-in for components and systems penetrating metal panels, to verify actual locations of penetrations relative to seams before metal panel installation.
- C. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
  - 1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.
    - a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.
  - 2. Install metal panels perpendicular to structural supports unless otherwise indicated.
  - 3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
  - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
  - 5. Locate metal panel splices over structural supports with end laps in alignment.
  - 6. Lap metal flashing over metal panels to allow moisture to run over and off the material.
- D. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.
  - 1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated

items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

- E. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
- F. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.
  - 1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.
  - 2. Prepare joints and apply sealants to comply with requirements.

### 3.5 METAL ROOF PANEL INSTALLATION

- A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
  - 1. Install ridge and hip caps as metal roof panel work proceeds.
  - 2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.
- B. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.
  - 1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
  - 2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
  - 3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
  - 4. At metal panel splices, nest panels with minimum 6-inch end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.
- C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.
- D. Metal Roof Panel Installation Tolerances: Shim and align metal roof panels within installed tolerance of 1/4 inch in 20 feet on slope and location lines and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### 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 metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
  - 2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
  - 3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.
- 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. 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. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- D. Downspouts: Join sections with 1-1/2-inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.
  - 1. Provide elbows at base of downspouts to direct water away from building.
  - 2. Tie downspouts to underground drainage system indicated.

### 3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage qualified special inspector to perform field quality control special inspections and to submit reports.
- B. Product will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.

### 3.8 CLEANING AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.
  - 1. Clean and prepare surfaces by SSPC-SP 2, "Hand Tool Cleaning," or by SSPC-SP 3, "Power Tool Cleaning."
  - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Metal Panels: Remove temporary protective coverings and strippable films, if any, as metal panels are installed. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
  - 1. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 133419

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## SECTION 260510 – LIMITED ELECTRICAL FOR SMALL PROJECTS

### 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. Copper power and control wire rated 600V or less.
2. Low-voltage instrumentation cable.
3. Industrial Category 5e Ethernet cable.
4. Industrial Category 6 Ethernet cable.
5. Connectors, splices, and terminations.
6. Grounding and bonding components.
7. Support systems for raceways, boxes, and electrical equipment.
8. Metal conduits and fittings.
9. Nonmetallic conduit and fittings.
10. Boxes, enclosures, and cabinets.
11. Handholes and boxes for exterior underground cabling.
12. Switches.
13. Wiring Devices.
14. Lighting.
15. Identification requirements.

#### 1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit. See also RAC.
- B. CCT: Correlated color temperature.
- C. CRI: Color rendering index.
- D. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- E. Duct: A single duct or multiple ducts. Duct may be installed singly or as a component of a duct bank.
- F. Duct Bank:
  1. Two or more ducts installed in parallel, with or without additional casing materials.
  2. Multiple duct banks.

- G. EMI: Electromagnetic interference.
- H. Fixture: See “Luminaire.”
- I. GFCI: Ground-fault circuit interrupter.
- J. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote-control and signaling power-limited circuits.
- K. Lumen: Measured output of lamp and luminaire, or both.
- L. Luminaire: Complete lighting unit, including lamp, reflector, and housing.
- M. RAC: Rigid aluminum conduit. See also ARC.
- N. RoHS: Restriction of Hazardous Substances.
- O. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.
- P. National Electrical Code (NEC) / NFPA conduit types:
  - 1. RMC – rigid metal conduit.
  - 2. FMC – flexible metal conduit.
  - 3. LFMC – liquidtight flexible metal conduit.
  - 4. PVC – rigid polyvinyl chloride conduit.
  - 5. LFNC – liquidtight flexible nonmetallic conduit.
  - 6. RNC – rigid nonmetallic conduit.
  - 7. EMT – Electrical metallic tubing.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product used on this project.
- B. Shop Drawings:
  - 1. Precast Handholes: Include plans, elevations, sections, and details.
- C. Installation Working Drawings: For underground conduit routing.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

## PART 2 - PRODUCTS

### 2.1 ELECTRICAL MATERIALS

- A. Listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
- B. Comply with associated UL Standards as applicable and listed in this specification.

### 2.2 WIRE

- 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. Alpha Wire Company.
  - 2. Encore Wire Corporations.
  - 3. General Cable Technologies Corporation.
  - 4. Okonite Company (The).
  - 5. Service Wire Co.
  - 6. Southwire Company.
- B. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.
- C. Standards:
  - 1. RoHS compliant.
  - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Size: Minimum No. 12 AWG for power circuits, minimum No. 14 AWG for control circuits.
- F. Stranding: Refer to Part 3 "Conductor Applications" Article.
- G. Conductor Insulation: Refer to Part 3 "Conductor Applications" Article.
  - 1. Type RHW-2: Comply with UL 44.
  - 2. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
  - 3. Type THHN and Type THWN-2: Comply with UL 83.
  - 4. Type XHHW-2: Comply with UL 44.

### 2.3 INSTRUMENTATION CABLE

- 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. Belden.
2. Rockbestos.

B. Single or Multiple Paired Cable: NEC type ITC (Instrumentation Tray Cable), UL Type TC for 4-20mA process instrumentation signals and use under NEC Article 72.

1. One or Multi-pair, twisted, shielded, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. XLPE insulation, 600V.
3. Shield: 100 percent aluminum/polyester foil with drain wire. Pairs individually shielded.
4. PVC jacket with manufacturer's identification.
5. Standards: UL 1277 Type TC, UL 1581.

## 2.4 INDUSTRIAL CATEGORY 5E ETHERNET CABLE

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. Rockwell Automation 1585-C8HB-S.

B. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz *Ethernet/IP* compliant.

C. Standard: UL, UL PLTC, UL AWM 2570 80C 600V, TIA 568B.

D. Conductors: 100-ohm, No. 22 AWG solid copper.

E. Shielding/Screening: Overall foil shield.

F. Cable Rating: 600V.

G. Jacket: PVC.

## 2.5 INDUSTRIAL CATEGORY 6 ETHERNET CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz *Ethernet/IP* compliant.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, No. 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: 300V.

F. Jacket: PVC.

## 2.6 CONNECTORS, SPLICES, AND TERMINATIONS

- 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. 3M Electrical Products.
  - 2. Ideal Industries, Inc.
  - 3. TE Connectivity Ltd.
  - 4. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. Material: Tin-plated copper.
  - 2. Type:
    - a. Locking spade with insulated sleeve for No. 10 AWG and smaller.
    - b. One hole with long barrels for No. 8 AWG to No. 4/0 AWG.
    - c. Two holes with long barrels for 250 kcmil and larger.
  - 3. Termination: Compression for No. 8 AWG and larger.
- D. Connectors:
  - 1. Solderless pressure type (wirenuts) for No. 10 AWG and smaller.
  - 2. Pre-filled with silicone-based sealant for exterior, wet, or corrosive locations.
  - 3. Split bolt type for No. 8 AWG and larger splices.
- E. Motor Terminations: Mechanical compression ring type, secured with bolt, nut, and spring washer. Insulated with Raychem type RVC, roll-on stub insulator or equal.
- F. Industrial Category 5e Ethernet Cable Terminations: Match conductor count, RJ45 type, intended for shielded cable. Rockwell Automation Bulletin 1585J or equal.
- G. Industrial Category 6 Ethernet Cable Hardware: Comply with the performance requirements of Category 6. Cables shall be terminated with connecting hardware of same category or higher.

## 2.7 GROUNDING AND BONDING MATERIALS

- 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. ERICO; a brand of nVent.
  - 2. Hubbell Incorporated (Construction and Energy Group).
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 4. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Standard: Comply with UL 467 for grounding and bonding materials and equipment.

- C. Grounding Conductors:
  - 1. Insulated conductors to match corresponding 600V phase conductor insulation requirements.
  - 2. Bare copper conductors: tin-plated.
- D. Ground rods: Copper-clad steel, sectional type; 3/4-inch diameter by 10-foot; minimum copper thickness 0.25 mm (10 mil).
- E. Grounding conduit hubs: Malleable iron type, mechanical type, terminal with threaded hub, sized for the associated conduit.
- F. Waterpipe ground clamps: cast bronze saddle type, sized for the associated water pipe.
- G. Exothermic weld: CADWELD process, or equal. Molds and powder furnished by same manufacturer and selected for specific combination of conductors and connected items. Use low emission type, CADWELD EXOLON or equal for welds used indoors in occupied buildings or confined spaces.

## 2.8 SUPPORT SYSTEMS

- A. Aluminum Channel:
  - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 2. Channel Material: 6063-T5 aluminum alloy.
  - 3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
- B. Stainless Steel Channel:
  - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 2. Material for Channel, Fittings, and Accessories: Stainless steel, Type 316.
- C. Hot-dipped Galvanized Steel Channel:
  - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 2. Material for Channel, Fittings, and Accessories: Hot-dipped galvanized steel.
- D. Nonmetallic Channel:
  - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  - 2. Channel Material: Ultraviolet resistant FRP.
  - 3. Fittings and Accessories Material: Stainless steel, Type 316 or compatible non-metallic.
- E. Accessories: conduit clamps, straps, hangers, rods, backplates, anchors, nuts, washers, etc. shall match channel material as listed in the SUPPORT MATERIALS APPLICATION Article. Use of galvanized steel components is only allowed with galvanized steel channel.
- F. Threaded rod: 3/8-inch minimum diameter.
- G. Expansion anchors: 3/8-inch minimum diameter.

## 2.9 METAL CONDUITS AND FITTINGS

- A. Rigid Aluminum Conduit: Comply with ANSI C80.5 and UL 6A.
- B. EMT: Comply with ANSI C80.3 and UL 797.
- C. LFMC: Sealtite®, Type UA, continuously interlocked flexible steel conduit with sunlight and chemical resistant PVC jacket and complying with UL 360.
- D. FMC: Comply with UL 1; zinc-coated steel.
- E. Metallic Fittings: Comply with NEMA FB 1 and UL 514B.
  - 1. Use cast aluminum fittings with RAC.
  - 2. Use malleable iron, three-piece screw in type with LMFC.
  - 3. Use Myers Electric Products, Inc. or equal, grounding type for conduit hubs.
  - 4. Use die-cast compression type fittings with EMT, no set-screw type.

## 2.10 NONMETALLIC CONDUIT AND FITTINGS

- A. RNC: Schedule 40 or Schedule 80 PVC based on application; comply with NEMA TC 2 and UL 651.
- B. LFNC-B: Comply with UL 1660, Type B.
- C. Nonmetallic Fittings:
  - 1. RNC: Comply with NEMA TC 3; match conduit type and material.
  - 2. LFNC: Comply with UL 514B; dust-tight, liquid-tight, chemical resistant thermoplastic/nylon construction with tapered thread hub and neoprene O-ring gasket. Push-on fittings are prohibited.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.11 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: Pressed steel. Comply with NEMA OS 1 and UL 514A.
- B. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- C. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- D. NEMA 1 and NEMA 12 Pull and Junction Boxes:
  - 1. Material: Sheet steel, minimum 14 gauge, without knockouts.
  - 2. Construction: flanged box, galvanized with continuous weld seams that are ground smooth.
  - 3. Cover: Gasketed, hanged, fastened with quick connect door clamp.

- E. NEMA 4X Pull and Junction Boxes:
  - 1. Material: Type 316 stainless steel, minimum 14 gauge, without knockouts.
  - 2. Construction: flanged box, continuous weld seams that are ground smooth.
  - 3. Cover: Gasketed, hanged, fastened with quick connect door clamp.
- F. NEMA 4X Chemical Area Pull and Junction Boxes: When Drawings classify the area as CORROSIVE, ultraviolet resistant fiberglass reinforced plastic (FRP) with Type 316 stainless steel hardware and gasketed covers.
- G. NEMA 7/4 Pull and Junction Boxes: When Drawings classify the area for Class 1, Division 1, Group D hazardous area, cast aluminum with stainless steel bolts; Type EJB-N4 as manufactured by Crouse Hinds or equal.
- H. Handholes and Boxes for Exterior Underground Cabling: Comply with details as indicated on Drawings.

## 2.12 SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Square D; Schneider Electric USA.
- B. Non-Fusible Disconnect Switch: Type HD, Heavy Duty, Three Pole, Single Throw, 600-V 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. NEMA 4X stainless steel enclosure for outdoor locations.

## 2.13 WIRING DEVICES

- A. General Wiring Device Requirements:
  - 1. Comply with NEMA WD 1.
  - 2. Device Color: Gray.
- B. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eaton (Arrow Hart).
    - b. Leviton Manufacturing Co., Inc.
    - c. Pass & Seymour/Legrand (Pass & Seymour).
    - d. Hubbell (Kellems).
  - 2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.

3. Configuration: NEMA WD 1, Configuration 5-20R.
4. Type: Non-feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

C. Wall Plates:

1. Single Source: Obtain wall plates from same manufacturer of wiring devices.
2. Single and combination types shall match corresponding wiring devices.
  - a. Plate-Securing Screws: Metal with head color to match plate finish.
  - b. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
  - c. Material for Unfinished Spaces: Cast aluminum.
  - d. Material for Indoor Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.
3. Wet-Location, Weatherproof receptacle While-In-Use Cover Plates: heavy duty die-cast aluminum back and cover, deep cover, gasketed, single or double gang as required, lockable hasp, as manufactured by Thomas & Betts (Red Dot); Eaton (Arrow Hart); Carlon; or equal.

2.14 LIGHTING

A. Luminaire Requirements:

1. UL Compliance:
  - a. UL1598, Luminaires (non-hazardous locations).
  - b. UL 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.
  - c. UL 773, Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting.
2. Metal Parts:
  - a. Free of burrs and sharp corners and edges.
  - b. Sheet metal components to be steel unless otherwise indicated.
  - c. Form and support to prevent warping and sagging.
  - d. Steel: ASTM A36/A36M for carbon structural steel, ASTM A568/A568M for sheet steel.
  - e. Stainless Steel: Manufacturer's standard grade, ASTM A240/A240M.
  - f. Galvanized Steel: ASTM A653/A653M.
  - g. Aluminum: ASTM B209.
3. Variations in metal finishes are unacceptable in the same piece.
4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to

prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

5. Photoelectric Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 footcandles and off at 4.5 to 10 footcandles with 15 second minimum time delay.

B. Luminaire Types:

1. Refer to Light Fixture Schedule on Drawings for light fixture type, manufacturer, voltage, lumen levels, lamp and housing details, color temperature, diffuser, details, and other accessories.

## 2.15 IDENTIFICATION

- A. Factory applied insulation color for No. 8 AWG conductors and smaller. Factory applied insulation color or field applied colored electrical tape for No. 6 AWG conductors and larger:

1. Color for 208/120V Circuits:

- a. Phase A: Black.
- b. Phase B: Red.
- c. Phase C: Blue.
- d. Neutral: White.

2. Color for 240/120V Circuits (Single Phase):

- a. Phase A: Black.
- b. Phase B: Red.
- c. Neutral: White.

3. Color for 240 $\Delta$ /120V Circuits (Three Phase, Four Wire, high leg, center tap):

- a. Phase A: Black.
- b. Phase B: Orange (high leg).
- c. Phase C: Blue.
- Neutral: White.

4. Color for 480/277V Circuits:

- a. Phase A: Brown.
- b. Phase B: Orange.
- c. Phase C: Yellow.
- d. Neutral: Gray.

5. Color for Equipment Grounds: Green.

6. Color of Individual Control Conductors:

- a. AC: Red.
- b. DC: Blue.

B. Nameplates and Labels:

1. Equipment Identification and Source Nameplates:

- a. Black letters on white field.
- b. Engraved, laminated plastic, 3/16-inch-high lettering.
- c. Provide for all electrical equipment. Match Drawing designation.
- d. Include power source information, i.e., "FED FROM MCC-2" or provide separate nameplate.

2. Device Identification Labels:

- a. Black letters on white field.
- b. Machine generated, self-adhesive, 1/4-inch-high lettering.
- c. Provide for all receptacles, wall switching, lighting fixtures, photocells, exit lights, instruments, etc.
- d. Include power source and branch circuit information, i.e., "LP-2/15" indicates panelboard LP-2, branch circuit 15.

3. Wire and Cable Labels:

- a. Black letters on white field.
- b. Wraparound or sleeve type.

C. Detectable Underground-Line Warning Tape:

- 1. Foil-backed, detectable buried utility tape with black lettering on a bright background.
- 2. Width: 6 inches.
- 3. Overall Thickness: 5 mils.
- 4. Background Color / Description:
  - a. Red / Electric: electrical power, control, or instrumentation.
  - b. Orange / Fiber: fiber optic cables.

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Comply with the applicable National Electrical Contractors Association (NECA) documents for installation requirements except where requirement on Drawings or in this specification are stricter.

- 1. NECA 1: Standard for Good Workmanship in Electrical Construction.
- 2. NECA 101: Standard for Installing Steel Conduits.
- 3. NECA 102: Standard for Installing Aluminum Rigid Metal Conduit.
- 4. NECA 111: Standard for Installing Nonmetallic Raceways.
- 5. NECA 331: Standard for Installing Building and Service Entrance Grounding and Bonding.

6. NECA / NEMA 605: Recommended Practice for Installing Underground Nonmetallic Utility Duct.

### 3.2 CONDUCTOR APPLICATIONS

- A. Wires and Cables: Copper, stranded, except for lighting and receptacle wiring which may be solid.
- B. Wire for lighting, receptacles, and other circuits not exceeding 150 volts to ground shall be NEC type THWN-2/THHN. Below grade and underground the wire shall be type THWN-2/THHN.
- C. Wire for power circuits over 150 volts to ground shall be NEC type XHHW-2 for sizes No. 4/0 AWG and smaller, and shall be NEC type RHW-2 for sizes 250 kcmil and larger.
- D. Equipment grounding conductors shall be the same NEC type as the phase conductors described previously, green and sized per NEC Table 250.122.
- E. Bare copper ground wire shall be stranded, tinned soft drawn annealed copper wire.
- F. Ground grid conductors shall be uninsulated unless shown otherwise on the Drawings.
- G. Wire for control, status, and alarm shall be NEC type THWN-2/THHN.
- H. Multi-conductor power cable shall be stranded, 600V, cross-linked polyethylene insulated with PVC jacket, Type TC (XLP) with ground.
- I. Multi-conductor control cable shall be NEC type TC (tray cable), stranded, No. 14 AWG, THHN/THWN-2 600V insulated color coded conductors, bare stranded ground wire, with overall PVC cable jacket.

### 3.3 CONDUCTOR INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway. Use of steel fish tapes and/or steel pulling cables in PVC conduit or raceways that terminate into energized enclosures is prohibited.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- F. Adequately support cables.

- G. 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.
- H. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Do not splice service or feeder cables without prior written approval of Engineer. Instrumentation and Ethernet cables may not be spliced and shall be continuous from terminal to terminal.
- I. Wiring at Outlets:
  - 1. Install conductor at each outlet, with at least 6 inches of slack.
  - 2. Form solid wire into loop to fit around device terminal screw. Do not overlap wire.
- J. Identify and color-code conductors and cables.
- K. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.
- L. Identify circuit number associated with lights, receptacles, and other miscellaneous loads to panelboards. Identify phase and neutral conductors with circuit number.
- M. Install instrumentation and Ethernet cabling in separate raceway from control or power wiring.
- N. Separation from EMI Sources:
  - 1. Separation between open instrumentation cables or cables in non-metallic or non-ferrous raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Equipment or circuits rated less than 2 kVA: Minimum 5 inches.
    - b. Equipment or circuits rated between 2 and 5 kVA: Minimum 12 inches.
    - c. Equipment or circuits rated more than 5 kVA: Minimum 24 inches.

### 3.4 GROUNDING

- A. Comply with NEC Article 250.
- B. Install insulated green equipment grounding conductor in all power and control raceways.
- C. For instrumentation wiring, ground shield at one end only as recommended by instrument manufacturer and in accordance with Owner's standard.
- D. Install grounding conductors in conduit or sleeves when passing through floor slabs.
- E. Use exothermic welding process for all underground connections, connections to structural steel, connections to ground rods, or other connections which will become inaccessible at project completion.

### 3.5 SUPPORT MATERIALS APPLICATION

- A. Dry, indoor, conditioned, non-process space: Hot-dipped galvanized steel.
- B. Outdoor, process areas, or areas shown on the drawings as “DUST”, “DAMP”, or “WET”: Aluminum and/or stainless-steel channel, depending upon load requirements.
- C. Areas shown on the drawings as “CORROSIVE”: Nonmetallic.

### 3.6 RACEWAY APPLICATIONS

- A. Refer to Appendix Table 260510-1 for specific raceway application requirements.
- B. Minimum Raceway Size: 3/4-inch trade size.

### 3.7 BOX APPLICATIONS

- A. All boxes shall be metallic unless specified herein or indicated on the Drawings.
- B. Use cast malleable iron for boxes and conduit fittings for exposed switch, receptacle, and lighting outlets.
- C. Use pressed steel boxes for concealed switch, receptacles, and lighting outlets.
- D. Pull boxes, junction boxes, cabinets, etc. shall be suitable for the location and conform to the NEMA enclosure rating and material descriptions as indicated on the Drawings.
- E. Where no size is indicated for junction boxes, pull boxes, or terminal cabinets, size in accordance with NEC Article 314.

### 3.8 RACEWAY INSTALLATIONS

- A. Complete raceway installation before starting conductor installation.
- B. Tightly plug ends of conduits during construction to exclude dust and moisture.
- C. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- D. Arrange conduit system to allow liquids such as water, condensation, etc. will drain away from equipment served. If conduit drainage is not possible, plug conduits using conduit seals.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run. Support within 12 inches of changes in direction.
- F. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- G. Support conduit within 12 inches 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. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- J. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits. Install Meyers grounding type hubs when conduits terminate at gasketed enclosures.
- K. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- L. 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.
- M. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. 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.
- P. 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 using "Duxseal" or seal fitting at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Conduit extending from interior to exterior of building.
  - 4. Conduit extending into pressurized duct and equipment.
  - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
  - 6. Where otherwise required by NFPA 70.
- Q. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- R. Install expansion joint fittings where necessary to compensate for thermal expansion and contraction.

- S. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission or movement; and for transformers and motors.
- T. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- U. A maximum continuous run of conduit shall not exceed 300 feet and shall be reduced by 75 feet for each 90-degree elbow.
- V. Provide a 4-inch concrete housekeeping pad at all slab and grade penetrations. Provide a 45 degree, 3/4-inch chamfer at all exposed edges.
- W. Protect metallic finish conduit installed in contact with concrete or below grade with two coats of bitumastic paint, heat shrink tubing, or approved equivalent. Extend protection on riser conduits from 12 inches below slab to 6 inches above slab.
- X. In hazardous locations, seal conduits terminating at boxes enclosing circuit opening equipment at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits. Similarly seal all conduits leading from or entering hazardous locations at points of exit or entrance. Seal exposed conduits passing through hazardous locations at both the entrance to and the exit from the hazardous locations.
- Y. Install conduit sealing and drain fittings in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.

### 3.9 UNDERGROUND SYSTEM INSTALLATION

- A. Coordinate final arrangement with other underground utilities, site grading, and surface features.
- B. Comply with Division 31 specifications for earthwork, excavation, trenching, backfill, and compaction.
- C. Raceway Drainage:
  - 1. Drain away from buildings.
  - 2. Drain towards manholes or handholes.
  - 3. Slope raceway not less than 3-inches per 100-feet.
- D. Restoration: Restore surface features and re-establish grade, paving, and vegetation to original unless otherwise indicated.
- E. Separate underground copper signal conduits (instrumentation and telecommunication) from power conduits by a minimum of 12 inches unless noted otherwise. Keep crossing of these conduits to a minimum; cross at 90-degree angles.

- F. Transition to Metal Conduit:
  - 1. Use fittings manufactured for RNC to metal conduit transition.
  - 2. Make transition from underground duct to metal conduit at least 10 feet outside the building wall, without reducing duct line slope away from building and without forming a trap in the line.
- G. Minimum Cover and Additional Detail: As indicated per details on Drawings.
- H. Where Drawings call for concrete encased duct bank, color concrete red.

### 3.10 ELECTRICAL PENETRATIONS

- A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc.
- B. Locate all slots and concealed conduits and stub-ups for electrical work and place and form as required before concrete is poured.
- C. Make weathertight and restore finishes on exterior penetrations.
- D. Use conduit wall seals where underground conduits penetrate walls or at other locations indicated on the Drawings.
- E. Seal openings where conduits pass through walls or floors to prevent passage of flame and smoke. Maintain fire rating of walls.
- F. Patch and paint interior wall penetrations to match original.

### 3.11 SWITCH INSTALLATION

- A. Coordinate layout and installation of switches with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Mount disconnect switches on Type 316 stainless steel or aluminum channel or as shown on Drawings.
- C. Install equipment and device identification.

### 3.12 WIRING DEVICE INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated in the drawing.
- B. Device Mounting Heights (as measured to the center of the device box): As noted on the drawings.

C. Coordination with Other Trades:

1. 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.
2. 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.
3. Install wiring devices after all wall preparation, including painting, is complete.

D. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. 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.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
  - a. Cut back and pigtail or replace all damaged conductors.
  - b. Straighten conductors that remain and remove corrosion and foreign matter.
  - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

E. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. 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. Do not overlap conductors.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

G. 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.

- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.
- I. Identify each receptacle with panelboard identification and circuit number.
- J. Confirm correct wiring using a digital wiring analyzer.

### 3.13 LIGHTING INSTALLATION

- A. Include all components necessary for a complete installation, including supports and hangers, etc.
- B. Adjust luminaires as necessary or directed by Engineer.
- C. Replace all damaged, defective, or burned-out components at no additional cost to the Owner.
- D. Coordinate light fixture installation with HVAC ducts, equipment, and other obstacles.
- E. Install luminaires level, plumb, and square with ceilings and walls.
- F. Perform the following tests and inspections:
  - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- G. Perform startup service:
  - 1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
  - 2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

### 3.14 IDENTIFICATION INSTALLATION

- A. Self-Adhesive Identification Products: Before applying identification product, prepare and clean attachment surface with manufacturer recommended product to allow for effective bond.
- B. Verify and coordinate identification names and other features.
- C. Nameplate Attachment:
  - 1. Screw mounted for NEMA 1 enclosures.
  - 2. Epoxy or similar waterproof adhesive for all other enclosure types.
- D. Install identification and power source nameplates for electrical equipment. Refer to Part 2 "Identification" Article for requirements.

- E. Install circuit identification labels for cables and conductors at each termination location and within pull boxes and handholes. Refer to PART 2 “Identification” Article for color code and additional requirements.
- F. Install device identification labels for receptacles, light switches, etc. Refer to Part 2 “Identification” Article for requirements.
- G. Install underground warning tape during backfilling of trenches for underground conduits and duct banks in accordance with details on Drawings.
- H. Panelboard Identification:
  - 1. Provide equipment and power source nameplates as previously described.
  - 2. Label branch circuit phase and neutral wires with associated pole number.
  - 3. Install typed as built circuit directory giving location and nature of load served.

### 3.15 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections for conductors and cables.
  - 1. Visually inspect for correct installation.
  - 2. Perform continuity test.
  - 3. Perform insulation-resistance test for power and control conductors in accordance with NETA standards.
  - 4. Verify uniform resistance of parallel conductors.
- B. Cable will be considered defective if it does not pass tests and inspections.
- C. Conduct fall-of-potential grounding electrode system test in accordance with IEEE 81.
- D. Prepare test and inspection reports.

### 3.16 CLEANING / PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration. Repair damage as recommended by manufacturer.
- B. Remove all rubbish and construction debris from inside electrical equipment and enclosures.

3.17 APPENDICES

A. Table 260510-1: Raceway Application Guidelines

| Table 260510-1<br>Raceway Application Guidelines |                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Raceway Type                                     | Location / Application                                                                                                                                                                                                                                                                                                                                                            |
| Aluminum Rigid Conduit (ARC)                     | All indoor and outdoor applications, except where other types are listed.<br>All exposed, non-corrosive areas.<br>All concealed, non-corrosive areas.<br>Under slabs in slab on grade construction.<br>Stub-ups through slabs.<br><br>Use LFMC for flexible connections.<br><br>When installed underground or in contact with concrete, paint with two coats of bitumastic paint. |
| Electrical Metallic Tubing (EMT)                 | Not used on this project.                                                                                                                                                                                                                                                                                                                                                         |
| PVC Schedule 40                                  | Not used on this project.                                                                                                                                                                                                                                                                                                                                                         |
| PVC Schedule 80                                  | Direct buried.<br>Corrosive areas.<br>Protection of grounding electrode conductors.<br>Protection of lightning conductors.<br><br>Where exposed, use LFNC for flexible connections.<br><br>Use ARC elbows for underground applications.                                                                                                                                           |

END OF SECTION 260510