S T A T E O F C O N N E C T I C U T
DEPARTMENT OF TRANSPORTATION

2800 BERLIN TURNPIKE, P.O. BOX 317546
NEWINGTON, CONNECTICUT 06131-7546

Phone: 860-594-3128

September 8, 2014

Subject: Project No. 431-0006
Waterbury Bus Maintenance Facility Replacement in the Town of Watertown.

NOTICE TO CONTRACTORS:

This is to notify all concerned and especially the prospective bidders that the bid opening for the subject project is being postponed Four (4) weeks from September 24th to October 22nd, at 2:00 P.M. in the Conference Room of the Department of Transportation Administration Building, 2800 Berlin Turnpike, Newington, Connecticut.

Addenda No. 1 is attached and can also be obtained on the Statewide Contracting Portal at http://www.biznet.ct.gov/scp_search/BidResults.aspx?groupid=64

This addendum is necessary to revise the contract documents.

Pre-Bid Questions and Answers: Questions pertaining to DOT advertised construction projects must be presented through the CTDOT Pre-Bid Q and A Website. The Department cannot guarantee that all questions will be answered prior to the bid date. **PLEASE NOTE - at 12:01 am, the day before the bid, the subject project(s) being bid will be removed from the Q and A Website, Projects Advertised Section, at which time questions can no longer be submitted through the Q and A Website. At this time, the Q and A for those projects will be considered final, unless otherwise stated and/or the bid is postponed to a future date and time to allow for further questions and answers to be posted.**

Philip J. Melchionne
For: Gregory D. Straka
Contracts Manager
Division of Contracts Administration

SEPTEMBER 5, 2014
WATERBURY BUS MAINTENANCE FACILITY REPLACEMENT
FEDERAL AID PROJECT NO. CT-90-X523
STATE PROJECT NO. 0431-0006
TOWN OF WATERTOWN

ADDENDUM NO. 1

SPECIAL PROVISIONS

NEW SPECIAL PROVISION

The following Special Provision is hereby added to the Contract:

- ITEM NO. 0000202A – MULTI-USE TRAIL

NEW CSI SECTIONS

The following CSI Sections are hereby added to the Contract:

- DIVISION 02 – SECTION 023200 GEOTECHNICAL INVESTIGATION
- DIVISION 31 – SECTION 310001 RAPID IMPACT COMPACTION

REVISED SPECIAL PROVISIONS

The following Special Provisions are hereby deleted in their entirety and replaced with the attached like-named Special Provisions:

- NOTICE TO CONTRACTOR - UTILITY GENERATED SCHEDULE
- NOTICE TO CONTRACTOR – MEASUREMENT AND PAYMENT
- NOTICE TO CONTRACTOR – PROJECT PHASING REQUIREMENTS
- NOTICE TO CONTRACTOR – EARLY SUBMITTALS
- NOTICE TO CONTRACTOR – SCHEDULE OF VALUE FOR MAJOR LUMP SUM ITEMS
- NOTICE TO CONTRACTOR – FM GLOBAL SUBMITTALS
- NOTICE TO CONTRACTOR – PRE-BID SITE VISIT
- ITEM NO. 0969050A – DOCUMENT CONTROL SPECIALIST

REVISED CSI SECTIONS

The following CSI Sections are hereby deleted in their entirety and replaced with the attached like-named CSI Sections:

- DIVISION 03 – SECTION 033000 CAST-IN-PLACE CONCRETE
- DIVISION 03 – SECTION 033610 BONDED POST-TENSIONED CONCRETE
- DIVISION 04 – SECTION 042000 UNIT MASONRY
- DIVISION 05 – SECTION 051200 STRUCTURAL STEEL FRAMING

- DIVISION 05 – SECTION 052100 STEEL JOIST
- DIVISION 05 – SECTION 053100 STEEL DECKING
- DIVISION 05 – SECTION 055100 METAL STAIRS
- DIVISION 06 – SECTION 062023 INTERIOR FINISH CARPENTRY
- DIVISION 07 – SECTION 071416 COLD FLUID-APPLIED WATERPROOFING
- DIVISION 07 – SECTION 075423 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING
- DIVISION 09 – SECTION 099600 HIGH PERFORMANCE COATINGS
- DIVISION 13 – SECTION 131200 CANOPIES
- DIVISION 26 – SECTION 262726 WIRING DEVICES
- DIVISION 30 – SECTION 300000 FORM 816 SITE WORK

CONTRACT ITEMS

NEW CONTRACT ITEM

ITEM NO.	DESCRIPTION	UNIT	QUANTITY
0000202A	MULTI-USE TRAIL	L.S.	L.S.

REVISED CONTRACT ITEMS

ITEM NO.	DESCRIPTION	ORIGINAL QUANTITY	REVISED QUANTITY
0101117	CONTROLLED MATERIALS HANDLING	24,810 C.Y.	24,841 C.Y.
0202315	DISPOSAL OF CONTROLLED MATERIALS	37,020 TON	27,389 TON

PLANS

NEW PLANS

The following Plan Sheets are hereby added to the Contract:

SUBSET	PLAN SHEETS
03	03.026-1.A1, and 03.037-1.A1

HIGHWAY STANDARD SHEETS

HW-910_01, HW-910_02, HW-910_11, and HW-910_17

REVISED PLANS

The following Plan Sheets are hereby deleted and replaced with the like-numbered Plan Sheets:

SUBSET	PLAN SHEETS

03	03.004.A1, 03.005.A1, 03.006.A1, 03.007.A1, 03.008.A1, 03.009.A1, 03.010.A1, 03.011.A1, 03.012.A1, 03.013.A1, 03.015.A1, 03.016.A1, 03.017.A1, 03.018.A1, 03.019.A1, 03.021.A1, 03.022.A1, 03.023.A1, 03.024.A1, 03.025.A1, 03.026.A1, and 03.029.A1
06	06.002.A1, 06.003.A1, 06.004.A1, 06.006.A1, and 06.007.A1
07	07.002.A1, 07.003.A1, 07.005.A1, 07.006.A1, 07.007.A1, 07.008.A1, 07.009.A1, 07.010.A1, 07.011.A1, 07.012.A1, 07.013.A1, 07.014.A1, 07.015.A1, 07.016.A1, 07.017.A1, 07.018.A1, 07.019.A1, 07.020.A1, 07.021.A1, 07.022.A1, 07.023.A1, 07.024.A1, 07.025.A1, 07.026.A1, 07.027.A1, 07.028.A1, 07.029.A1, 07.030.A1, 07.031.A1, 07.032.A1, 07.035.A1, 07.036.A1, 07.038.A1, 07.039.A1, 07.040.A1, 07.042.A1, 07.043.A1, 07.045.A1, 07.046.A1, 07.048.A1, 07.049.A1, 07.050.A1, 07.051.A1, 07.054.A1, 07.055.A1, 07.056.A1, 07.061.A1, 07.062.A1, 07.063.A1, 07.066.A1, 07.067.A1, 07.069.A1, 07.070.A1, 07.071.A1, 07.072.A1, 07.073.A1, 07.074.A1, 07.075.A1, 07.076.A1, 07.077.A1, 07.078.A1, 07.079.A1, 07.080.A1, 07.081.A1, 07.082.A1, 07.083.A1, 07.084.A1, 07.085.A1, 07.086.A1, 07.087.A1, 07.088.A1, 07.090.A1, 07.093.A1, 07.094.A1, 07.095.A1, 07.102.A1, and 07.107.A1
09	09.002.A1, 09.004.A1, 09.005.A1, 09.006.A1, 09.007.A1, 09.008.A1, 09.009.A1, 09.011.A1, 09.012.A1, 09.013.A1, 09.014,A1, 09.015.A1, 09.016.A1, 09.018.A1, 09.030,A1, 09.032.A1, 09.036,A1, 09.038.A1, 09.040.A1, 09.041.A1, 09.042.A1, 09.043.A1, 09.044.A1, 09.045.A1, 09.046.A1, 09.048.A1, 09.050.A1, 09.053.A1, 09.054.A1, 09.056.A1, 09.057.A1, 09.058.A1, 09.059.A1, and 09.061.A1
13	13.003.A1, 13.055.A1, 13.063.A1, and 13.071.A1
16	16.002.A1

The Bid Proposal Form has been revised to reflect these changes.

The Highway Standard Sheet Index does not reflect these changes.

There will be no change in the number of calendar days due to this Addendum.

The foregoing is hereby made a part of the contract.

ITEM # 0000202A – MULTI-USE TRAIL

Description: Under this item, the Contractor shall complete all work depicted on the Contract Plans and described in the CSI-formatted Specifications that make up this Major Lump Sum Item (MLSI). Refer to Form 816 Article 1.20-1.02.04 for additional information in this regard.

Any work incidental to another bid item which is not specifically described or included in the bid item, but which is required for performance and completion of the work required under the Contract, shall be considered to be included under this item.

Materials: All materials shall be as required by the Contract Plans and as described in the CSI-formatted Specifications that make up this MLSI.

Construction Methods: All methods of construction shall conform to the requirements as stipulated in the CSI-formatted Specifications that make up this MLSI.

Method of Measurement: This item will be paid for at the contract lump sum price for "Item No. 0000202A – Multi-Use Trail" complete.

Basis of Payment: This item will be paid for at the contract lump sum price for "Item No. 0000202 – Multi-Use Trail", which price shall include all administrative and procedural requirements, material, equipment, labor, and work incidental thereto.

PAY ITEM	PAY UNIT
"Item No. 0000202A – Multi-Use Trail"	LS

SECTION 023200 – GEOTECHNICAL INVESTIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Geotechnical investigation report prepared by Haley & Aldrich, Inc.
Final Geotechnical Design Evaluation
Waterbury Bus Maintenance Facility Replacement
Revised 7 August 2014

This geotechnical investigation is available for review by Contractor's bidding the project on the Connecticut Department of Transportation's Project Wise document management system. The awarded Contractor will be provided a copy of the geotechnical investigation at the start of construction.

The subsurface investigations are for information purposes only and bidders are responsible for any conclusions drawn from the data provided. The owner and architect/engineer of record assume no responsibility for the completeness and accuracy of the information provided.

END OF SECTION 023200

SECTION 310001 - RAPID IMPACT COMPACTION

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. Description of work:

1. Rapid Impact Compaction (RIC) shall consist of designing, furnishing, and performing ground improvement. RIC shall include the densification of shallow soils using a 7.5 ton ram (minimum) mounted on an excavator that repeatedly strikes the ground with a minimum 3.28 feet (or equivalent energy) fall height. RIC shall provide controlled impact compaction to reduce settlement and improve bearing capacity as specified herein. The RIC means and methods shall be designed by a specialized Contractor. The RIC Contractor shall monitor both the number of blows and the ground deflection as the result of each impact point. The compaction shall be performed to meet the requirements and performance specified herein.

2. The RIC Contractor shall be responsible for all the design and detailing, and for all dimension, coordination, installation, and testing. The RIC program shall improve the average penetration resistance N-value of the existing soils as required to achieve the described allowable bearing capacity and settlement tolerance for the project in accordance with acceptable engineering practices. The energy applied by the RIC shall be sufficient to densify zones of soft, loose soils/materials and collapse void space to the minimum depth specified below the established working grade.

3. The RIC Contractor shall perform RIC within the areal limits specified on the drawings.

1.3 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.0502 and NOTICE TO CONTACTOR – SUBMITTALS

B. Detailed design calculations with the layout of compaction and sequence.

C. Detailed explanation of the calculations, including analysis and design data prepared, sealed by a Professional Engineer, licensed in the State of Connecticut.

D. Quality control test program for rapid impact compaction.

E. A notarized manufacturer's certification prior to the start of work, stating that the aggregate and other materials used comply with the requirements of this specification.

F. Baseline survey of all structures within 200 feet of the project site. The survey shall be performed by a firm specializing in construction damage surveys with proposed drop pattern and compaction sequence shown. A detailed plan indicating measures to be taken to protect nearby structures and utilities from damage and the instrumentation that will be used to monitor the condition of the nearby structures and utilities during the RIC work to ensure compliance with the vibration limitation requirements of this section.

G. A quality control plan stating in detail the method of in-situ measurement to be used before and after treatment in order to verify that the requirements of this section have been met.

H. A test sections work plan, including all the information required by this section. The test sections work plan shall provide measurement for anticipated vibration level at the property line which shall be measured by readings taken at a distance from the test section boundary which is equal to the distance between the property line and the nearest point thereto of the RIC work

1.4 QUALITY ASSURANCE

A. The RIC Contractor engaged shall have suitable equipment, and personnel experienced in rapid impact compaction.

B. The RIC Contractor shall comply with all applicable provisions of state/local building and safety codes and other codes/standards referenced in this specification, except when more stringent requirements are shown/specified herein.

C. The RIC Contractor shall demonstrate a consistent record of at least ten (10) successful projects over the preceding five (5) years of equal or greater magnitude with similar soil conditions, depths and volumes of work as contained in this project.

D. The RIC Contractor shall retain a professional engineer, registered in the State of Connecticut, who shall be in responsible charge of the design, and testing required for the design of the RIC program.

E. A qualified surveyor shall be engaged to perform all surveys, layouts, and measurements for the RIC. The surveyor shall conduct the layout work to the lines and levels, and deviations from specified tolerances, and other data as required. The surveyor shall record and maintain all information pertinent to rapid impact compaction and shall cooperate with other testing and inspection personnel to provide data for required reports

1.5 FIELD INSPECTION AND QUALITY CONTROL

A. Owner shall employ and pay for a qualified, independent Geotechnical Engineer, to perform inspection services during RIC operations.

B. The service of this Geotechnical Engineer is intended for the Owner's verification and shall in no way relieve the Contractor of his responsibility to be in compliance with the requirements of the Contract Documents and to provide his own testing, inspection and quality control.

C. Field Tests:

A. The RIC Contractor shall design their soil improvement system for an allowable bearing capacity of at least 4,000 psf and to limit total static settlement to be 1 in. or less, with differential settlements between individual footings, or within a 30-ft distance along a continuous strip footing, not exceeding 0.5 in.

B. At least three borings following completion of the RIC work, as directed by the Owner's Geotechnical Engineer, shall be performed at the RIC Contractors expense. Standard Penetration Tests (SPT) shall be performed continuously from the ground surface to depths of 10 to 20 feet beneath grades

1.6 PROJECT CONDITIONS

A. Prior to RIC equipment mobilization, the site shall be graded such that the water will not pond. Any large debris or rubble that is uncovered during grading operations that may interfere with RIC shall be removed and replaced with loose granular fill.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials for the RIC application shall include Compacted Granular Fill CTDOT M.02.01 for the working platform above RIC stabilized soils.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by RIC operations.

B. Protect and maintain erosion and sedimentation controls during RIC operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost.

D. The layout of the area to be compacted shall be completed prior to mobilization of the RIC equipment. Stakes shall be placed at the building corners based on the shop drawings.

3.2 RAPID IMPACT COMPACTION, GENERAL

A. The RIC Contractor shall perform the RIC work so as to limit vibration to less than 0.75 inches per second at all points. The RIC Contractor shall continuously monitor vibrations during the RIC work using three-dimensional seismographs. At least three seismographs shall be employed at all times during the RIC work.

B. The RIC Contractor shall establish and maintain horizontal and vertical ground control, including two base lines, perpendicular to each other.

C. The RIC Contractor shall perform grading on a daily basis to ensure positive drainage at all times and such that no puddles form within the RIC area.

D. Prior to commencement of compaction, one 20-foot-by-20-foot test area shall be tested. Shallow test borings, 10 to 20 feet in depth, shall be performed to characterize the pre-compaction conditions of the soils. Three test borings shall be performed. The test area shall be compacted per the procedure proposed by the RIC Contractor. Three post-compaction test borings shall be conducted to determine if the compactive energy delivered to the test area will yield the soil improvement desired. If the soil improvement desired is obtained then the planned RIC compaction procedures shall be deemed acceptable.

E. The production compaction shall proceed based on the layout and compaction procedure outlined in the shop drawings submitted by the RIC Contractor and confirmed in the test area.

F. The RIC Contractor shall establish grid locations at 30 foot centers in the field which shall proceed systematically from point to point across the entire work area.

G. Surface mud or other unsuitable materials shall be removed from the area of the RIC work so as to avoid the need to excavate disturbed soils driven into the ground during the RIC work and a dense, stable subgrade shall be achieved prior to the commencing of RIC work.

H. The RIC Contractor shall maintain a stable and level working surface after each compactive pass. After each pass, the work area and/or working mat shall be re-leveled as necessary to support equipment for the next pass.

I. Survey control (horizontal and vertical) shall be re-established prior to the next pass. In areas of the RIC work where densification criteria has not be achieved, adjust procedures and make additional passes as necessary to densify the soils to the required degree.

J. The Contractor shall make such adjustments in the work program for subsequent passes as shall be required to produce uniform results throughout the site.

K. Areas that are found to be excessively hard or soft during RIC compaction shall be identified and overexcavated and replaced with approved granular fill. It is the Contractor's responsibility to identify these areas to the Owner's Geotechnical Engineer for evaluation. The extent of the excavation shall be documented so that RIC can be performed in these areas. Overexcavation and replacement activities shall be performed in a timely manner to prevent interruption of the RIC operation.

L. After the final pass, level all craters and thoroughly compact and grade the resulting working mat surface to provide a drained surface. The surface compaction shall include a minimum of ten passes of a 20 ton vibratory roller. The upper 12 inches (working platform) shall be Compacted Granular Fill. Load bearing fill material shall then be placed and compacted in lifts as specified in the Contract Documents

3.3 FIELD QUALITY CONTROL

A. The testing agency shall submit daily reports for each of performance of the RIC work.

B. A post-completion damage survey of all structures which are surveyed in the baseline survey shall be submitted.

C. The Owner's Geotechnical Consultant will observe the performance and testing of the RIC system.

END OF SECTION 310001

NOTICE TO CONTRACTOR – UTILITY GENERATED SCHEDULE

The attached project specific utility work schedule was provided to the Connecticut Department of Transportation (Department) by the utility companies regarding their identified work on this project.

The utility scheduling information is provided to assist the Contractor in scheduling its activities. However, the Department does not ensure its accuracy and Section 1.05.06 of the Standard Specifications still is in force.

The utility scheduling information shall be incorporated into the Contractor's pre-award schedule in accordance with the Department's Bidding and Award Manual and Section 1.05.08 of the Contract.

After award, the Contractor shall conduct a utility coordination meeting or meetings to obtain contemporaneous scheduling information from the utilities prior to submitting its baseline schedule to the Department in accordance with Item # 0969000A – Project Coordinator of the Contract.

The Contractor shall incorporate the contemporaneous utility scheduling information into its baseline schedule submittal. The baseline schedule shall include Contractor predecessor and successor activities to the utility work in such detail as acceptable to the Engineer.

NOTICE TO CONTRACTOR – MEASUREMENT AND PAYMENT

This Project is being bid with both lump sum and unit price items. The bid items include unit price and lump sum items which are IN ADDITION TO the Major Lump Sum Item (MLSI) of the Project, Item No. 0100150A, titled "-Maintenance Facility, Item No. 1408801A, titled “Pump Station Building and Equipment” and Item No. 0000202, titled “Multi-use Trail”. These separate items will be measured for payment on a unit price or lump sum basis (whichever is applicable) for which a separate bid price is required, at the quantities as indicated in the Bid Proposal Form. Each item to be measured is more specifically described in a corresponding Form 816 Standard Specification related to that item, or a special provision, as applicable.

Standard Form 816 Items are referenced by their standard item numbers. Refer to the applicable article of Form 816 for the requirements for this item. Special Provisions included in this Contract are referenced by their item number followed by an "A" suffix. Refer to the Special Provisions contained within this Contract for requirements for this item.

All work depicted on the Contract Plans and described in the Contract Specifications, including mobilization, is included in the MLSI of the Project, with the exception of the unit price or other lump sum items listed in the Bid Proposal Form. Any work incidental to an item which is not specifically described or included in the item, but which is required for performance and completion of the work required under the Contract, is included in the MLSI.

NOTICE TO CONTRACTOR – PROJECT PHASING REQUIREMENTS

Although the Contractor is responsible for developing its own phasing plan for the Engineer's approval for the Project work, the following outline-phasing plan requires certain Project work to be performed during specific time periods:

Phase 1
The Contractor shall:

A. *Begin and complete installation of fencing and gate required to secure the entire Project site.*
B. *Begin and complete Environmental and Safety controls.*
C. *Begin and complete installation of construction trailers where indicated on the drawings. Provide temporary power and communications as required by the contract.*
D. *Begin and complete installation of personnel Restroom trailers including temporary water and sewer as indicated on drawings.*

Phase 2
The Contractor shall:

A. *Begin and complete clearing and grubbing, site layout and rough grading and excavation.*
B. *Begin and complete off-site utilities.*
C. *Begin and complete off-site pump station no.2.*
D. *Begin and complete on-site utilities/ storm drainage.*

Phase 3
The Contractor shall:

A. *Begin and complete foundations and underslab utilities.*
B. *Begin and complete concrete slabs on grade.*
C. *Begin and complete structural steel erection and composite flood construction.*
D. *Begin and complete exterior envelope.*

Phase 4
The Contractor shall:

A. *Begin and complete interior partitions.*
B. *Begin and complete mechanical, electrical and plumbing rough-ins.*
C. *Begin and complete setting mechanical equipment.*
D. *Begin and complete bus equipment and lifts.*
E. *Begin and complete mechanical, electrical and plumbing fixtures.*
F. *Begin and complete interior finishes and signage.*

<u>Phase 5</u>
The Contractor shall:

A. *Begin and complete start-up/ commissioning.*
B. *Begin and complete punch-list.*
C. *Substantial completion.*

<u>Phase 6</u>
The Contractor shall:

A. *Begin and complete close-out procedures.*
B. *Final completion.*

The Engineer will hold a Semi-Final Inspection for the Project. Once the Department personnel have permanently occupied the building, the Contractor shall remove the temporary facilities as described in Form 816 Article 1.20-1.08.03 and complete any remaining site construction.

NOTICE TO CONTRACTOR – EARLY SUBMITTALS

The Contractor is hereby advised that the Department has identified the potential need to order certain materials and equipment, and thereby submit certain submittals for approval early in the construction process to ensure the Project is completed within the allowable Contract Time. Submittals shall be in accordance with Form 816 Article 1.20-1.05.02. The following items have been identified as possibly requiring early ordering thereby requiring early submission of shop drawings and product data, including color selection charts and samples:

1. Division 3 Section 033610 "Bonded Post-Tensioned Concrete"; bonded post-tensioned concrete.
2. Division 5 Section 051200 "Structural Steel Framing"; structural steel.
3. Division 5 Section 051200 "Structural Steel Framing"; steel joists.
4. Division 7 Section 074213 "Metal Wall Panels; metal wall panels.
5. Division 7 Section 075423 "Thermoplastic Polyolefin (TPO) Roofing"; roofing.
6. Division 8 Section 087100 "Door Hardware"; door hardware.
7. Division 21 Section 211313 "Wet Pipe Sprinkler Systems"; sprinkler system.
8. Division 21 Section 211316 "Dry Pipe Sprinkler Systems"; sprinkler system.
9. Division 23 Section 237200 "Air to Air Energy Recovery Units"; air recovery units.
10. Division 26 Section 262300 "Switchgear"; switchgear.
11. Division 26 Section 263213 "Engine Generator Systems"; generator.
12. Division 26 Section 263213 (OPS) "Engine Generators (Off Site Pump Station No.2)"; generator.
13. Division 33 Section 333213.13A.4 "Above Grade Wet Well Mounted Quad-Plex Pump Station - Pump Station No.2, pump station.
14. Division 33 Section 333213.13B.2 "Recessed Wet Well Mounted Duplex Pump Station - Pump Station No.1, pump station.

The following items have been identified as possibly requiring early submission for purposes of project coordination and project work scheduling:

Selection of the Project Coordinator
Baseline Critical Path Schedule
Contractor's Submittal Schedule

The lists above are not intended to be all-inclusive and do not relieve the Contractor from coordinating the activities of its subcontractors and suppliers. The Contractor will not be permitted to perform any physical work on the Project without the approval of the required submittals. Failure to properly plan for long lead items within the Contract schedule will not be justification for additional construction time.

It is recommended that the Contractor identify early in the construction sequencing process the subcontractors and suppliers associated with long lead-time items and submit the appropriate shop drawings and supporting data, including color selection charts and samples, for review upon Notice to Proceed.

NOTICE TO CONTRACTOR – SCHEDULE OF VALUES FOR MAJOR LUMP SUM ITEMS

The Contractor is hereby notified that separate Schedules of Values must be submitted for the three (3) individual Major Lump Sum Items (MLSI) for this project. The three MLSI for this project are as follows:

Maintenance Facility
Water and Wastewater Facilities
Multi-use Trail

The schedule of values for each site, as noted above, shall be submitted in accordance with Form 816, Article 1.20-1.03.01.

NOTICE TO CONTRACTOR – FM GLOBAL SUBMITTALS

Copies of the following submittals requiring FM Global review for conformance with the Contract shall be transmitted to the Designer in accordance with NOTICE TO CONTRACTOR - SUBMITTALS.

1. 05 31 00, "Steel Decking"
2. 07 42 13, "Metal Wall Panels"
3. 07 54 23, "Thermoplastic Polyolefin (TPO) Roofing"
4. 07 71 00, "Roof Specialties"
5. 07 81 23, "Intumescent Fireproofing"
6. 07 84 13, "Penetration Firestopping"
7. 07 84 46, "Fire Resistive Joint Systems"
8. 08 11 13, "Hollow Metal Doors and Frames"
9. 08 33 23, "Overhead Coiling Doors"
10. 08 36 13, "Sectional Doors"
11. 08 41 13, "Aluminum Framed Entrances and Storefronts"
12. 08 44 13, "Glazed Aluminum Curtain Walls"
13. 08 62 00, "Unit Skylights"
14. 08 80 00, "Glazing"
15. 11 14 00, " Fuel and Fluid Management"
16. 11 51 00, "Shop Equipment"
17. 11 56 00, "Fueling System Equipment"
18. 21 05 23, "General Duty Valves for Water Based Fire Suppression Piping"
19. 21 12 00, "Fire Suppression Standpipes"
20. 21 13 13, "Wet Pipe Sprinkler Systems"
21. 21 13 16, "Dry Pipe Sprinkler Systems"
22. 22 11 19, "Domestic Water Piping Specialties"
23. 23 05 23, "Valves"
24. 23 05 29, "Supports and Anchors"
25. 23 52 16, "Condensing Boilers".
26. 23 72 00, "Air-To-Air Energy Recovery Units"
27. 26 41 13, "Lightning Protection System".
28. 28 31 00, "Voice Communication Fire Alarm and Detection System".
29. 33 10 00, "Water Distribution System".

The following FM Global forms are required to be submitted by the Contractor:

FORM NO.	FORM DESCRIPTION
1-28	DESIGN WIND LOADS
1-29	ROOF DECK SECUREMENT AND ABOVE-DECK ROOF COMPONENTS
1-45	AIR CONDITIONING AND VENTILATING SYSTEM
1-49	PERIMETER FLASHING
1-54	ROOF LOADS FOR NEW CONSTRUCTION
1-57	PLASTICS IN CONSTRUCTION
2-8N	NFPA 13 STANDARD FOR THE INSTALLATION OF SPRINKLER SYSTEMS 1996 EDITION
3-10	INSTALLATION AND MAINTENANCE OF PRIVATE FIRE SERVICE MAINS AND THEIR APPURTENANCES
3-26	FIRE PROTECTION WATER DEMAND FOR NONSTORAGE SPRINKLERED PROPERTIES
5-4	TRANSFORMERS
5-11	LIGHTING AND SURGE PROTECTION FOR ELECTRICAL SYSTEMS
5-19	SWITCHGEAR AND CIRCUIT BREAKERS
5-23	EMERGENCY AND STANDBY POWER SYSTEMS
5-48	AUTOMATIC FIRE DETECTION
82	INSTALLER CHECKLIST FOR AUTOMATIC LIGHTED BOILER SAFETY COMBUSTION CONTROL SYSTEM
85A	CONTRACTOR'S MATERIAL & TEST CERTIFICATE FOR ABOVEGROUND PIPING
85B	CONTRACTOR'S MATERIAL & TEST CERTIFICATE FOR UNDERGROUND PIPING
2332	CONTRACTOR'S APPLICATION FOR ACCEPTANCE OF GASEOUS EXTINGUISHING SYSTEM INSTALLATION
2688	APPLICATION FOR ACCEPTANCE OF ROOF SYSTEM

The above lists may not be all-inclusive and do not relieve the Contractor from its responsibility to provide FM Global with other submittals or forms for approval as may be required elsewhere in the Contract Documents.

NOTICE TO CONTRACTOR – PRE-BID SITE VISIT

A Pre-Bid Site Visit will be held on **September 10, 2014, 10 a.m. at the project site entrance on Route 262 (Frost Bridge Road) in Watertown, Connecticut.**

Work for this Project also involves areas of work that are adjacent to the project site. Therefore, all bidders are strongly encouraged to attend this Pre-Bid Site Visit. There will be no other opportunity afforded to bidders to inspect the Project site.

All attendees must bring hard hats, safety vests, safety glasses, and safety shoes to the site visit. No one will be allowed on the site visit without wearing this safety gear.

Those planning to attend must contact Mr. Philip Melchionne, Contract Section, prior to September 10, 2014, by E-mail to DOTContracts@ct.gov for confirmation. You must provide your name, name of firm, phone number, and number of attendees.

Bidders are advised that no questions will be entertained at the site visit. For all questions you must follow the procedure explained in the special provision entitled "**NOTICE TO CONTRACTOR – PRE-BID QUESTIONS AND ANSWERS**". All questions must be submitted no later than 3:30 PM, Wednesday, September 17, 2014.

ITEM #0969050A – DOCUMENT CONTROL SPECIALIST

Description: Under this item the Contractor shall furnish the services of an administrative employee, entitled Document Control Specialist who will ensure that the Contractor and all other parties as designated by the Engineer will prepare, status, electronically file and send all project correspondence and drawings utilizing a document control system as established and maintained by the Department. The primary function of the document control system is to ensure timely processing of all contract documentation in coordination with the project schedule. This document control system will also provide uniform project information and reporting. The Document Control Specialist shall be designated by name, in writing with a resume of their qualifications, within five (5) calendar days of the award of the Contract and shall not be changed without prior written notice to the Department.

The Document Control Specialist shall be knowledgeable of the status of all contract documentation aspects of the work throughout the length of the Contract. The Contractor shall prepare and maintain the contract documentation utilizing the SharePoint document control system. The document control system will be physically located in a secure location designated by the Department. The Contractor will directly access the document control system via the internet. The Department will provide the Contractor access to the SharePoint Document Control System. All references to the use of SharePoint shall refer to the Engineer's shared document control system as described above. All information that resides on the shared document control system shall become the sole property of the Engineer.

The minimum lump sum bid for this item shall be equal to 0.25% of the Contractor's total bid. Failure of the Contractor to bid at least the minimum amount will result in the Department adjusting the Contractor's bid to include the minimum bid amount for this item.

Documentation Requirements: All correspondence for the project shall be submitted and controlled using SharePoint, including, but not limited to: transmittals, meeting minutes, requests for information (RFI's), requests for change (RFC's), submittals, field memos, notices, letters, and punch lists. All common correspondence files (submittals, requests, answers, changes, reports, minutes, agendas, letters, etc.) shall be stored within the common file server, including any and all file attachments. Submittals, including shop drawings, working drawings, catalog cuts, material certifications, and all documentation required by contract, shall be submitted electronically via SharePoint. Original hardcopy documents may still be required as determined by the Engineer. The Contractor is responsible to coordinate the overall creation and submission of all project documentation to meet the requirements of the project schedule and Technical Specifications.

The named Document Control Specialist shall be designated as the Submittal Coordinator and will be responsible for maintaining information related to the responsibility, status, elapsed time since submission, held time, start/finish times, and a history of all submittal revisions. A submittal log must be maintained to indicate the latest construction submittals sent and received

and the distribution of these drawings to the Department. Each submittal (shop drawing, working drawing, product data, samples, etc) must be individually entered, tracked, and the status maintained, including all revisions. The Contractor is responsible to utilize the latest drawings marked "Conforms" or "Conforms as Noted" as identified in the control system. All revisions are to be logged into the control system, describing each change.

All meeting minutes shall be uploaded into the control system. The Contractor is responsible to utilize meeting minutes and respond (electronically) to meeting minute items assigned to the Contractor.

Documents (letters, logs, shop or working drawings, sketches, payrolls, etc) to be transmitted to the Department by the Contractor, for which the Contractor does not have an electronic version, shall be scanned, converted into an Adobe Acrobat PDF format, and attached accordingly in SharePoint.

The document control system shall be available for Contractor use at all times unless system maintenance (i.e. backups, upgrades, etc) is being performed. System maintenance will generally be limited to 10 PM – 6AM, Monday - Friday and at various times on weekends. In the event a Contractor's authorized user cannot access the control system, the Contractor shall notify the Department's control system representative. In the event the control system becomes unavailable during normal business hours for an extended period of time, the Contractor may issue correspondence requiring immediate attention by the Department in hard copy format. The hard copy correspondence must be entered into the control system immediately upon becoming available again. Inability by the Contractor to gain access to the document control system for any reason shall not be grounds for claim. The use of the database is not required for proprietary cost and contract information.

The Department shall be allocated a minimum of ten (10) calendar days (using a 7-day calendar, exclusive of holidays) for review and response to each RFI submitted. RFI's requiring information from outside agencies shall be allocated twenty-one (21) days (using a 7-day calendar, exclusive of holidays).

The Department shall be allocated a minimum of thirty (30) calendar days (using a 7-day calendar, exclusive of holidays) for review and response to each RFC submitted. RFC's requiring information from outside agencies shall be allocated sixty (60) days (using a 7-day calendar, exclusive of holidays).

The Department reserves the right to reject any RFC submitted in the form of an RFI for the purpose of reducing the Department's review and response time. Such documents will not be considered for review by the Department and will be returned to the Contractor for resubmission. Review and response time for such document will commence upon resubmission in the correct format.

The Department shall be allocated a minimum of twenty-one (21) calendar days (using a 7-day calendar, exclusive of holidays) for review and approval of each submittal, unless specified otherwise within the contract documents. Any submittals requiring approval by an outside

Agency shall be allocated a minimum of sixty (60) calendar days (using a 7-day calendar, exclusive of holidays). A schedule of submittals shall be submitted to The Department for review prior to the start of construction. These durations are a MINIMUM, and will likely increase with the number of outstanding submittals in The Department's possession. Therefore, whenever multiple Contractor submittals are under review by the Department, the Contractor shall prioritize the submittals and notify the Department thereof. The submittal schedule must be submitted early for review as a subset of the baseline schedule. The Department shall not be held responsible for any delay associated with the approval or rejection of any substitution or other revisions proposed by the Contractor.

Submittals

Submittal and review activities are required in the Project Schedule per Item No. 0969000A, Project Coordinator. Submittal activities must be coordinated between the Project Coordinator and Document Control Specialist such that submittal information common to both the project schedule and the document control system (required and actual dates, sequence of submission, resubmissions if required) correspond with one another. All resubmissions shall be numbered with the original submittal number but designated a new revision number. All resubmissions shall be logged into the control system to properly calculate the entire duration required for the submittal process from the original submission date to final approval to indicate total days to process the submittal through all review cycles. Coordination of submittals is required for same work and interfacing work so that one submittal will not delay another.

Refer to the following Notices to Contractor for additional submittal requirements:

- Submittals
- Early Submittals
- FM Global Submittals
- Closeout Documents
- Potential for Asbestos Containing Materials

Submittal numbering, naming conventions, etc. shall be in accordance with the project-specific SharePoint site. Training on the use of the SharePoint site shall be provided as described below.

The Contractor shall examine and check each submittal for accuracy, completeness, coordination with related submittals and compliance with the Contract before it is transmitted to the Designer for review. The Contractor shall sign and submit the Submittal Register Form (sample attached to this section) with each submittal which includes the following statement: "Having reviewed this submittal, I certify that it is complete, accurate, coordinated in all aspects of the item being submitted and conforms to the requirements of the Contract in all respects, including all Federal requirements such as "Buy America", except as otherwise noted." By reviewing and certifying each submittal, the Contractor represents that he has determined and verified materials, field measurements and field construction criteria related thereto, and has checked and coordinated information contained within such submittals with requirements of the Work and the Contract. Shop drawings submitted without this signed statement will be rejected immediately and returned to the Contractor.

Shop drawings, working drawings and submittal attachments shall be submitted in Adobe Acrobat PDF format.

Submittal of samples for review and approval by the Designer shall be submitted using a SharePoint-generated transmittal. The Contractor shall ship the quantity of physical samples required by the contract to the Designer with the hard copy of the transmittal. The Designer shall generate the return transmittal in SharePoint (indicating the sample's review status as to Conforms, Conforms as Noted, Revise and Resubmit, Rejected, or No Action Required) and transmit it to the Contractor. The Designer shall retain one set of samples marked "Conforms" or "Conforms as Noted", transmit one set of same to the Engineer, and transmit the remaining sets of same to the Contractor.

Submittals requiring a signature by a licensed engineer or other party shall be digitally signed utilizing a digital ID obtained from an Adobe partner Certified Document Service (CDS) provider (see adobe.com for the list of CDS providers).

Required Start & Expected Finish shall represent the date range for the review process. Required Start shall be the date the submittal is issued by the Contractor for review. Expected Finish shall be the completion date for the review cycle (either 21 or 60 days later, as appropriate).

Two (2) sets of hard copies of all submittals marked "Conforms" or "Conforms as Noted" shall be transmitted, by the Contractor, to the Engineer within five (5) working days. The Contractor shall submit hard copies of all letters signed in ink with any attachments to the addressee (original) and the ConnDOT District Office (copies) for their records. Scans of signed letters and their attachments shall be stored in SharePoint by the Contractor. The Contractor shall submit wet stamped hard copies of all conformed shop drawings requiring the signature of a professional engineer (eg, steel bar joists, etc.) to the Department for their records. Scanned copies of these conformed shop submittals or other electronic copies will be stored by the Contractor in SharePoint. The Contractor shall submit hard copies and electronic copies of Maintenance Manuals and Warranties.

Submittal Schedules

In order to facilitate the Department's review of the large number of submittals anticipated for this project, the Contractor is to provide a submittal schedule in accordance with the Standard Specifications (Form 816) Section 1.20-1.05.02, Subsection 3, and as described herein. The submittal schedule will be maintained in SharePoint and shall meet the following requirements:

A submittal schedule must be created for each contract item, including those under the contract Major Lump Sum Item(s), requiring a submittal. At a minimum, the submittal schedule shall include a Contract Item Number, Title, Status, Required Start, and Required Finish, where the Status is "Unsubmitted" for those items not yet submitted, and the Required Start and Required Finish represents the review period as described above. The Required Start and Required Finish dates must be coordinated with the project CPM schedule.

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Additionally, the Contractor shall prepare and distribute a 60 day "Look Ahead Submittal Schedule", to be updated accordingly and presented and discussed at the scheduled project coordination meetings as part of the standing meeting agenda. The Look Ahead Submittal Schedule will be based on the CPM schedule (without limitation on early submittals), and will provide the following in matrix/spreadsheet format:

- Contract Item No. (Note - for the MLSI, provide CSI Division No. & Specification Section No.)
- Contractor's best estimate to identify the actual submittals to be made for those Contract Items or specification sections with multiple submittals
- Contractor's best estimate of a target date the identified submittals will be made
- Identification of planned "Hot Submittals" needed to support near-term construction activities
- Identification of planned "Major Submittals" which are anticipated to require significant review effort (e.g., coordination drawings)

The Contractor shall also generate and distribute a submittal log to be presented and discussed at the scheduled project coordination meetings as part of the standing meeting agenda. The submittal log will show all submittals currently under review and the status of each. The submittal log will be able to be generated from the SharePoint site from the current status of the submittals in the system.

Documentation Control System Access Requirements: Within five (5) days of Contract Award, the Contractor shall designate, in writing, up to five (5) named Contractor personnel, to be approved and authorized by the Engineer to access the document control system. The Contractor shall designate one (1) of the five (5) authorized personnel to be the Document Control Specialist and act as the document control system contact person for the Contractor. All Contractor personnel requesting access authorization must complete the minimum training requirements described below and submit a certificate of completion to the Department. Upon receipt of the request (with training certificate(s)) and approval thereof, the Department will issue a username and password to each of the authorized Contractor personnel. The Contractor will ensure that only authorized Contractor personnel access and utilize the control system in a responsible, non-destructive manner. The Contractor shall make every reasonable effort to prevent the disclosure of access information for unauthorized use of the control system. The Department, at its discretion, may revoke access authorization from any user if it is determined that the user: a) has used the control system for any other reason then is intended by this specification; b) is no longer in the Contractor's employ or associated with the project or c) has disclosed their access authorization for use by another person or party for any reason. The Contractor is responsible to ensure their authorized users have access to the public internet from a computer system running any currently supported Microsoft Windows Operating System and Microsoft Internet Explorer Web Browser with a minimum Cipher Strength of 128 bit, and is supported by Microsoft SharePoint 2010. Browsers supported by Microsoft SharePoint 2010 can be found here: http://technet.microsoft.com/en-us/library/cc263526%28v=office.14%29.aspx. Minimum modem speed shall be 768K (business DSL). The Contractor is responsible to ensure that anti-virus software is installed and maintained on any computer accessing the Department's document control system. Additionally, it is the Contractor's sole responsibility to maintain a

compatible software system. Compatibility is defined as the ability to send and receive documents in a format viewable by the Department. The Contractor must provide valid individual email addresses for each authorized user to the Department based upon a MAPI compliant email system, such as Microsoft Outlook or Exchange.

Training Requirements: Contractor personnel accessing the document control system must fulfill minimum training requirements. Personnel must attend a two (2) day project specific SharePoint training class provided by the Department. Training requests are to be made through the Engineer. The Department will provide the training facility and will supply all hardware, software, etc. required for the class. The costs of all Contractor personnel's training time are the responsibility of the Contractor.

Any additional training required, as a result of adding additional or replacing existing Contractor staff, shall be included in the total cost of this item.

Submittals: Within thirty (30) calendar days after award, the Submittal Coordinator shall prepare, in accordance with all requirements of this specification, and submit for review and acceptance, a Submittal Schedule and shall have the following minimum requirements attached:

- Submittal Summary Report
- Submittal Bar Chart Report

Method of Measurement: Within ten (10) calendar days of the award of the Contract, the Contractor shall submit to the Engineer for approval a cost breakdown of his lump sum bid price. The submission must include substantiation showing that the costs breakdown submitted are reasonable based on the Contractor's lump sum bid. The cost breakdown shall be in accordance with the following payment schedule:

1) The cost to successfully complete all training to utilize the document control system, in accordance with these specifications, shall not exceed 5% of the total cost of the item.

2) The development cost to prepare the Submittal Forecast in accordance with these specifications shall not exceed 5% of the total cost of the item. Payment for this work will be made upon acceptance of the Submittal Forecast by the Engineer.

3) The cost to provide services of the Document Control Specialist, including costs to maintain the Submittal Forecast; Coordinating the Document Control System submittal information with the CPM Schedule submissions; preparing, submitting, utilizing, maintaining, coordinating and updating document control system items as required by all Contractor personnel with access rights to the system, shall be paid as a per month cost. This cost shall be derived taking the remaining item cost and dividing it by the number of contract months.

Basis of Payment: This service shall be paid for at the contract lump sum price for "Document Control Specialist" complete, which price shall include the Contractor personnel's training time, preparation, statusing, electronically scanning, filing, and sending all project correspondence, and the furnishing, maintenance, and supply costs for all services as noted above in the

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utilization of the document control system as established and maintained by the Department. The lump sum price will be certified for payment as described in "Method of Measurement" subject to the following conditions:

1) Failure by the Contractor to utilize and regularly update the specified SharePoint database in a manner acceptable to the Department or failure to utilize the common file server for the storage of all project related files may result in the withholding of all contract payments until such time as all specification requirements have been satisfied. Failure by the designated Document Control Specialist to update submittal statuses on a regular basis shall result in the replacement of the Document Control Special at the Engineer's request. Additionally, the Contractor may be found in violation of Article 1.02.02 of the Standard Specifications "for having failed to prosecute work continuously, diligently and cooperatively in an orderly sequence".

2) In the event the project extends beyond the original completion date by more than thirty (30) calendar days, and a time extension is granted to the Contractor, the Department may require the continued utilization of the Document Control System which shall be paid at the per month cost for the services of the Document Control Specialist.

Pay Item	Pay Unit
Document Control Specialist	L.S.

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SUBMITTAL REGISTER FORM

The use of this Submittal Register Form is required for all submittals

Project Name: WATERBURY BUS MAINTENANCE FACILITY REPLACEMENT
Watertown, CT
State Project No. 0431-0006
Connecticut Department of Transportation

Design Engineer: Wendel

Contractor: _____

Address: _____

Telephone No.: _____

Subcontractor: _____

Address: _____

Telephone No.: _____

Submittal Number: _____

Submittal Title: _____

Specification Section and Paragraph Number: _____

Contract Drawing and Detail Reference: _____

Date of Initial Submittal: _____

Date of this Submittal: _____

CPM Activity Number: _____

This Submittal Prepared By: _____

Having reviewed this submittal, I certify that it is complete, accurate, coordinated in all aspects of the item being submitted and conforms to the requirements of the Contract in all respects, including all Federal requirements such as "Buy America" except as otherwise noted.

By: _____
Signature

_____
Printed or Typed Name

_____
Title

_____
Date

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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.

B. Coordinate with the Earthwork and Dampproofing Sections of the Specifications to ensure that all selected fill and polyethylene vapor barriers have been placed as specified prior to placing slabs on earth.

C. Coordinate with Concrete Formwork, Expansion and Contraction Joints, Concrete reinforcement, Specialty-Finished Concrete, and other appropriate Sections of the Specifications to ensure that proper provisions for and contingent to cast-in-place concrete are performed prior to placing of the concrete specified herein.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, embed, and finishes, for the following:

1. Footings, Grade Beams, Walls (bldg & site), Columns, Slabs, Beams.
2. Slabs-on-grade.
3. PT slab and beam.
4. Composite slab construction with steel deck.
5. Equipment pads and bases.
6. Fill for steel pan stairs.

B. Related Sections:

1. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 05 31 00 “Steel Decking” for steel deck construction

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.2-1.05.02 and <u>NOTICE TO CONTRACTOR-SUMITTALS.</u>

B. Product Data: For proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others if requested by the Owner.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Comply with ACI 315 "Manual of Standard practice for Detailing Reinforced Concrete Structures" showing bar sizes, 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. Include special reinforcing required for openings through concrete structures. SD works should be prepared by or under supervision of qualified professional engineer register in the Connecticut state.

E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer that has a record of successful in-service performance and who is legally authorized to practice in the jurisdiction where Project is located detailing fabrication and erection of forms for specific finished concrete surfaces. Show form construction including joining, special form joints or reveals, location and pattern of form tie placement, and other items that affect exposed concrete visually.

1. A/E's review is for general architectural applications and features only. Designing formwork for structural stability and efficiency is Contractor's responsibility.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: In lieu of material laboratory test reports when permitted by the Owner and A/E. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.

B. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

C. 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.

D. Codes and Standards: Comply with provisions of the following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI Publications: Comply with the latest editions of the following unless modified by requirements in the Contract Documents:

ACI 301, "Specifications for Structural Concrete," Sections 1 through 5 and Section 7, "Lightweight Concrete."
ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
ACI 318, “Building Code Requirements for Reinforced Concrete.”

2. ACI 347, “Guide to Formwork for Concrete.
3. ACI 305R, "Hot Weather Concreting."
4. ACI 306R, "Cold Weather Concreting."
5. ACI 523.1R, “Guide for Cast-in-Place Low Density Concrete.”
6. ASTM C138, “Standard Test Method for Unit Weight, Yield, and Air Content of Concrete.”
7. ASTM C150, “Standard Specification for Portland Cement.”
8. ASTM C311, “Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.”
9. ASTM C494, “Standard Specification for Chemical Admixtures for Concrete.”
10. ASTM C495, “Standard Test Methods for Compressive Strength of Lightweight Insulating Concrete.”
11. ASTM C496, “Standard Test Methods for Splitting Tensile Strength of Cylindrical Concrete Specimens.”
12. ASTM C513, “Standard Test Methods for Securing, Preparing, Obtaining, and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength.”
13. ASTM C796, “Standard Method of Testing Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.”
14. ASTM C869, “Standard Specification for Foaming Agents for Use in Making Preformed Foam for Cellular Concrete.”

15. Concrete Reinforcing Steel Institute (CRSI): “Manual of Standard Practice.”

E. Concrete Testing Service: The Owner will engage a qualified independent testing agency, approved by the Owner, who will make all concrete compression tests on the Project according to the standards described and listed in the “Field Quality Control” article of this Specification.

1. The costs of sampling and testing of cast-in-place concrete shall be paid for by the Owner.
2. The Contractor shall notify the testing laboratory, as selected by the Owner, 48 hours prior to each placing of concrete so that arrangements can be made for testing.

F. Preinstallation Conference: conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
2.

Contractor's superintendent.
Independent testing agency responsible for field quality control.
Ready-mix concrete manufacturer.
Concrete subcontractor.

Special concrete finish subcontractor.
Structural engineer.

3. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on the Drawings.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   High-density overlay, Class 1 or better.
   B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

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 with a maximum of 350 g/L volatile organic compounds (VOC's) that will not bond with, stain, or adversely affect concrete surfaces and will 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 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 will leave no corrodible metal closer than 1-1/2 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

C. Deformed-Steel Wire: ASTM A 496/A 496M, flat sheet.

D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 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.
2. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs. Use supports that will not puncture vapor barrier/retarder.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project unless otherwise acceptable to the Owner:

1. Portland Cement: ASTM C 150, Type I. Contractor may use Type III cement in concrete as approved by the Owner. Supplement with the following:
2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Silica Fume: ASTM C 1240, amorphous silica., proportioned in accordance with ACI 211.1

C. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded, with a total water soluble chloride ion content below 0.02 percent. Provide aggregates from a single source for exposed concrete.

1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
2. Local aggregates not complying with ASTM C 33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to the Owner.

D. Lightweight Aggregate: ASTM C 330.

E. Water: ASTM C 94/C 94M, clean, potable, and free from injurious amounts of oil, alkali, organic matter, or other deleterious material.

2.5 ADMIXTURES

A. General: Provide concrete admixtures that contain less than 0.1 percent chloride ions.

B. Air-Entraining Admixture: ASTM C 260, ready-to-use air-entraining admixture formulated to improve stability of air entrainment, to increase resistance to damage from freeze/thaw cycles, and to scaling from de-icing salts, reduced permeability for increased watertightness, reduced segregation and bleeding, and improved plasticity and workablility, certified by manufacturer to be compatible with other required admixtures.

1. Products: Subject to compliance with requirements, provide one of the following:

- BASF Corporation – Admixture Systems; Micro Air, MB-VR, or MB-AE 90.
- Euclid Chemical Company (The), an RPM company; EUCON BCN.
- Grace Construction Products, W. R. Grace & Co.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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 C 494/C 494M, Type A, ready-to-use water-reducing liquid admixture formulated for flat and cast concrete work, to improve workability, reduce segregation, improve finishing characteristics, increase compressive and flexural strength, and not initiate or promote corrosion of reinforcing.

   Products: Subject to compliance with requirements, provide one of the following:

   - BASF Corporation – Admixture Systems; Pozzolith Series or PolyHeed Series.
   - Euclid Chemical Company (The), an RPM company; WR-75 or WR-91.
   - Grace Construction Products, W. R. Grace & Co.

2. Retarding Admixture for Hot Weather: ASTM C 494/C 494M, Type B and D, ready-to-use, liquid admixture, formulated for concrete work to retard setting time, and facilitate placing and finishing.
3.
4. Products: Subject to compliance with requirements, provide one of the following:

- BASF Corporation – Admixture Systems; Pozzolith Series or PolyHeed Series.

- Euclid Chemical Company (The), an RPM company; WR-75 or WR-91.

- Grace Construction Products, W. R. Grace & Co.

5. Non-Corrosive Accelerator for Cold Weather: ASTM C 494/C 494M, Type C and E**,** ready-to-use, non-chloride, liquid admixture formulated for concrete work to accelerate setting time, and increase early and ultimate strengths across a wide range of cold weather and sub-freezing temperatures.
6.
7. Products: Subject to compliance with requirements, provide one of the following:
8.

- BASF Corporation – Admixture Systems; Pozzutec 20+ or Pozzolith NC 534.

- Euclid Chemical Company (The), an RPM company.

- Grace Construction Products, W. R. Grace & Co.

9. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
10. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
11. High-Range, Water-Reducing Admixture for Cold Weather: ASTM C 494/C 494M, Type F, high-range, water-reducing admixture formulated to aid in the production of concrete with the following qualities in a plastic state:

1) Plasticity range of 6inches to 9 inches.

2) Normal setting characteristics.

3) Extended slump retention.

4) Controlled time of set.

5) Cohesive and non-segregating.

6) Minimal bleed water.

In a hardened state, admixture shall provide the following engineering properties:

- 1) Higher, earlier strengths than can be achieved with conventional superplasticizers.
- 2) Increased ultimate compressive strength.
- 3) Higher modulus of elasticity.
- 4) Improved bond strength to steel.
- 5) High durability.
- 6) Reduced shrinkage and creep.
- 7) Highly reliable in-place structural integrity.

Typical Locations: Columns, elevated slabs, walls for temperatures 85 deg F and below.

Products: Subject to compliance with requirements, provide one of the following:

- BASF Corporation – Admixture Systems; Rheobuild 1000 or Glenium Series.
- Euclid Chemical Company (The), an RPM company; Eucon 37.
- Grace Construction Products, W.R. Grace & Co.

12. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
13. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
14. Workability-Retaining Admixture: ASTM C 494/C 494M, Type S.
    Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- BASF Corporation – Admixture Systems; RheoTEC Z-60.
- Euclid Chemical Company (The), an RPM company; EUCON BCN or EUCON CIA.
- Grace Construction Products, W. R. Grace & Co.

D. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C. Add to all concrete receiving traffic (SOG and topping)

1. Products: Subject to compliance with requirements, provide one of the following:

- BASF Corporation – Admixture Systems; Rheocrete CNI.

- Euclid Chemical Company (The), an RPM company; EUCON BCN or EUCON CIA.
- Grace Construction Products, W. R. Grace & Co.; DCI.

2.6 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, not less than 3/4 inch long.

1. Products: Subject to compliance with requirements, provide one of the following:

Monofilament Micro-Fibers:

- BASF Corporation – Admixture Systems; MasterFiber M Series.
- FORTA Corporation; FORTA Econo-Mono.
- Grace Construction Products, W. R. Grace & Co.; Grace.

B. Fibrillated Micro-Fibers:

- BASF Corporation – Admixture Systems; MasterFiber F Series.
- FORTA Corporation; FORTA Econo-Net.
- Grace Construction Products, W. R. Grace & Co.; Grace Fibers.

2.7 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.

- Greenstreak.
- Williams Products, Inc.
- Vinylex Corp.

3. Profile: Flat, dumbbell-type or center-bulb type waterstops.

B. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.

- Greenstreak.

- Paul Murphy Plastics Company.
- Vinylex Corp.

3. Profile: Flat, dumbbell-type or center-bulb type waterstops.

C. RX-Bentonite Waterstop: Furnish and install expanding bentonite-based waterstops , illustrated on the project drawings and comply with waterproofing section 071416.

2.8 VAPOR RETARDERS

A. Vapor Retarders: Provide vapor retarder that is resistant to deterioration when tested according to ASTM E 154, as follows:

1. Water-resistant barrier consisting of heavy kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.

B. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Products: Subject to compliance with requirements, provide one of the following:
2.

- Fortifiber Building Systems Group; Moistop Ultra 15.
- Raven Industries Inc.; Vapor Block 15.
- Reef Industries, Inc.; Griffolyn 15 mil Green.

C. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

D. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

E. Sand Cushion: Clean, manufactured, or natural sand.

2.9 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 4 (4.75-mm) sieve. This product shall be used at maintenance area E & F.

1. Available Products:
2.

- Anti-Hydro International, Inc.; Emery.

- Dayton Superior Corporation; Emery Non-Slip.
- Emeri-Crete, Inc.; Emeri-Topcrete.

B. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.

1. Available Products:
2.

- Anti-Hydro International, Inc.; A-H Alox.
- L&M Construction Chemicals, Inc.; Grip It AO.
- Sonneborn, Div. of ChemRex; Frictex NS.

C. Emery Dry-Shake Floor Hardener: Unpigmented, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content. This product shall be used at Bus Traffic Pass on the 1st level shown on the sheet S-125, class 5 finish. The contractor is to sit pre-installation conference including the manufacturer Rep and his attendant at first application on the site.

1. Color: As selected by Architect from manufacturer's full range.
2. Available Products:

- L&M Construction Chemicals, Inc. Emeryplate FF
- Sika Construction, Sikafloor-1 Metaltop.
- Dayton Superior, Emery Tuff.

D. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces on Battery room.

1. Available Products:
2.

- Burke by Edoco; Titan Hard.
- ChemMasters; Chemisil Plus.
- ChemTec International; ChemTec One.

2.10 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Curing Paper: Provide regular reinforced composite kraft paper complying with ASTM C 171. Polyethylene film and burlene are not permitted.

C. Non-Insulated Curing Tarp: Provide reusable polypropylene (PP) or vinyl-caoted polyester covers by one of the following:

1. Hamilton Form Company, Ltd.; Tarps.
2. Reef Industries, Inc.; Transguard 4000.

3. ChemTec International; ChemTec One

D. Insulated Curing Blankets: To prevent frost during cold weather pours, provide reusable polypropylene (PP) or vinyl-coated polyester covers having fully-bonded, closed-cell insulation core by one of the following:

1. Hamilton Form Company, Ltd.; Concrete Curing Blankets.
2. TVM Building Products; TVM Concrete Curing Blankets.
3. ChemTec International; ChemTec One

E. Water: Provide fresh, clean, potable water free of oil, grease, waxy films, curing compounds, release agents and other deleterious materials that would negatively affect the quality, durability, and performance of the concrete.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Description: Apply nondissipating curing compounds to interior concrete slabs that will later receive resilient flooring, concrete toppings, epoxy or urethane based coatings, penetrating concrete sealer.
2. Products: Subject to compliance with requirements, provide one of the following:
   BASF Corporation – Building Systems; Kure-N-Seal WB.
   Euclid Chemical Company (The), an RPM company; Aqua Cure VOX; Clearseal WB 150.
   L&M Construction Chemicals, Inc.; Dress & Seal WB.

G. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Description: Apply nondissipating curing compounds to interior concrete slabs that will later receive resilient flooring, concrete toppings, epoxy or urethane based coatings, penetrating concrete sealer.
2. Products: Subject to compliance with requirements, provide one of the following:
3.

- BASF Corporation – Building Systems; Kure-N-Seal W.
- Euclid Chemical Company (The), an RPM company; Diamond Clear VOX; Clearseal WB STD.
- L&M Construction Chemicals, Inc.; Dress & Seal WB.

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. Description: Apply membrane-forming curing and sealing compounds to interior concrete slabs within telecommunications, low voltage, and electrical rooms.
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
3.

- BASF Corporation – Building Systems; Kure 1315.

- L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
- Meadows, W.R., Inc.; Vocomp-30.

4. VOC Content: Curing and sealing compounds shall not exceed the VOC limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113. Architectural Coatings, rules in effect on July 1, 2008.

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, non-load bearing, and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Reglets: Where sheet flashing or bituminous membranes are terminated in reglets, fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment 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 underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

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 C 109/C 109M.
5. Products: Subject to compliance with requirements, provide the following:
6.

- Ardex Engineered Cements; Ardex K-500 Self-Leveling Concrete Topping.
- Euclid Chemical Company (The), an RPM company; Diamond Clear VOX; Clearseal WB STD.
- L&M Construction Chemicals, Inc.; Dress & Seal WB.

2.13 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.
   2. Do not use the same testing agency for field quality control testing.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Pozzolan: 25 percent.
   2. Ground Granulated Blast-Furnace Slag: 50 percent.
   3. Combined Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with pozzolan not exceeding 25 percent.
   4. Silica Fume: 10 percent.
   5. Combined Pozzolans and Silica Fume: 35 percent with pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
   6. Combined Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Submit written reports to Owner of each proposed mix for each class of concrete at least 15 days prior to start of Work. Do not begin concrete production until proposed mix designs have been reviewed by Owner.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.02 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

2.14 DESIGN MIXES

A. Design Mixes to provide normal weight concrete with the following properties as indicated on Drawings and schedules:

1.
2. Minimum Compressive Strength: 5000 psi at 28 days.
   Maximum Water-Cementitious Materials Ratio: 0.40 (non-air-entrained); 0.35 (air-entrained). Typical concrete U.O.N.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Maximum Water-Cementitious Materials Ratio: 0.44 (non-air-entrained); 0.35 (air-entrained). Foundation concrete.
5. Minimum Compressive Strength: 3500 psi at 28 days.
6. Maximum Water-Cementitious Materials Ratio: 0.50 (non-air-entrained); 0.40 (air-entrained). SOG of area D only.
7. Minimum Compressive Strength: 2500 psi at 28 days.
   Maximum Water-Cementitious Materials Ratio: 0.67 (non-air-entrained); 0.54 (air-entrained). Lean concrete.

B. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) rations as follows:

1. Subjected to freezing and thawing: W/C 0.45 max.
2. Subjected to deicers/watertight: W/C 0.40 max.
3. Subjected to brackish water, salt spray or deicers: W/C 0.40 max.

C. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. Ramps, Slabs, and Sloping Surfaces: Not more than 3 inches.
2. Reinforced Foundation Systems: Not less than 1 inch and not more than 3 inches.
3. Concrete Containing High-Range Water-Reducing Admixture (Superplasticizer): Not more than 8 inches after adding admixture.
4. Other Concrete: Not more than 4 inches.

D. Lightweight Structural Concrete: Lightweight aggregate and concrete shall conform to ASTM C 330. Proportion mix to produce concrete with a minimum compressive strength of 4000 psi at 28 days and a calculated equilibrium unit weight of 110 pcf plus or minus 3 pcf as determined by ASTM C 567. Concrete slump at the point of placement shall be the minimum necessary for efficient mixing, placing, and finishing. Maximum slump shall be 6 inches for pumped concrete and 5 inches elsewhere. Air-entrain concrete exposed to weather according to ACI 301 requirements.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by Owner. Laboratory test data for revised mix design and strength results must be submitted to and accepted by owner before using in Work.

F. Fiber Reinforcement: Add at manufacturer’s recommended rate but not less than 1.5 lb per cu. yd.

2.15 FABRICATING REINFORCEMENT

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

2.16 ADMIXTURES

A. Use air-entraining admixtures in exterior exposed concrete, structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within the following limits:

1. Standard Weight Concrete: The air content in all concrete exposed to weathering shall be maintained at 5% + or 1-1/2% for ground level exterior work. Other concrete exposed to weathering shall be 3% more or less 1- 1-1/2%. All slabs which are to receive a dust coat surface hardener shall have an air content not to exceed 3%.
2. Lightweight Concrete: The air content in all lightweight concrete exposed to weathering shall be maintained at 7-1/2% ± 1-1/2%.

B. Rate of Hardening:

1. Under 50 degrees F, Ambient Temperature
2. Over 90 degrees F, Ambient Temperature
3. Between 50 degrees F and 90 degrees F.

2.17 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate the installation of joint materials, vapor retarder/barrier, and other related materials with placement of forms and reinforcing steel.

3.2 FORMWORK

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 exposed to view.
2. Class C, 1/2 inch for other concrete surfaces.

D. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in the Work. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

E. Fabricate 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 where slope is too steep to place concrete with bottom forms only, for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible before and during concrete placement. 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.

G. Chamfer exterior corners and edges of permanently exposed concrete to produce uniform smooth lines and tight edge joints.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.

J. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, 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.

3.3 EMBEDDED ITEMS

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's "Code of Standard Practice for Steel Buildings and Bridges."
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.

3.4 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 deg 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 supports 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 will not be 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 Owner.

3.5 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 VAPOR RETARDERS

A. Place vapor retarder in position with longest dimension parallel with direction of pour, according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended mastic or pressure-sensitive tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

C. Cover vapor retarder with sand cushion, and compact to depth indicated.

3.7 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with metal chairs, runners, bolsters, spacers, and hangers as approved by Owner

D. Place reinforcement to maintain minimum concrete cover as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. 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. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.8 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 Owner.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Provide keyways at least 1-1/2 inches deep into construction joints in walls and slabs and between walls and footings. Bulkheads designed and accepted for this purpose may be used for slabs.
3. 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.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible, coordinate with typical details on S-301.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction (Control) Joints in Slabs-on-Grade: Form contraction joints in slabs-on-grade to form patterns as indicated. Use saw cuts 1/8-inch- wide by one-fourth of slab depth or inserts 1/4 inch wide by one-fourth of slab depth, unless otherwise indicated.

1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

4. Joint fillers and sealants are specified in Section 07 92 00 “Joint Sealants.”

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 07 92 00 "Joint Sealants," are indicated.
2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.9 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.10 PREPARING FORM SURFACES

A. General: Coat contact surfaces of forms with an approved, nonresidual, low-VOC, form-coating compound before placing reinforcement.

B. Do not allow excess form-coating material to accumulate in forms or come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer’s instructions.

3.11 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Notify other trades to permit installation of their work.

B. General: Comply with ACI 304, “Guide for Measuring, Mixing, Transporting, and Placing Concrete,” and as specified.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be 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 at its final location.

D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers no deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators 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.

E. Placing Concrete Slabs: 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. Bring slab surfaces to correct level 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.

F. Cold-Weather Placement: Comply with ACI 306R 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 has fallen or is expected to fall below 40 deg F for three successive days, uniformly heat water and aggregates before mixing to obtain a concrete mix temperature of not less than 50 degrees F (10 degrees C) and not more than 80 degrees F (27 degrees C) at point of placement, or as recommended 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.

G. Hot-Weather Placement: When hot weather conditions exist that would impair quality and strength of concrete, place concrete complying with ACI 305R and as follows:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg 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. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
4. Use water-reducing admixtures when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to Owner.

3.12 FINISHING FORMED SURFACES

A. Rough-Formed Finish: Provide a rough-formed finish on formed concrete surfaces not exposed to view in the finished Work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched, and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth-Formed Finish: Provide a smooth-formed finish on formed concrete surface exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed. No form ties should be used at exposed to view concrete surface.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Grout-Cleaned Finish: Provide grout-cleaned finish on scheduled concrete surfaces that have received smooth-formed finish treatment.

   Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard Portland cement and white portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.

   Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep surface damp by fog spray for at least 36 hours after rubbing.

D. 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.

3.13 MONOLITHIC SLAB FINISHES

A. General: Concrete faces shall be finished in accordance with the following methods. The type of surface finish required on the structure or various portions of the building shall be as indicated on the Drawings. Strict compliance with the Specifications and their intent pertaining to finished surface shall be insisted on. Any surfaces of defective finish will not be accepted, until finishing has been completed in conformity with the Specifications. All concrete surfaces on which a rubbed finish is specified shall be finished within twenty-four hours after the forms are removed.

1. Ordinary Surface Finish: Immediately following the removal of forms all fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly

cleaned, and after having been kept saturated with water for a period of not less than three hours shall be carefully pointed and trued with mortar of cement and fine aggregate mixed in the proportions used in the grade of the concrete being finished. Mortar used in pointing shall be not more than one hour old. Any excess mortar at the surface of the concrete due to filling from tie holes shall be struck off flush with a cloth. The mortar patches shall be cured as specified under "Concrete Curing and Protection" article in Part 3 of this Section. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges. The resulting surfaces shall be true and uniform. Al surfaces which cannot be repaired to the satisfaction of the Owner shall be "rubbed" as specified for rubbed surface finish.

2. Rubbed Surface Finish: As soon as the pointing has set sufficiently the entire surface shall be thoroughly wet with a brush and rubbed with a No. 6 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and regular projections, producing a smooth dense surface without pits or irregularities. The material which, in the above process has been ground to a paste, shall now be carefully spread or brushed uniformly over the entire surface and allowed to take a "reset." The final finish shall be obtained by a thorough rubbing with a No. 10 carborundum stone or abrasive of equal quality. This rubbing shall continue until the entire surface is of a smooth texture and uniform in color.
3. Brush Finish: After the concrete has been struck off, the surface shall be thoroughly worked and floated with a wooden, canvas, or cork float, the operation to be performed by skilled and experienced concrete finishers. Before this last finish is set, the surfaces shall be lightly striped with a fine brush to remove the surface cement film, leaving a fine-grained, smooth, but sanded texture.
4. Steel Trowel Finish: Steel trowel finish shall be produced by lightly tamping concrete to force coarse aggregate away from the surface then screed to proper level, providing a reasonably smooth surface. When water sheen has disappeared from the surface, concrete shall be floated and lightly trowelled. When concrete has set sufficiently to ring under the trowel, it shall be given a second steel troweling to produce a smooth, level, dense surface. Care shall be taken not to over trowel while the concrete is wet, causing an excessive amount of fines to be brought to the surface. Sufficient time shall be allowed for excess surface water to disappear. Dry cement or mixture or cement and sand shall not be sprinkled directly on slab. Particular attention shall be given to curing slabs as specified herein.

B. Prevention and Removal of Stains on Concrete: The Contractor shall prevent rust of structural steel, staining by bituminous materials or any other substance from discoloring and portion of the concrete. The Contractor, therefore, shall devise and use construction procedures or methods that prevent staining of any of the concrete. If, however, any portion of the concrete is stained, the Contractor shall remove such stains and restore the concrete to its original color without damage to the concrete all at his expense and approved by the Owner.

C. Unspecified Finishes: When the type of finish is not specified on the Drawings, the following finishes shall be used as applicable:

1. Brushed Finish: With perpendicular to traffic 1/8" Amp. Max, For sidewalks, garage floors, ramps (interior and exterior), exterior platforms, exterior steps and landings.
2. Trowel Finish: Apply a trowel finish to monolithic slab surfaces exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or another thin film-finish coating system.
   Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and finish surfaces to tolerances of F(F) 20 (floor flatness) and F(L) 17 (floor levelness) measured according to ASTM E 1155. Grind smooth any surface defects that would telegraph through applied floor covering system.
3. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.
4. Nonslip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route.
5. Coordinate required final finish with Owner before application.

D. Finishing Tolerances:
1. Brush Finishes: Surfaces scheduled to receive either a float or brush finish shall be true planes within 1/4 inch in 10 feet, as determined by a 10 foot straightedge placed anywhere on the slab in any direction.
2. Steel Trowel Finish: Surfaces scheduled to receive either a steel trowel or hardened finish shall be true planes within 1/8 inch in 10 feet, as determined by a 10 foot straight edge placed anywhere on the slab in any direction.

E. Construction Joints: The use and location of monolithic construction joints shall be indicated on Shop Drawings and subject to prior approval by the owner. In general, they shall be in accordance with the following:
1. Preparation of Joints: The surface of the concrete shall be roughened, thoroughly cleaned, and all laitance removed. In addition to the foregoing, joints shall be thoroughly wetted and slushed with coat of neat cement grout immediately before placing of new concrete.
2. Joints Between Horizontal Members and Walls or Columns: At least two hours must elapse after depositing concrete in columns or walls before depositing in beams, girders, or slabs supported thereon. Beams, girders, brackets, column capitals, and haunches shall be considered as part of the floor system and shall be placed monolithically unless otherwise specifically indicated on the plans.
3. Joints in Horizontal Members: Construction joints in floors shall be located in the middle one-third of the spans of slabs, beams, or girders, unless a beam interacts a girder at this point, in which case the joints in the girders shall be offset a distance equal to twice the width of the beam. Provision shall be made for shear by use if inclined reinforcement.

3.14 DEFECTIVE CONCRETE WORK

A. Porous areas, open or porous construction joints and honey-combed concrete indicate that all the requirements for mixing, placing, and handling have not been complied with and shall be considered as sufficient cause for rejection of the members of the structure thus affected. Defective work exposed upon removal of forms shall be entirely removed or repaired as required within 48 hours after forms have been removed.

B. No repaired area will be accepted unless:

1. The structural requirements have not been impaired by reducing the net section of compression members.
2. The bond between the steel and the concrete has not been reduced.
3. The areas shall be finished so as to conform in every respect to the texture, contour, and color of the surrounding concrete.

C. If the above limitations cannot be satisfied, the members or unit involved shall be removed and satisfactorily replaced entirely at the Contractor's expense.

D. Defective areas shall be cut out to such depth that all voids, honeycomb, or other defect shall be entirely removed. The edges of the material remaining in place shall be cut perpendicular to the finished surface to the full depth of the material removed but not less than one inch.

E. If the removal of defective concrete affects the structural requirements as above defined, the member likewise shall be removed and replaced.

F. The area to be repaired and a space at least 5 inches wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar. The patch shall be made with mortar, the mix of which shall be predetermined by making trial batches to secure mix matching the color and texture of surrounding concrete. The use of light colored or white Portland cement will be permitted in order to facilitate color matching. The amount of water used in mixing the mortar shall be as little as is consistent with the requirements of handling and placing. The mortar shall then be put aside for one hour during which time it shall be mixed with a trowel to prevent settling. No additional water shall be added to the mix. The area being repaired shall be thoroughly cleaned and brush coated with a slurry coat of one part Portland cement and one part sand. The mortar shall be thoroughly compacted in place and screeded off so as to leave the patch slightly higher than the surrounding area. It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finally finished. The patch shall be finished in such a manner as to match the adjoining surface. On surfaces where unlined forms have been used the final finish shall be obtained with straightedge spanning the patch and held parallel to the direction to the form marks. After the patches have set sufficiently so that the surface will not be damaged curing and protection of concrete shall proceed as specified herein.

3.15 ACCEPTANCE OF CAST-IN-PLACE CONCRETE

A. Acceptance of cast-in-place concrete shall be in accordance with Chapter 18 of ACI 301.

3.16 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. 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. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Provide concrete sealant on all electrical housekeeping pads and in all electrical rooms.

E. Provide concrete sealant on all mechanical housekeeping pads.

F. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in safety inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.17 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306R for cold-weather protection and ACI 305R 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. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

D. 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 the remainder of the curing period.

E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

F. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Provide moisture curing by the following methods:
   Keep concrete surface continuously wet by covering with water. Accomplishments by use of mechanical sprinklers and standard portable tap water.
   Cover concrete surface with specified absorptive cover, water saturated, and kept continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with a 4 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 3 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
3. Curing Compound: Apply curing compound on exposed interior slabs and on exterior slabs, walks, and curbs as follows:

Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete and conforming to ASTM C 309.

4. Saturated Sand Curing: Sand for saturated sand curing shall be clean, sharp natural sand, containing no deleterious material that will stain the concrete.
5. Curing Paper: Waterproof paper conforming to ASTM C 171 or opaque polyethylene.

3.18 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Owner.

3.19 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas with cement mortar immediately after removing forms when approved by the Owner. Remove and replace concrete that cannot be repaired and patched to Owner's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

1. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Provide test areas 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.

C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Owner. 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. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Where possible, repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Owner. If defects cannot be repaired, remove and replace the concrete.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.

1. Repair finished unformed surfaces containing defects that affect the concrete’s durability. 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, spalling, popouts, honeycombs, rock pockets, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas in unformed surfaces 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. Proprietary underlayment compounds may be used when acceptable to the Owner.
4. 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 to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
5. Repair isolated random cracks and single holes 1 inch or less in diameter by dry-pack method. 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 dry-pack before bonding agent has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, with Owner's approval for methods and procedure, using specified epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Owner's approval.

3.20 FIELD QUALITY CONTROL

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

B. Special Inspections: Special Inspections required are enumerated in the Schedule of Special Inspection Services.

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain samples from the first three (3) batches at the start of placement for each day's pour of each concrete mixture exceeding 5 cu. Yd., plus one (1) set for each additional 50 cu. Yd. or fraction thereof.

   Should any portion of required testing and/or batch time not meet specified requirements, the concrete batch in question shall be rejected. Testing shall then be performed until three (3) consecutive batches of concrete meets all specified requirements, including batch time. Testing shall return to the

specified frequency only when all testing requirements have been satisfied for there (3) consecutive batches of concrete.

- All appropriate parties shall be notified immediately of each failed test.

- Additional testing required due to concrete not meeting specified requirements shall be performed at contractors expense.

When frequency of testing will provide fewer than five composite samples of each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if few than five are used.
Slump: ASTM C 143/C 143M; one test at point of placement for each load's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
Air Content: ASTM C 231, pressure method, for lightweight or normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each day's pour of each type of air-entrained concrete
Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
Unit Weight: ASTM C 567, 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.
Compression Test Specimens: AST C 31.
Cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
Cast and field cure one set of four standard cylinder specimens for each composite sample.
Compressive-Strength Tests: ASTM C 39; for each set, test one specimen at 7 days, two specimens at 28 days, and hold one specimen in reserve for later testing if required.
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.
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.
Test results shall be reported in writing to the Owner, Architect, Structural Engineer, ready-mix producer, and Contractor within 24 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, concrete type and class, 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.
Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

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 Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Architect

Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 to 48 hours of finishing

2. a. Calculate the actual overall F numbers using the inferior/superior method.
3. b. Take measurements for elevated slabs before removal of any shores and formwork.
4. c. Provide the Architect and Contractor with the results of all profile tests, including a running tabulation of the overall F numbers to date, within 72 hours after the completion of each slab placement

3.21 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

SECTION 033610 - BONDED POST-TENSIONED CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract Documents, including General and Supplementary Conditions, apply to the work specified in this Section.

B. This Section includes all labor, material, equipment and related services necessary to furnish, install, stress and grout all post-tensioning indicated on the drawings or specified herein, including, but not limited to the following:

1. Furnishing all post-tensioning materials, including prestressing steel, anchorages (bearing plates, grout caps, anchor heads, strand and duct couplers, wedges, spirals), duct, grout tubes, support bars, bar chairs, grouting materials and all accessories.
2. Performing all post-tensioning operations, including placement, stressing, grouting of tendons, and finishing of stressing recesses.

C. Related Work specified elsewhere:

1. Cast-In-Place Concrete: Section 033000
2. Div. 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(d) (9),16a-38k-4(b)4,16a-38k-4(b)5:
   1. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 QUALIFICATIONS

A. All post-tensioned concrete work shall be under the immediate control of a person experienced in this type of work. He shall exercise close check and rigid control of all operations as necessary for full compliance with the Contract Documents.

B. The post-tensioning work shall involve a Post-Tensioning Specialty Contractor (P-T Organization) which specializes in post-tensioning and has successfully performed five previous building projects with bonded tendons that are similar to the one involved in this Contract. This P-T Organization shall supply its own post-tensioning system and shall have performed work under the same business name for the past five years. The P-T Organization shall employ a Superintendent who has a minimum of five years experience and technical knowledge of the type of post-tensioning system supplied and who shall oversee all field handling, placement, stressing, and grouting operations. The superintendent's resume shall be submitted to the Engineer of Record (Engineer) and approved prior to bid. The Superintendent and/or supervisor of the grouting operation must be a certified American Segmental Bridge Institute (ASBI) grouting technician.

C. The P-T Organization shall have a minimum Errors and Omissions Insurance coverage of $1,000,000.00.

D. The post-tensioning system shall be a bonded/grouted system that conforms to all material requirements of ACI 318. The system shall be fully encapsulated – no part or length of strand may be exposed to concrete at any point. The P-T Organization shall have a qualified registered professional engineer, licensed in the state in which the project is located, oversee the production of shop drawings and associated calculations, and certify that the post-tensioning system conforms in all aspects to the requirements of ACI 318. The professional engineer shall be a full-time employee of the P-T Organization.

E. Any P-T Organization intending to bid post-tensioning work shall submit the following to the Engineer for approval not less than 30 calendar days prior to bid date.

1. List of projects described in 1.2.B above, with the following information:
   - Consulting structural engineer, with name, address, and phone number of the individual in the company who was responsible for the project.
   - Contractor, with name, address and phone number of the Project Manager who was responsible for the project.
   - Value of post-tensioning subcontract.
   - Quantity of post-tensioning strand used on the project.

2. Resume of Professional Engineer referenced in 1.2.D. and Superintendent referenced in 1.2.B.

3. Details of anchorages as described in Section 2.3.

4. Sample of slab and beam ducts (12 inch minimum length).

5. Grout mix and properties (Re: 3.6.).

6. QA/QC plan for the supply and installation of the post-tensioning system. The QA/QC plan shall include manufacturing, assembling, plant and job site storage, handling, installation inspection, stressing, grouting and finishing.

F. Prior to the bid, written approval must be received from the Engineer in order for P-T Organizations to bid. The Engineer shall grant approval based on compliance with the specific criteria referenced herein. The Engineer's decision is final. Proposals from unapproved P-T Organizations will be rejected at the shop drawing approval stage and any delays due to such rejection shall be the responsibility of the Contractor.

G. P-T Contractors/Organizations should provide a payment and bid bond on the project. The payment and bond should cover the entire contract amount with agreed percentage.

1.3 SUMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and <u>NOTICE TO CONTRACTOR-SUBMITTALS.</u>

B. Shop Drawings

1. Complete shop drawings must be approved by the Engineer P.E. prior to starting the post-tensioning work. Once approved, shop drawings and data shall not be changed without prior, written approval of the Engineer. Post-tensioned concrete

construction operations shall not commence without approved shop drawings on file at the job site.

At a minimum, the shop drawings shall show:

- Overall concrete dimensions and pertinent member concrete dimensions
- Tendon profiles, support heights, chair types and sizes, method of support, quantity of support chairs and mild reinforcement
- Details as are necessary for the fabrication and accurate placement and stressing of the post-tensioning tendons
- Anchorage components and their assembly
- Requirements for local zone confinement reinforcement at anchorages
- Requirements for reinforcement around stressing pockets and closures
- Placement sequences, stressing procedures, including notes regarding jack clearances, sequencing, initial tensioning forces, gauge pressures
- Theoretical elongations
- Grouting materials and methods
- Identification of each tendon
- Openings, shafts, ramps, etc.
- Material summaries, including material certifications.

The drawings shall be signed and sealed by the P-T Organization's Professional Engineer.

Along with friction and elongation calculations, the P-T Organization shall also provide signed and sealed design calculations of local anchorage zone reinforcing that may be required in accordance with AASHTO.

C. Loss and Local Anchorage Zone Calculations

1. The P-T Organization shall furnish to the Engineer, with the shop drawings, calculations of all losses to verify that design forces are obtainable for the number of strands detailed, and local anchorage zone calculations. The loss calculations shall clearly show the assumed friction and wobble coefficients and the basis for their use. The long-term losses, including shrinkage, creep and elastic shortening, shall be quantified by calculations. The calculations shall be signed and sealed by the P-T Organization's Professional Engineer. The P-T Organization shall assist the Engineer in general anchorage zone calculations if requested.

D. Approvals

1. The Engineer's approval shall not relieve the Contractor of his responsibility for performing the work in accordance with the Contract Documents.

1.4 INSPECTION

A. The P-T Organization shall submit QA/QC plan for review.
B. A *Special Inspector* shall be employed by the Owner for checking the placement and stressing of the post-tensioning, placement of reinforcing, grouting of the tendons, and placement and testing of concrete, and other items, as may be required by Local Codes.

C. Duties of the Special Inspector shall include:

1. Check duct integrity, anchorage positioning, tendon support locations, and size and placement of reinforcing in post-tensioned areas.

2. Check that tendon profiles are within the tolerances required (refer to section 3.3).

3. Verify that no concrete be placed in post-tensioned members until placement of tendons and conventional reinforcement steel have been inspected and approved.

4. Record elongations accurately for submittal to the Engineer. The Engineer shall approve stressing records prior to removal of stressing tails. Stressing records shall show a tendon reference mark, theoretical elongation, measured elongation, actual gauge pressure, date, signature of stressing operator, signature of project inspector witnessing the operation, and serial number of stressing ram and gauge.

5. Prior to stressing, verify that calibration charts are submitted for each set of stressing equipment used on the project to the Engineer. The calibration chart shall show the calibration curve for the combination of stressing jack and gauge used.

6. Observe grouting procedures and record that each duct is completely grouted. Inspect quality and testing of grout outlined in Section 3.6 .

2 PRODUCTS

2.1 The following post-tensioning materials and design procedures specifications apply and are considered to be a part of this section.

- ASTM A 416
- ACI 318
- AASHTO - “Standard Specifications for Highway Bridges” (latest edition)
- Post-Tensioning Institute “Specification for Grouting of Post-Tensioned Structures”

2.2 Prestressing Steel

A. Prestressing steel shall be ½" diameter (As = .153 sq. in), seven-wire, low-relaxation strand for prestressed concrete manufactured in accordance with ASTM A416, Grade 270, and shall have a minimum ultimate tensile strength of 41,300 pounds.

B. Certified mill test reports on the prestressing steel shall be submitted to the Engineer upon request and shall show the heat number and identification, ultimate tensile strength, yield strength at 1% extension under load, elongation at failure, modulus of elasticity, diameter and net area of strand,

and type of material. These values shall conform to the latest revisions of ASTM A416.

2.3 Anchorages

A. The post-tensioning system anchorages shall be specifically suited for bonded tendons. The anchorages shall consist of a cast-in bearing plate and a separate anchor head that is placed after concrete placement; “slap-on” anchorages shall not be permitted. All post-tensioning system anchorages must be approved in writing as per Section 1.2. Grout tubes shall not project out of the top or bottom of the slab. Anchorages shall include details that completely encapsulate the post-tensioning steel, all connections shall be mechanical and not friction-type connections.

B. The load from the anchoring device shall be uniformly distributed to the concrete by approved devices. Such approved devices shall conform to the following requirements:

1. The final unit compressive stress on the concrete directly underneath the plate or assembly shall not exceed 3,000 pounds per square inch.

2. Bending stresses in the plates or assemblies induced by the pull of the prestressing steel shall not cause visible distortion in the bearing plate when the ultimate strand load is applied as determined by testing.

3. Alternately, anchorages may be designed as special anchorage devices that use confinement reinforcement. Such special anchorage devices shall be subject to all testing requirements in AASHTO.

C. Information to be submitted for approval:

1. Complete description of the post-tensioning system anchorage and method proposed for use; such descriptions shall include tendon size, blockout dimensions, tendon layout and design calculations as required to fully substantiate any deviations from the method shown on the Contract Plans.

2. Certified Test Reports confirming the post-tensioning system anchorage meets or exceeds the minimum test requirements of AASHTO.

3. All post-tensioning system stressing anchorages shall be capable of lift-off, detensioning or retensioning a tendon at any time prior to removing the strand tails

D. Couplers

1. Coupling of bonded tendons shall be used only at locations specifically indicated and/or accepted by the Engineer.

2. Coupling of tendons shall not be used at points of sharp tendon curvature.

3. Tendon couplers shall be an integral part of the post-tensioning system and designed as such and they shall be subjected to similar requirements as the post-tensioning system anchorage.

4. Grout connections at couplers shall not project out of the top or bottom of the slab.

5. Lapping tendons at joints shall not be permitted as an effective tendon splice.

2.4 Tendons Ducts:

A. Duct shall be PT-Plus by VSL, Dywidag-System International USA, CCL-USA or preapproved equivalent.

B. Alternate plastic duct systems may be approved if documentation of test results indicating compliance (a letter of certification is not sufficient) with the following performance requirements is submitted to the Engineer at least 10 days prior to bid date:

1. Plastic duct shall be made of High Density Polyethylene (HDPE) according to ASTM D3350 cell classification 324420C, or Polypropylene with a specific gravity of 0.90 to 0.91.

2. Corrugation of ducts may be either spiral, concentric, or any other shape for which it has been demonstrated that the duct can be completely filled with grout.

3. Duct shall be mortar-tight and capable of transferring satisfactory bond stress. Duct shall be designed specifically for post-tensioning tendons.

4. The inside cross-sectional slab duct area shall be a minimum of five times the nominal area of the strands. Beam duct area shall conform to ACI-318 requirements.

5. The wall thickness of the duct shall be such that wearing through the wall by the strand during stressing is prevented. This requirement shall be met at specified minimum radius of curvature of the particular tendon size with a total strand movement of 3 feet and the full tendon stressed to 80% GUTS. The minimum remaining wall thickness of the duct after testing shall be at least 0.04 inches.

6. If couplers are required, ducts shall be coupled with specially designed couplers in a manner that is watertight without the use of tape.

7. Ducts with couplers shall be able to transfer longitudinal forces as follows without effecting watertightness : for duct diameter up to 2-1/2 inches, 200 pounds, and for duct diameter exceeding 2-1/2 inches, 400 pounds.

8. Ducts with couplers shall be capable of bending to a specified minimum radius of curvature without causing damage or sharp kinks in the duct. This requirement is met if at least three full cycles of reversed bending have been applied to the duct and watertightness is not affected (Re: 2.4.2.9). A minimum radius of curvature of 3 feet shall apply for ducts in prefabricated tendon applications.

9. Ducts including couplers shall be watertight. Watertightness is provided if water loss in 40 inch long duct specimens with couplers, tested according to 2.4.2.7 and 2.4.2.8, do not exceed 1.5% of the duct volume within 5 minutes. Water shall be kept at a pressure of 7 psi during the test.

10. Irreversible deformations of the duct cross-sectional dimensions, i.e. diameter, under a point load of 150 pounds shall not exceed 1/4 inch nor 5% of the duct cross-sectional dimensions, whichever is larger, one minute after removal of the load at 70ºF ambient temperature. The point load shall be applied without impact through a #4 reinforcement bar, bearing on the duct between corrugations.

11. Friction and wobble coefficients for the particular duct shall be submitted by the P-T Organization to the Engineer Frictional losses due to vertical and horizontal intentional or non-intentional variance from a straight line trajectory shall be based on experimentally determined curvature and wobble coefficients, and experience from previous jobs.

2.5 Grout

A. Refer to Section 3.6.

3 EXECUTION

3.1 Scheduling

A preconstruction conference shall be held. Attendees shall include the Engineer, Contractor’s representative, and the P-T Organization’s Professional Engineer

and Superintendent. At this time, the post-tensioning operations shall be coordinated with the General Construction schedule. The Engineer shall approve all tensioning locations, construction joints, and the acceptability of the general plan of the field post-tensioning operations.

3.2 Fabrication

A. Post-tensioning tendons shall be manufactured in accordance with detailed shop drawings approved by the Engineer.

B. Post-tensioning tendons shall be of the non-fixed length type to allow for possible form adjustments in the field.

C. Tendon fabrication and delivery should be coordinated by General Contractor so as to prevent lengthy job site storage. All prestressing steel shall be satisfactorily protected from excessive rust or other corrosion prior to placement. Sufficient protection shall also be provided for exposed prestressing steel at the ends of members to prevent deterioration by corrosion.

3.3 Placing

A. All placement shall be under the immediate control of the P-T Organization's Superintendent. He shall exercise close check and rigid control of all operations as necessary for full compliance with all requirements.

B. Placement of mild steel reinforcement shall be coordinated with placement of post-tensioning tendons. Proper tendon location takes precedence.

C. Tendons shall clear openings and drains by a minimum of 3 inches.

D. Slight deviation in horizontal spacing of the slab tendons is permitted where required to avoid openings and inserts, as detailed on the placement drawings.

E. Post-tensioning tendons shall have parabolic profiles (unless otherwise required by the design) and shall conform to the control points shown on the drawings. Support heights locating these profiles shall account for the center of gravity of the strands within the ducts. Low points of the tendons are at mid-span and high point corresponds to the center line of support, unless otherwise noted.

F. Suitable horizontal and vertical supports or chairs shall be installed as shown on the shop drawings to hold the tendons in true position. Tendons shall be tied to supports or chairs at maximum spacings as recommended by the Post-Tensioning Institute. All strands in a given pour shall be full length without splices or couplers unless called for on the approved shop drawings.

G. Post-tensioning tendons and anchorages shall be placed with a vertical tolerance of 1/4 inch in concrete dimensions less than 8 inches, 3/8 inch in concrete dimensions of 8 inches to 24 inches, and 1/2 inch in concrete dimensions of greater than 24 inches.

H. All post-tensioning tendons shall have a grout vent at all anchorages. Grout vents shall not project out of the top of the slab.

I. Post-tensioning anchorages shall be installed perpendicular to the tendon axis and have the minimum required tangent length.

J. Duct materials shall be inspected prior to concrete placement. Damaged duct shall be repaired in accordance with procedures acceptable to the engineer of record.

K. Where the end of a post-tensioning tendon will not be covered by concrete, the anchorages shall be recessed so that the ends of the prestressing steel will be at least 1-1/2 inch inside the edge of the concrete.

L. Tendons shall not be subjected to excessive temperatures, welding sparks or electric ground currents. To insure that this requirement is met, burning and welding operations shall not be conducted in the vicinity of tendons without prior approval. Stressing tails may be removed by rapid oxyacetylene burning or friction blade cutting to within 1" of the face of the anchorhead.

M. Pre-placing of strands in flat duct is mandatory prior to concrete placement. Pre-placing of strands in round duct is recommended prior to concrete placement. Placing of strand in round duct after concreting is satisfactory provided that measures are taken to prevent movement or floatation of the duct during concreting.

3.4 Concrete Placement

A. Concrete shall be placed in conformance with the requirements as outlined in Division 3, Cast-In-Place Concrete.

B. Calcium Chloride shall not be used as an admixture in post-tensioned concrete.

C. No concrete shall be placed in a particular pour until the tendons and reinforcement have been inspected and approved by the Special Inspector or the Engineer or his designated representative. The approval of the engineer of record shall not relieve the Contractor from his obligation for proper placement, and stressing of tendons, or other terms of this contract.

D. Concrete shall be placed in such a manner as to insure that the position of the post-tensioning tendons and conventional reinforcement remains unchanged. If the post-tensioning tendons move out of their designed positions, they shall be adjusted to their correct positions prior to proceeding with concrete placing operations.

E. Special provisions shall be made to insure proper consolidation of concrete in anchorage zones to prevent any voids or honeycombing.

3.5 Stressing

A. All post-tensioning shall be under the immediate control of the P-T Organization's Superintendent. He shall exercise close check and rigid control of all operations as necessary for full compliance with all requirements.

B. Before post-tensioning operations begin, all equipment shall be carefully inspected and tested by the P-T Organization. Tests shall include calibration of gauges, capacity of jacks and rams, and general condition and working order of equipment.

C. The stressing operations shall not begin until tests of the concrete cylinders, cured under jobsite conditions, verify the minimum compressive strength specified on the Contract Drawings. However, if specified on the Contract Drawings, an early partial prestress force may be applied at a concrete compressive strength less than the minimum compressive strength to help minimize plastic shrinkage cracking. The partial prestress force shall be proportionately lower than the full prestress force according to the actual concrete strength at the time the partial prestress force is applied. The full prestress shall be applied when the concrete strength reaches the minimum compressive strength specified.

D. It is intended that the stressing operation begin at the earliest possible time so as to minimize the occurrence of shrinkage and temperature cracking. To this end, it is anticipated that measures be taken (such as low water/cement ratio concrete and proper curing) in order that the early strength gain is achieved within three days, but no longer than five days, from date of concrete placement.

E. Strength of concrete members will be determined by testing standard ASTM 6" diameter test cylinders for each representative pour of 100 cu. yds, or fraction thereof, a minimum of six field-cured, and two lab-cured specimens shall be made. Lab-cured cylinders will be tested at 28 days. Field-cured cylinders shall be maintained at the site and cured under conditions identical to the in-place concrete sections represented by them. They shall be tested in sets of two, at the Contractor's discretion. Such tests shall be the basis for determining when stressing operations may commence. When field-cured cylinders have attained the designated compressive strength, stressing operations may commence. Falsework removal and reshoring may commence when stressing operations are complete and prior to injection grouting of the tendons.

F. The post-tensioning tendons shall be stressed by means of hydraulic jacks equipped with calibrated hydraulic pressure gauges to permit the stress in the prestressing steel to be computed at any time. A calibration chart shall accompany each jack-pump-gauge unit. In no case shall a jack and gauge combination be used which have not been calibrated to each other. In order to insure that proper calibration is maintained, care shall be exercised in the handling of all stressing equipment.

G. The stressing operations shall be conducted so that accurate elongation of the prestressing steel can be measured and recorded to the nearest 1/8 inch and compared with predicted elongations. An agreement within $\pm$ 7% between

measured and predicted elongations shall be satisfactory. If inconsistencies exceeding ± 7% occur, the Engineer, with the assistance of the P-T Organization, shall review and determine whether any additional action is required.

H. Stressing from both ends of the prestressing steel shall be performed when there is excessive friction between the prestressing steel and the duct, depending upon the location of construction joints and construction sequencing. Stressing locations for each tendon shall be shown on the approved shop drawings.

I. The maximum temporary tensile stress (jacking stress) in the prestressing steel shall not exceed 80% of the specified guaranteed minimum ultimate tensile strength of the prestressing steel. The prestressing steel shall be anchored at stresses (initial stress) that will result in the ultimate retention of working forces of not less than those shown on the Contract Drawings

J. Records shall be kept by the Special Inspector of the elongation and force applied to each strand and this shall be submitted to the Engineer promptly upon completion of stressing of each pour.

K. Safety precautions shall be taken to prevent workers from standing over or behind the stressing jacks when tendons are being stressed. Only essential personnel shall be permitted in the area during stressing.

3.6 Grouting

A. The P-T Organization shall own and furnish all specialized equipment necessary to grout the tendons.

B. Grouting records certifying the proper grouting of each duct shall be submitted within 72 hours after grouting by the Special Inspector to the Engineer for review. Information shall include: grout materials and proportions, worker's names, date and time, ambient temperature, weather conditions, and concrete temperature, maximum pumping pressure at inlet. Additional information such as possible blockages, leaks in the system, or interruptions in the flow of grout, and procedures taken to correct the deficiency, shall be reported.

C. A trial grout mix shall be batched in advance of grouting operations to verify the grout properties and the compatibility of the cement, water and admixtures.

D. Four types of grout are available for grouting. Class C grout is prepackaged grout and may exhibit thixotropic properties.

E. Materials and Equipment:

1. Portland cement shall conform to the following:
   a) Specifications for portland cement ASTM C150 Type I, II, or I/II.

b) Cement used for grouting shall be fresh and not contain any lumps or other indications of hydration or "pack set".

2. Water:
   a) The water used in the grout shall be potable, clean and free of injurious quantities of substances known to be harmful to or incompatible with the Portland cement, prestressing steel, or admixtures.

3. Admixtures:
   a) Admixtures shall impart the properties of low water content, good flowability, adequate open time, minimum bleed, minimum permeability and adequate compressive strength to the grout. Admixtures shall contain no substances known to be harmful to or incompatible with the Portland cement or prestressing steel. Admixtures containing chlorides, fluorides, sulfites, and nitrates shall not be used.

4. Grouting Equipment:
   a) The grouting equipment shall include a colloidal type mechanical mixer capable of continuous mixing which will produce a grout free of lumps and undispersed cement. The holding tank shall contain an agitator for the purpose of keeping the grout in continuous motion until injected into the tendon. When using thixotropic grout, the equipment shall consist of two identical charging/holding tanks.
   b) The pumping device shall be a positive displacement type capable of producing an outlet pressure at the pump of at least 145 psi.
   c) The grouting equipment shall have seals adequate to prevent the introduction of air, oil or other foreign substances into the grout.
   d) Accessory equipment which will provide for accurate solid and liquid measures of all grout components shall be provided to batch all materials.
   e) The grouting equipment shall contain a screen having clear openings of 1/8 inch maximum size to filter the grout prior to its introduction into the holding tank or immediately prior to Being injected into the tendon. A maximum screen opening of 3/16 inch can be used for thixotropic grouts. The screen shall be easily accessible for inspection and cleaning.
   f) The holding tank and/or mixing tank must be kept partially full of grout at all times during the pumping operation to prevent air from being drawn or siphoned into the grout hose or duct.

F. Grout Property Requirements:

1. The maximum water-cement ratio shall be 0.45.

2. The grout must remain pumpable for a minimum of 30 minutes. The initial flow cone efflux time of a non-thixotropic grout shall

be a minimum of 11 seconds and a maximum of 30 seconds immediately after mixing. Refer to ASTM C939, Standard Test Method For Flow Of Grout. For thixotropic grouts, the efflux time shall have a minimum of 9 seconds and a maximum of 20 seconds for a 1-liter discharge. Use a modified version of ASTM C939 by filling the flow cone to the top instead of the standard level.

3. All classes of grout shall exhibit no measurable bleed after 3 hours when using a wick induced bleed test at 20°C (70°F). Refer to ASTM C940, Standard Test Method For Expansion And Bleeding Of Freshly Mixed Grouts. Class B and C grouts shall have a maximum bleed of 4 percent when using the Schupack Pressure Bleed Test with 20 psi and a vertical rise of 0 to 2 feet.

4. The minimum compressive strength of the grout at 7 days shall be 3,000 psi. The minimum compressive strength of the grout at 28 days shall be 5,000 psi. Refer to ASTM C942, Standard Test Method For Compressive Strength Of Grout.

5. The permeability of the grout shall be determined by referring to ASTM C1202, Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration. Grout at 28 days of age shall have a maximum value of 2500 Coulombs after 6 hours.

6. The volume change of grout shall be 0.0% to +0.1% at 24 hours. The volume change at 28 days shall not be greater than +0.2%. Refer to ASTM C1090, Standard Test Method for Measuring Changes in Height of Cylindrical Specimen from Hydraulic-Cement Grout.

7. The temperature of the freshly prepared grout shall not be less than 40F or greater than 100F, the optimal temperature range is 50F-70F.

8. The setting time of the grout shall be greater than 3 hours and less than 12 hours. Refer to ASTM C953, Standard Test Method for Time of Setting of Grouts for Preplaced Aggregate Concrete in the Laboratory.

G. Mixing and Injection of the Grout:

1. It is generally desirable that tendons be grouted as soon as practical after approval of the stressing operations.

2. After a period of freezing weather conditions, grouting may be carried out only when it is certain that no ice will be trapped in the ducts.

3. Grouting may proceed when the surrounding concrete temperature is a minimum of 35F and rising. The grout temperature shall be maintained between 40F-90F before entering the duct. Grout temperature must be maintained at a minimum of 35F after entering the duct for three consecutive days after grouting or until a minimum compressive strength of 800 psi is attained as determined by job-cured 2 inch cube tests.

4. Grout fittings shall be non-metallic and not project out of the top or bottom of the slab.

5. Mixing shall be of such duration as to obtain a uniform and thoroughly blended grout, approximately 2-3 minutes.

6. Grout shall completely fill the void space within the duct under a normal pumping pressure of 75 psi. For internal flat ducts, pumping pressure shall not exceed 100 psi. For internal circular ducts, pumping pressure shall not exceed 245 psi.

7. Grout shall be injected from the lower end of the tendon in a continuous manner until it is discharged from the opposite end. The grout shall be continuously ejected from the outlet until no slugs of water or air are visible and the grout at the outlet is approximately the same viscosity as that at the inlet. Close the valve at the outlet followed by the valve at the inlet prior to relieving the pressure at the grout pump.

8. Grout injection shall be between 15ft. and 50 ft. per minute unless otherwise approved by Engineer.

9. Leaks at the grout fittings at each end of the tendon or at any intermediate locations shall not be permitted.

10. Grout fittings may be removed flush with the concrete such that there is no spalling, after the grout has set for 24 hours.

3.7 Field Testing

1. One bleed test shall be taken per day for Class B and D grouts. The test shall be taken from the mixer. The sample test shall be either a Wick Induced Bleed Test or Schupack Pressure Bleed Test.

2. Two mud balance tests shall be taken per day for all classes of grout. Mud balance tests shall be performed in addition to the two daily tests whenever an apparent change in the grout appears.

3. One strength test shall be taken during the grouting.

4. At least two flow cone tests – one at the mixer and one at the outlet, per every two hours of grouting operation for all classes of grout. The flow

cone tests shall be either the ASTM C939 or the modified ASTM C939 tests.

3.8 Finishing of Stressing Recesses

1. Stressing recesses shall be properly prepared and then filled flush with a non-shrink, non-metallic, non-corrosive grout to give a satisfactory appearance per the project requirements.

END OF SECTION 033610

SECTION 042000 - UNIT MASONRY

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. Concrete masonry units.
2. Decorative concrete masonry units.
3. Precast architectural concrete trim units.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.

B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section for credit 16a-38-4(d)11 and 16a-38-4(b)4.
   a. The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
4. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

   a. For Concrete Unit Masonry: f'm = 1900 psi

B. Delegated Design: Engage a qualified professional engineer, to design precast architectural concrete trim units.

C. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
2. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and <u>NOTICE TO CONTRACTOR – SUBMITTALS.</u>

B. Product Data: For each type of product indicated.

C. Design Mixtures: For each precast architectural concrete trim unit mixture. Include compressive strength and water-absorption tests.

D. Shop Drawings: For the following:

1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
3. Precast architectural concrete trim units:
   a. Detail fabrication and installation of architectural precast concrete units.

b. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
c. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
d. Indicate details at building corners.

E. Samples for Initial Selection:

1. Precast architectural concrete trim units.
2. Colored mortar.
3. Weep holes/vents.

F. Samples for Verification: For each type and color of the following:

1. Decorative CMUs.
2. Color mortar. Make Samples using same sand and mortar ingredients to be used on Project.
3. Weep holes and vents.
4. Accessories embedded in masonry.
5. Precast architectural concrete trim units: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

1. Masonry units.
   a. Include material test reports substantiating compliance with requirements.
   b. For masonry units, include data and calculations establishing average net-area compressive strength of units.
2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.
8. Precast architectural concrete trim units:
   a. Include material test reports substantiating compliance with requirements for aggregates.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE (UNIT MASONRY)

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panel: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build sample panel of wall area as shown on drawings, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least 16 inches (400 mm) long in exterior face.
    b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
    c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
2. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

5. Remove mock-ups in its entirety when directed by the architect.

F. Preinstallation Conference: Conduct conference at Project site.

1.9 QUALITY ASSURANCE (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant or designated as an APA-certified plant for production of architectural precast concrete products.
2. Fabricator is located within 500 miles (800 km) of Project site.

B. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.11 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.

2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged and bullnose units for outside corners, where indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units .

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Products: Subject to compliance with requirements, provide one of the following:

1) ACM Chemistries; RainBloc.
2) BASF Aktiengesellschaft; Rheopel Plus.
3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi .
2. Density Classification: Medium weight unless otherwise indicated.
3. Size : Manufactured to dimensions 3/8 inch less than nominal dimensions.
   a. Nominal Dimensions: Unless otherwise noted, provide 8 inch high x 16 inches wide x depth indicated on the drawings.

D. Decorative CMUs: ASTM C 90.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ravenstone, Trendstone Ground Face Masonry Units; Trenwyth Industries, Inc.
2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
3. Density Classification: Normal weight.
4. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
5. Pattern and Texture:

a. Standard pattern, ground-face finish.

6. Colors: As selected by Architect from manufacturer's full range.

2.3 MASONRY LINTELS

A. General: Provide one of the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 PRECAST ARCHITECTURAL CONCRETE TRIM UNITS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.

1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.

B. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C 618, Class N.
3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.

1. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.

D. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.

E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.

F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

G. Finish:
1. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attach.
2. Finish exposed surfaces of architectural precast concrete units to match face-surface finish.

H. Color: As selected by Architect from manufacturer’s full range.
1. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors, Inc.; SGS Mortar Colors.

E. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Products: Subject to compliance with requirements, provide one of the following:

1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
2) Lafarge North America Inc.; Eaglebond Portland & Lime.
3) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
3. Pigments shall not exceed 10 percent of portland cement by weight.

F. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C 404.

H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ACM Chemistries; RainBloc for Mortar.
b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

I. Water: Potable.

2.6 REINFORCEMENT (UNIT MASONRY)

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Mill- galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Exterior and Interior Walls in Rooms S102, S103, S104, S105, S106, S107, S108, S108A, S109, S110, S111, S112, S114, Stair R: Stainless steel.
4. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
5. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
6. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
7. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
8. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

2.7 REINFORCING MATERIALS (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

E. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.8 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units.
2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
3. Wire: Fabricate from 3/16-inch- (4.76-mm-), hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.

D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel-wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.

E. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).

2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch- (1.90-mm-) thick steel sheet, galvanized after fabrication.
3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-(4.76-mm-)diameter, hot-dip galvanized-steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

5. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213.
      2) Wire-Bond; RJ-711.

   b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (76 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section.

6. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.

7. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.

2.9 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

C. Post-installed Anchors: Torque-controlled expansion anchors or chemical anchors.

   1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
   2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
   3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide matching splice plates at joints
3. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
      2) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
      3) York Manufacturing, Inc.; Multi-Flash 500.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.02 mm).

   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
      2) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
      3) Hohmann & Barnard, Inc.; Textroflash.

   b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use flexible flashing with stainless steel metal drip edge.
4. Where flashing is fully concealed, use flexible flashing.

D. Solder and Sealants for Sheet Metal Flashings

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, as specified in Division 7 Section “Joint Sealants.

E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:
   1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

      a. Products: Subject to compliance with requirements, provide one of the following:
         1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
         2) Heckmann Building Products Inc.; No. 85 Cell Vent.
         3) Hohmann & Barnard, Inc.; Quadro-Vent.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Advanced Building Products Inc.; Mortar Break.
      b. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
      c. Mortar Net USA, Ltd.; Mortar Net.

   2. Provide one of the following configurations:

      a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.

b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

2.12 CAVITY-WALL INSULATION

A. Refer to Division 07 Section “Thermal Insulation”.

2.13 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.14 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced and loadbearing masonry, use Type S.
3. For exterior, above-grade, non-load-bearing walls and parapet walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.

3. Application: Use pigmented mortar for exposed mortar joints with the following units:

   a. Decorative CMUs.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
   1. Application: Use colored aggregate mortar for exposed mortar joints with the following units:

      a. Decorative CMUs.

F. Grout for Unit Masonry: Comply with ASTM C 476.

   1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
   2. Proportion grout in accordance with ASTM C 476, Table 1orparagraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi.
   3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

2.15 FABRICATION (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.

B. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.

C. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.

D. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

E. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

F. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

G. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

I. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.

J. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

K. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.

2.16 FABRICATION TOLERANCES (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
5. Unless otherwise indicated, provide 3/8 inch high joints.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive direct-applied finishes (other than paint) unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using the following method:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
   a. Use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity atreturns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.9 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
3. Embed tie sections in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
5. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.10 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install preformed control-joint gaskets designed to fit standard sash block as indicated on the architectural drawings.

3.11 LINTELS

A. Install steel lintels where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches (100 mm), and 1-1/2 inches (38 mm) into the inner wythe..
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches (200 mm); with upper edge tucked under building paper or building wrap, lapping at least 4 inches (100 mm).
4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 32 inches o.c. unless otherwise indicated.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

3.13 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.14 PRECAST ARCHITECTURAL CONCRETE TRIM UNIT INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.

B. Set architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.

1. Maintain horizontal and vertical uniform joint width as erection progresses.
2. Unless otherwise indicated, maintain uniform joint widths of 3/8 inch.

C. Connect architectural precast concrete units in position by grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Grouting or Dry-Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

E. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

B. Inspections: Level 2 special inspections according to the "2005 Connecticut Supplement with 2009 Amendment – State Building Code."

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency for Vertically Reinforced Masonry: One set of tests for each 1500 sq. ft. (140 sq. m) of wall area or portion thereof, with a minimum of one test per day.

E. Testing Frequency for Non-loadbearing Masonry: One set of tests for each 5000 sq. ft. (460 sq. m) of wall area or portion thereof.

F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

G. Mortar Test (Compressive Strength): For each mix provided, according to ASTM C 780.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.16 REPAIRING, POINTING, AND CLEANING (UNIT MASONRY)

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.17 REPAIRS (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.18 CLEANING (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Clean surfaces of precast concrete units exposed to view.

B. Clean mortar and other deleterious material from concrete surfaces and adjacent materials immediately.

C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

3.19 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Refer to Section 017419 “Construction Waste Management and Disposal”.

B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

SECTION 051200 - STRUCTURAL STEEL FRAMING

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. Structural steel.
2. Grout.

B. Related Sections:
1. Section 03 3000 “Cast In Place Concrete” For concrete structure supporting structural steel and composite slab and composite structural steel members.
2. Section 04 2000 “Unit Masonry” for masonry bearing wall supporting structure steel beam and metal deck.
3. Section 05 31 00 "Steel Decking" for field installation of shear connectors through deck.
4. Section 05 50 00 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications, and other metal items not defined as structural steel.
5. Section 05 51 00 "Metal Stairs."
6. Section 09 91 23 "Interior Painting" for surface-preparation and priming requirements.
7. Div. 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4,16a-38k-4(b)5,16a-38k-4(d)9,16a-38k-4(d)11:
   1. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.3 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand loads indicated and comply with other information and restrictions indicated.

B. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.2-1.05.02 and <u>NOTICE TO CONTRACTOR-SUMITTALS.</u>

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Indicate welds by standard AWS symbols.
      a. Distinguish between shop and field welds, and show size, length, and type of each weld.
   3. For structural-steel connections indicated to comply with design loads, include structural analysis data on Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

B. Mill test reports for structural steel, including chemical and physical properties, signed by manufacturer certifying that their products comply with requirements.

C. Product Test Reports: For the following:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Shear stud connectors.
   4. Shop primers.
   5. Nonshrink grout.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Engage a qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, experienced in fabricating structural steel similar to that indicated for this Project, and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.
   1. Fabricator shall be registered with and approved by authorities having jurisdiction.

B. Installer Qualifications: Engage a qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE, experienced in completing structural steel work similar in material, design, and extent to that indicated for this Project, and with a record of successful in-service performance.

C. Comply with applicable provisions of the following specifications and documents:
   1. AISC's "Steel Construction Manual - American Institute of Steel Construction, Inc – 9th Edition, 3rd Edition for LRFD".
   2. AISC's "Seismic Provisions for Structural Steel Buildings."
   3. ASTM A 6 (ASTM A 6M) "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."
   4. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

5. Research Council on Structural Connections' (RCSC) "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Professional Engineer Qualifications: A professional engineer that has a record of successful in-service performance, who is legally authorized to practice in the jurisdiction where Project is located, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification..

F. Preinstallation Conference: The contractor shall conduct conference at Project site to coordinate with all parties of concern.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

C. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Clean and relubricate bolts and nuts that become dry or rusty before use.
   2. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Structural Steel Angles, Channels, Rods, Plates, and Bars: ASTM A 36/A 36M.

B. Structural Steel Wide Flange Shapes and Tees: ASTM A 992/A 992M, A572.

C. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.

D. Hot-Formed Structural Steel Tubing: ASTM A 501, seamless or welded.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
   1. Weight Class: As indicated on Drawings.
   2. Finish: Black except where indicated to be galvanized.

F. Carbon Steel Castings: ASTM A 27, Grade 65-35 (ASTM A 27M, Grade 450-240), medium-strength carbon steel.

G. High-Strength Steel Castings: ASTM A 148, Grade 80-50 (ASTM A 148M, Grade 550-3345).

H. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.
   1. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Finish: Hot-dip zinc-coating, ASTM A 153, Class C.
   2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

C. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers, uncoated.
   1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Anchor Rods, Bolts, Nuts, and Washers: As follows:
   1. Unheaded Rods: ASTM A 36/A 36M.
   2. Unheaded Rods: ASTM A 572/A 572M, Grade 50 (345).
   3. Unheaded Bolts: ASTM A 687, high strength.

4. Headed Bolts: ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); carbon steel, hex-head bolts; and carbon steel nuts.
5. Headed Bolts: ASTM A 325/A 325M, Type 1, heavy hex steel structural bolts and heavy hex carbon steel nuts.
6. Headed Bolts: ASTM A 490/A 490M, Type 1, heavy hex steel structural bolts and heavy hex carbon steel nuts.
7. Washers: ASTM A 36/A 36M.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
   1. Provide a dry film thickness of no less than 1.5 mils.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.
   1. Provide a minimum 1.7 oz./sq. ft. galvanized coating.

2.4 GROUT

A. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.
   1. Camber structural-steel members where indicated.
   2. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   3. Mark and match-mark materials for field assembly.
   4. Fabricate for delivery a sequence that will expedite and minimize field handling of structural steel.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
   6. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

B. Fabricate architecturally exposed structural steel with exposed surfaces smooth, square, and free of surface blemishes, including pitting, rust and scale seam marks, roller marks, rolled trade names, and roughness.

1. Remove blemishes by filling, grinding, or by welding and grinding, prior to cleaning, treating, and shop priming.
2. Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for architecturally exposed structural steel

C. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

D. Bolt Holes: Drill or punch standard bolt holes perpendicular to metal surfaces.

E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

H. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Drill or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. Non-High-Strength Bolts: Shop install and tighten non-high-strength bolts, except where high-strength bolts are indicated.

B. High-Strength Bolts: Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. High-Strength Bolts: Shop install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
1. Bolts: ASTM A 325/A 325M high-strength bolts, unless otherwise indicated.
2. Bolts: ASTM A 490/A 490M high-strength bolts, unless otherwise indicated.
3. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
4. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

D. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."
   2. SSPC-SP 3, "Power Tool Cleaning."
   3. SSPC-SP 5, “White Metal Blast Cleaning.”
   4. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
   5. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel indicated for galvanizing according to ASTM A 123/A 123M.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.
   2. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in or remove and replace structural steel that test reports and inspections indicate do not comply with specified requirements.

C. Additional testing, at Contractor’s expense, will be performed to determine compliance of corrected Work with specified requirements.

D. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Load and resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

F. Direct-tension indicator gaps will be verified to comply with ASTM F 959, Table 2.

G. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M. Test all full penetration welds using the following inspection procedures, at testing agency's option:
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. Ultrasonic Inspection: ASTM E 164.
   4. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level “2-2T.”.

H. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling 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.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
   1. Maintain erection tolerances of architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Establish required leveling and plumbing measurements on mean operating temperature of structure.
   3. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. Non-High-Strength Bolts: Install and tighten non-high-strength bolts, except where high-strength bolts are indicated.

B. High-Strength Bolts: Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

C. High-Strength Bolts: Install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
   1. Bolts: ASTM A 325/A 325M high-strength bolts, unless otherwise indicated.
   2. Bolts: ASTM A 490/A 490M high-strength bolts, unless otherwise indicated.
   3. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.
   4. Connection Type: Slip-critical, direct-tension, or tensioned shear/bearing connections as indicated.

D. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
   3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 1/2 inch and larger. Grind flush butt welds. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Bolted Connections: Field-bolted connections will be tested and inspected according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
   1. Direct-tension indicator gaps will be verified to comply with ASTM F 959, table 2.

D. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, all full penetration field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      a. Liquid Penetrant Inspection: ASTM E 165.
      b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
      c. Ultrasonic Inspection: ASTM E 164.
      d. Radiographic Inspection: ASTM E 94 and ASTM E 142; minimum quality level “2-2T.”

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

F. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
   1. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean field welds, bolted connections, abraded areas, and areas where galvanizing is damaged or missing and apply galvanizing repair paint to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, abraded areas, and exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils.

END OF SECTION 051200

SECTION 052100 - STEEL JOISTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions apply to this section.

1.2 SECTION INCLUDES

A. Short spans and long span joists.

B. Bridging, anchorages, headers and framing required to make a complete and rigid job.

C. Wall anchors at the ends of each line of bridging.

D. Shop painting, cleaning and touch-up of paint at field welds and at other points where shop coat is damaged.

1.3 RELATED WORK

A. All other sections of Division 5, Metals.

B. Div. 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4,16a-38k-4(b)5,16a-38k-4(d)9,16a-38k-4(d)11:
1. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.4 DESIGN CRITERIA

A. Building structure designed based on SJI. joist sizes selected and shown on the drawings.

B. Allowable Deflection: Design and fabricate for a maximum deflection of L/360 of the clear span including the required uniform live load, for all areas having suspended ceilings below.

C. Top Chords: Design for combined bending and direct stresses for live and dead loads. Top chord extensions shall extend back into joist to fully develop bending and shear stresses.

1. In addition, steel joists and joist girders furnished shall be designed to support the special loading requirements and fixed-end wind moments indicated on the drawings.

D. Wind Uplift: All bar joists shall be designed to resist a net wind uplift of 30 psf for a 12’-0” x12’-0” area at all exterior building corners, 30 psf for a 12’-0” width around the entire building perimeter, and 23 psf for all other roof areas. Locate bridging near the first bottom chord panel point and design all joist members to satisfy this additional loading condition.

1.5 QUALITY ASSURANCE

A. Joists: Fabricated in compliance with the references, specifically the requirements of span and loading as indicated by joist designation on the drawings.

B. Manufacturers Qualifications: Member Steel Joist Institute.

C. Welding Qualifications: Qualify welding processes and welders in accordance with the AWS - "Standard Qualification Procedure."

1.6 REFERENCES

A. Steel Joist Institute (SJI.):
- Standard Specifications and Load Tables - Open Web Steel Joists
- Short Span Steel Joists - K Series
- Deep Long Span Steel Joists – LH and DLH Series

B. American Institute of Steel Construction (AISC): "Manual of Steel Construction"

1. Allowable Stress Design (ASD) - Ninth Edition
2. Load and Resistance Factor Design (LRFD) - Third Edition

C. American Iron and Steel Institute (AISI): Specification for the Design of Cold-Formed Steel Structural Members

D. Steel Structures Painting Council (SSPC): Steel Structures Painting Manual, Volume 1 and Volume 2, Systems and Specifications, by Steel Structures Painting Council.

E. American Welding Society (AWS): D1.1 Structural Welding Code Standard Qualification Procedures

1.7 SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.2-1.05.02 and NOTICE TO CONTRACTOR-SUMITTALS.

B. Shop Drawings: Show layout of joist units, special connections, jointing and accessories. Include the mark, number, type, location and spacing of joists and bridging.

C. Design Computation: Provide design computation for all steel joists with special loads beyond those required by the standard joist tables. Computations shall be submitted under the seal and signature of registered professional Structural Engineer in the State of Connecticut.

1. See drawings for location of steel joists and joist girders with special loading requirements and fixed-end wind moments.

D. Certification: That joists comply with "AISC-SJI. Specifications".

E. Product Data: Specifications and installation instructions for each type of joist and its accessories.

1.8 DELIVERY, STORAGE HANDLING

A. Product Handling: As recommended in "AISC-SJI. Specifications". Handling and storage: Prevent deformation of members and excessive stresses.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel: Comply with "AISC-SJI. Specifications:

B. Threaded Fasteners:

1. ASTM A-325 or A-490 heavy hexagon structural bolts with nuts and hardened washers.

C. Prime Paint: AISC-SJI. Specifications, Type I Grey oxide; Type II Asphaltic not permitted.

2.2 SHORT SPAN STEEL JOISTS (K SERIES)

A. Design and fabricate in accordance with "AISC SJI. Standard Specifications and Load Tables for Short Span Steel Joists, K-Series."

B. Bearing Ends: Extend a minimum distance of 2-1/2 inches on steel supports, and a minimum of 4 inches on masonry and concrete supports.

C. All strut joists on column centerlines shall be designed to resist an additional wind fixed end moment of 15 kip-feet.

2.3 LONG SPAN STEEL JOIST (LH and DLH SERIES)

A. Design and fabricate in accordance with "AISC SJI. Standard Specifications and Load Tables for Long and Deep Long Span Steel Joist, LH and DLH-Series."

B. Bearing Ends: Extend a minimum distance of 4 inches on steel supports, and a minimum of 6 inches on masonry and concrete supports.

C. All strut joists on column centerlines shall be designed to resist an additional wind fixed end moment of 20 kip-feet.

2.4 FABRICATION

A. General: Fabricate in accordance with "AISC-SJI. Specifications."

1. Camber: Fabricate joists with camber as noted or indicated on drawings.

B. Extended Ends: Provide top chord extended ends on joists; design to support uniform loads indicated in "SJI. Specifications and Load Tables."

1. Design as cantilever beams with reactions carried back to not less than the first panel point of the joists.
2. Cantilevered extended ends shall be designed for a maximum live load deflection of the cantilevered length divided by 240 (Lc/240).

C. Ceiling Extension: Provide ceiling extensions in areas having ceilings attached directly to joist bottom chord.

1. Provide either an extended bottom chord element or a separate unit, to suit manufacturer's standards.
2. Sufficient strength to support the ceiling construction within deflection limit indicated.
3. Extend ends to within 1" of the finished wall surface, unless otherwise indicated.

D. End Anchorage and Bearing Plates: Provide end anchorages to secure joists to adjacent construction, comply with "AISC-SJI. Specifications" except as indicated.

1. Include beveled end bearings for installations where slope exceeds 1/4 inch (6.35 mm) in 12 inches (304.8 mm).

E. Header Units: Provide header units to support tail joists at openings in floor or roof system.

F. Bridging and Sag Rods: Provide bridging, sag rods and anchors for ends of lines, terminate at walls or beams.

G. Shop Painting: Shop paint all steel joists and joist girders except members or portion of members to be embedded in concrete or sprayed on fireproofing. Paint embedded steel on exposed portions and initial 2 inches of embedded areas only.

1. Remove loose scale, heavy rust, and other foreign materials from joists and accessories before application of shop paint in accordance with SSPC SP-2 "Hand Tool Cleaning" and SP-3 "Power Tool Cleaning."
2. Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning."
3. Apply one shop coat of rust inhibitive prime paint to steel joists and accessories, by spray, dipping, or other method.
4. Provide continuous minimum dry film thickness of not less than 1.0 mils.
5. Another coat shall be applied, at the time of erection, if the original protection has deteriorated in any manner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Erector must examine the areas and conditions under which steel joists are to be installed and provide notification in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 ERECTION

A. Placing Joists: Place and secure steel joist in accordance with "AISC-SJI. Specifications" and as herein specified. Place joists on supporting work, adjust and align in accurate locations and spacing before permanently fastening.

1. Provide temporary bridging, connections, and anchors to ensure lateral stability during

construction.
2. Do not place construction loads upon joists, until joists and bridging are securely in place.
3. Maximum spacing of joists is shown in plans on the structural drawings. Joists shall be spaced less than maximum distance shown in plans where it is necessary to avoid pipes, openings, parallel partitions, etc.
4. Set joists accurately, in proper locations. Alignment of each joist in place shall not deviate more than 3/8" in 10 feet from a straight line.
5. Bearing surfaces of the joists shall be in the same plane with full bearing on supports and anchored as indicated. For joist ends bearing on masonry, provide solid level bearing of 8" minimum depth filled with concrete.
6. Strut joists at columns shall have top chords bolted to structural members and the bottom chords shall be extended. Both top and bottom chords shall be welded to structural members after field adjustments. See structural details.

B. Attachment:

1. Welding: Field weld joists to supporting steel frame work in accordance with AISC-SJI. Specifications for the type of joists used. Coordinate welding sequence and procedure with the placing of joists.
2. Anchors: Furnish anchor bolts and other devices to be built into concrete and masonry construction. Furnish templates for accurate location of anchors to other work. Hook anchors not permitted.

C. Bridging:

1. Install bridging immediately after joists are erected. Brace end joists laterally by anchors or ties at each line of bridging.
2. Type as noted or detailed on structural drawings. Bridge both bottom and top chords. Weld all bridging.

   a) Install parallel bridging for short span joist and promptly after placing joist.
   b) Follow SJI recommendation/spec for all Bridging fabrications and installations.

3. Interruption of bridging: (e.g. ducts, suspended HVAC units, recessed light fixtures, etc.) Provide bridging at each end of such items that will overlap line of standard bridging.
4. Joists to be exposed in finished areas: Erect bridging in line with all sections straight, neatly installed and coordinated with building features.

3.3 PROTECTION

A. Distribute all construction loads so that carrying capacity of each joist is not exceeded.

B. Joists shall not be moved or cut, after permanently set, except under written direction of the Architect.

3.4 DEFECTIVE WORK

A. Joists with bent chords or web members, poor welds or other defects, will be rejected and must be replaced with material meeting these specifications.

3.5 TOUCH-UP PAINTING

A. After joist installation, paint all field bolt heads and nuts, and welded areas, abraded or rusty surfaces on joists and steel supporting members. Wire brush surfaces and clean with solvent before painting. Use the same type of paint as used for shop painting.

3.6 INSPECTION AND TESTING

A. General: Joists welded in place are subject to inspection and testing. Expense of removing and replacing any portion of the steel joists for testing purposes will be borne by the Owner if welds are found to be satisfactory. Remove and replace any work found to be defective and provide new acceptable work.

1. The Owner shall employ and pay for an inspection agency approved by the Architect to inspect the joist.
2. Documents: Provide the inspection agency with a complete set of Contract Documents and approved shop drawings before the work is started.
3. Notification: The Contractor shall notify the inspection agency before the start of erection of steel joists in order that the inspector may properly schedule the required inspections.

B. Mill Test Reports:

1. Furnish the inspection agency a copy of the certified mill test reports of chemical analysis and physical test for each heat number of structural steel.
2. Furnish an affidavit (six copies) from steel manufacturer, stating that steel furnished for the project complies with the specifications.

C. Shop Inspection includes:

1. General inspection of the joist fabrication, including welding and required camber.
2. Shop inspection shall be made in the field prior to erection of joist.
3. Mill Certificates shall be reviewed and approved by the inspection agency prior to fabrication.

D. Field Inspection includes:

1. Setting of bearing plates when required.
2. Field welding of joists to supports.
3. Bridging installation and materials.
4. Anchorage requirements called for on the drawings.
5. Alignment of adjacent joists.
6. Field touch-up of paint and painting of field welds prior to placement of deck.

E. Written Certification:

1. Upon completion of the installation of all steel joists, the inspection agency shall submit written certification that the joists as manufactured meet all the requirements of the Contract Documents.

3.7 CONTRACTOR'S RESPONSIBILITY

A. Acceptance of the shop and field inspection done by the testing agency pertaining to the structural steel, does not relieve the Contractor of his responsibility to insure that the project has the proper sizes, strength, fabrication and erection procedures and any other requirements of the Contract Documents.

B. Submit copies of all reports indicating conformance, QC plan, and exceptions to contract documents in a timely fashion to General Contractor for distribution to design consultants, owner, subcontractors and other interested parties.

C. Final Report: The Inspection Agency shall prepare a written report that summarizes the work inspected during the course of the project, and certifies that the work meets the requirements of the contract documents, specifications, and all governing agencies.

END OF SECTION 052100

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Roof deck.
2. Composite floor deck.
3. Metal form deck.
4. Stud shear connectors.

B. Related Sections:
1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill and reinforcing steel over steel deck.
2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 05 50 00 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
4. Section 09 91 23 "Interior Painting" for repair painting of primed deck and finish painting of deck.
5. Div. 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4,16a-38k-4(b)5,16a-38k-4(d)9,16a-38k-4(d)11:
   1. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.2-1.05.02 and <u>NOTICE TO CONTRACTOR-SUMITTALS.</u>

B. Product Data: For each type of deck, accessory, and product indicated.

C. Shop Drawings:
1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
   a. For steel deck indicated to comply with certain design loadings, include structural analysis data sealed and signed by the qualified professional engineer who was responsible for its preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates signed by Contractor certifying that welders comply with requirements specified under the Part 1.1 of this Section.

B. Product Certificates: Signed by manufacturers of steel deck certifying that their products comply with specified requirements.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
   1. Mechanical fasteners.

D. Research reports or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence steel deck's compliance with the building code in effect for the Project.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has completed steel deck similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
   1. Work shall be performed in compliance with Owner's insurance underwriters' requirements.

B. Engineer Qualifications: A structural engineer licensed in the state where Project is located and experienced in providing engineering services of the kind indicated that have resulted in the installation of steel deck similar to this Project in material, design, and extent, and that has a record of successful in-service performance.

C. Testing Agency Qualifications: An independent agency hired by the owner that is qualified according to ASTM E 329 for testing indicated.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 "Structural Welding Code – Steel" and AWS D1.3, "Structural Welding Code - Sheet Steel."
   1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

E. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1.7 COORDINATION

A. Coordinate installation of trench headers, preset inserts, and duct fittings in cellular metal floor deck with related units of Work specified in other Sections prior to casting concrete slab.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. General: Subject to compliance with requirements, provide products by one of the following:
   1. ASC Profiles, Inc.; a Blue Scope Steel company.
   2. Consolidated Systems, Inc.; Metal Dek Group.
   3. Epic Metals Corporation.

2.2 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Where indicated, provide steel deck panels identical to those tested as part of an assembly for fire resistance per ASTM E 119 by a testing and inspecting agency performing testing and follow-up services that is acceptable to authorities having jurisdiction.
   1. Fire-Resistance Ratings: As indicated by design designations listed in UL “Fire Resistance Directory,” or by Warnock Hersey or another qualified testing and inspecting agency.
   2. Labeling: Identify steel deck with appropriate markings of applicable testing and inspecting agency.

2.3 ROOF DECK

A. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
   1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade A, G90 zinc coating.
   2. Deck Profile: Type WR, wide rib.
   3. Profile Depth: 1-1/2 & 3 inches.
   4. Thickness: As indicated on Drawings.
   5. Span Condition: As indicated.
   6. Side Laps: Interlocking seam.

2.4 COMPOSITE FLOOR DECK

A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite

Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 611, Grade C, shop primed as follows:
   a. Shop Primer: Gray or white baked-on, lead- and chromate-free rust-inhibitive primer, conforming to the performance requirements of Fed. Spec. TT-P-664.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Grade A, G90 zinc coated according to ASTM A 653.
3. Profile Depth: As indicated.
4. Thickness: As indicated.
5. Span Condition: As indicated.

2.5 ACCESSORIES

A. General: Provide accessory materials for steel deck that comply with requirements indicated and recommendations of the steel deck manufacturer.

B. Side-Lap Fasteners: Manufacturer's standard. corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

C. Flexible Rib Closure Strips: Manufacturer's standard vulcanized, closed-cell, synthetic rubber.

D. Miscellaneous Roof Deck Accessories: Steel sheet, not less than 0.0359-inch design uncoated thickness, ridge and valley plates, finish strips, and reinforcing channels of same material as roof deck.

E. Pour Stops and Girder Fillers: Steel sheet, of same material and finish as deck, and of thickness and profile indicated.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material and thickness as deck panels, unless otherwise indicated.

G. Hanger Tabs: Manufacturer's standard piercing steel sheet hanger attachment devices for use with floor deck panels.

H. Weld Washers: Manufacturer's standard uncoated steel sheet weld washers, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

I. Flat Receiver Pan: Manufacturer's standard size, single-piece steel sheet, 0.071 inch thick minimum units, of same material as deck panels. For drains, cut holes in the field.

J. Recessed Sump Pans: Manufacturer's standard size, single-piece steel sheet, 0.071 inch thick minimum, of same material as deck panels, with 3-inch- wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

K. Shear Connectors

L. Steel Sheet Accessories: ASTM A 446, G90 coating class, galvanized according to ASTM A 653/A 653M.

M. Galvanizing Repair Paint: SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel decking.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Do not place deck panels on concrete supporting structure until concrete has cured and is dry.

B. Locate decking bundles to prevent overloading of supporting members.

3.3 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.4 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: per drawings.
2. Weld Spacing: Weld edge ribs of panels at each support. Space welds as shown in Drawings, with a minimum of one welds per rib at each support. Provide closer spacing as noted for in-plane diaphragm force and uplift resistance. In addition, secure deck to each supporting member in ribs where side laps occur.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports as shown in Drawings, but at intervals not exceeding 36 inches, using one of the following methods:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Lapped 2 inches minimum.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.5 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
1. Weld Diameter: 5/8 inch, nominal.
2. Weld Spacing: Space and locate welds as indicated on Drawings.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding 36 inches, using one of the following methods:
1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
2. Fasten with a minimum of 1-1/2-inch- long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
1. End Joints: Butted.

D. Shear Connectors: Weld shear connectors through deck to support framing according to AWS D1.1 and manufacturer’s instructions. Butt end joints of deck panels; do not overlap.
1. Where welded shear connectors are applied through deck, such shear connectors may take the place of a fusion weld above on a one-for-one basis.
2. Break ceramic ferrules (arc shields) loose and remove from deck.

E. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

F. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

G. Install piercing hanger tabs not more than 14 inches apart in both directions, within 9 inches of walls at ends, and not more than 12 inches from walls at sides unless otherwise indicated.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Shear connector welds will be inspected and tested according to the requirements of AWS D1.1 for stud welding and as follows:
   1. Shear connector welds will be visually inspected.
   2. Bend tests will be performed when visual inspections reveal either less than a continuous 360 degree flash or welding repairs to any shear connector.
   3. Tests will be conducted on additional shear connectors when weld fracture occurs on shear connectors already tested according to the requirements of AWS D1.1

D. Testing agency will report inspection results promptly and in writing to Contractor and Owner.

E. Remove and replace work that does not comply with specified requirements.

F. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush, clean, and paint abraded areas, welds, and rust spots on both surfaces of deck panels immediately after installation.
   1. Touch up painted surfaces with same type of shop paint used on adjacent surfaces.
   2. Where shop-painted surfaces are exposed in-service, apply touchup paint to blend into adjacent surfaces.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

SECTION 055100 - METAL STAIRS

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. Preassembled steel stairs with concrete-filled treads.
2. Ornamental steel-framed stairs.
3. Steel tube railings attached to metal stairs.
4. Steel tube handrails attached to walls adjacent to metal stairs.

B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4, 16a-38k-4(b)5, 16a-38k-4(d)9 and 16a-38k-4(d)11.
   a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 033000 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms. Section 055000 "Metal Fabrications" for metal nosings installed in metal stairs, metal ladders and discharge identification barrier gates.
3. Section 055213 “Pipe and Tube Railings” for steel pipe and tube railings not associated with metal stairs.
4. Section 057300 "Decorative Metal Railings" for ornamental metal railings.
5. Section 096613 "Portland Cement Terrazzo Flooring"for terrazzo treads, risers and landings for ornamental steel-framed stairs.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.

5. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch (6.4 mm), whichever is less.

C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Handrails and Top Rails of Guards:

a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
b. Infill load and other loads need not be assumed to act concurrently.

D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component Importance Factor: See structural drawings.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For metal stairs and the following:

1. Paint products.
2. Grout.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

D. Samples for Initial Selection: For products involving selection of color, texture, or design.

E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.

1. Preassembled Stairs: Commercial class.
2. Ornamental Stairs: Architectural class.

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."

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

C. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

D. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, structural steel, Grade 25 (Grade 170), unless another grade is required by design loads; exposed.

E. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating, structural steel, Grade 33 (Grade 230), unless another grade is required by design loads.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

D. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

E. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).

F. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

G. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchorscapable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Section 099123 "Interior Painting".

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

E. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa) unless otherwise indicated.

F. Welded Wire Fabric: ASTM A 185/A 185M, 6 by 6 inches (152 by 152 mm), W1.4 by W1.4, unless otherwise indicated.

2.5 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 welds: no evidence of a welded joint for Architectural class stairs, Type 2 welds: completely sanded joint, some undercutting and pinholes okay for Commercial class stairs. .

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

H. Fabricate joints that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.6 STEEL-FRAMED STAIRS

A. Stair Framing:

1. Fabricate stringers of steel channels and tubes.

a. Provide closures for exposed ends of channel and tube stringers.

2. Construct platforms of steel channel and headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld stringers to headers; weld framing members to stringers and headers.
4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal-Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements but not less than 0.067 inch (1.7 mm).

1. Steel Sheet: Uncoated cold-rolled steel sheet unless otherwise indicated.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they will be concealed by concrete fill. Do not weld risers to stringers.
3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
4. Shape metal pans to include nosing integral with riser.
5. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.7 STAIR RAILINGS

A. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: As indicated on the drawings.
2. Picket Infill: As indicated on the drawings.

B. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.

C. Form changes in direction of railings as follows:
1. By bending, where not indicated.
2. By radius bends of radius, where indicated.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

E. Close exposed ends of railing members with prefabricated end fittings.

F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.

1. Connect posts to stair framing by direct welding unless otherwise indicated.
2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

2.8 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal stairs after assembly.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

F. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

3.2 INSTALLING RAILINGS

A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

1. Anchor posts to steel by welding directly to steel supporting members.
2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt Provide bracket with 1-1/2-inch (38-mm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as required to comply with performance requirements

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
2. For hollow masonry anchorage, use toggle bolts.

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

END OF SECTION 055100

SECTION 062023 - INTERIOR FINISH CARPENTRY

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. Interior board paneling and trim.

B. Related Requirements:

1. Division 01, High Performance Buildings Requirements Section for credits MR5, MR, MR7, IEQ4.1.

   a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2. Section 061053 "Miscellaneous Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
3. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and <u>NOTICE TO CONTRACTOR – SUBMITTALS.</u>

B. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.
3. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.

C. Samples for Verification:
1. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. (300 sq. cm) for lumber and 8 by 10 inches (200 by 250 mm) for panels.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For fire-retardant-treated wood, from ICC-ES.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, trim, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Lumber: DOC PS 20 and the following grading rules:

1. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."
2. NHLA: National Hardwood Lumber Association, "Rules for the Measurement and Inspection of Hardwood & Cypress."
3. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
4. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
5. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West Coast Lumber."
6. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."

B. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.

1. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

C. Hardboard: AHA A135.4.

2.2 FIRE-RETARDANT-TREATED MATERIALS

A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction, and comply with testing requirements; testing by a qualified testing agency.

B. Fire-Retardant-Treated Lumber, Trim and Paneling by Pressure Process: Class A products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber, trim and paneling after treatment to a maximum moisture content of 19 and 15 percent respectively.

C. For exposed items indicated to receive a stained or natural finish, use organic resin chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.

D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.

E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

F. Application: All interior wood-board lumber, trim and paneling to be fire-retardant-treated.

2.3 INTERIOR TRIM

A. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

1. Species and Grade: Siberian Spruce.
   a. Basis-of-Design Product: Subject to compliance, provide reclaimed wood product from Viridian Reclaimed Wood.
2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
3. Finger Jointing: Not allowed.

4. Face Surface: Surfaced (smooth).

2.4 PANELING

A. Board Paneling: Interior wood-board paneling.

1. Species: Siberian Spruce.
2. Grade: Knotty No. 1.
3. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
4. Pattern: Tongue and groove.
5. Net Coverage Width: Not less than 3 inches.
6. Thickness; 3/4 inch.
7. Lengths: 4 feet to 8 feet.

2.5 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

2.6 FABRICATION

A. Back out or kerf backs of the following members except those with ends exposed in finished work:
1. Wood-board paneling.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Face fastening is prohibited.
3. Install to tolerance of 1/8 inch in 96 inches (3 mm in 2438 mm) for level and plumb. Install adjoining interior finish carpentry with 1/32-inch (0.8-mm) maximum offset for flush installation and 1/16-inch (1.5-mm) maximum offset for reveal installation.
4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 PANELING INSTALLATION

A. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
1. Stagger end joints in random pattern to uniformly distribute joints on each wall.
2. Locate end joints only over furring or blocking.
3. Fasten paneling by blind nailing through tongues.

3.5 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.6 CLEANING

A. Clean interior finish carpentry on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.7 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

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. Polyurethane waterproofing.
2. Drainage panels.

B. Related Requirements:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4.
   a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2. Section 093000 "Tiling" for fluid-applied waterproof membranes beneath ceramic tiles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including, but not limited to, the following:

   a. Surface preparation specified in other Sections.
   b. Minimum curing period.
   c. Forecasted weather conditions.
   d. Special details and sheet flashings.
   e. Repairs.

1.4 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and <u>NOTICE TO CONTRACTOR – SUBMITTALS.</u>

B. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

C. Shop Drawings:

1. Show locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

D. Samples: For each exposed product and for each color and texture specified, including the following products:

1. Flashing sheet, 8 by 8 inches (200 by 200 mm).
2. Membrane-reinforcing fabric, 8 by 8 inches (200 by 200 mm).
3. Insulation, 8 by 8 inches (200 by 200 mm).
4. Drainage panel, 4 by 4 inches (100 by 100 mm).

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE SUBMITTALS

A. Manufacturers Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.7 CLOSEOUT SUBMITTALS

Warranty: For Cold Fluid-Applied Waterproofing specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

B. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build mockup for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatments, inside and outside corner treatments, and protection.

a. Size: 100 sq. ft. (9.3 sq. m) in area.
b. Description: Each type of wall installation.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.10 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two years.

1. Warranty includes removing and reinstalling protection board, drainage panels and insulation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, and molded-sheet drainage panels from single source from single manufacturer.

2.2 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: ASTM C 836/C 836M and coal-tar free.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals, LLC, Building Systems; Sonoshield HLM 5000.
b. Carlisle Coatings & Waterproofing Inc; CCW-525-V.
c. Tremco Incorporated; Tremproof 201/60.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated acrylic latex, polyurethane, or epoxy.

C. Sheet Flashing: 50-mil- (1.3-mm-) minimum, nonstaining, uncured sheet neoprene.

1. Adhesive: Manufacturer's recommended contact adhesive.

D. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

E. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; ASTM C 920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck applications; Use NT exposure and as recommended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

2.4 VERTICAL MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21-mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate of 9 to 18 gpm per ft. (112 to 220 L/min. per m).

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Hydrotech, Inc; Hydrodrain 400.
b. Carlisle Coatings & Waterproofing; CCW MiraDRAIN 6200.
c. Grace Construction Products; W.R. Grace & Co. -- Conn; Hydroduct 220.

2.5 HORIZONTAL MOLDED-SHEET DRAINAGE PANELS

A. Nonwoven-Geotextile-Faced, High Compressive Strength, Molded-Sheet Drainage Panel: Composite subsurface drainage panel consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing with an apparent opening size not exceeding No. 80 (0.18-mm) sieve laminated to one side of the core

and a polymeric film bonded to the other side; and with a horizontal flow rate of not less than 3 gpm per ft.

1. Compressive Strength: Not less than 18,000 psf per ASTM D1621
2. Products: Subject to compliance with requirements, provide one of the following:

    a. American Hydrotech, Inc; Hydrodrain 700.
    b. Carlisle Coatings & Waterproofing; CCW MiraDRAIN 9800.
    c. Grace Construction Products; W.R. Grace & Co. -- Conn; Hydroduct 660.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 1471.

B. Apply waterproofing in two separate applications, and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrate according to waterproofing manufacturer's written instructions and to recommendations in ASTM C 1471. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.

1. Comply with ASTM C 1193 for joint-sealant installation.
2. Apply bond breaker on sealant surface, beneath preparation strip.
3. Prime substrate along each side of joint and apply a single thickness of preparation strip at least 6 inches (150 mm) wide along each side of joint. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat.

B. Install sheet flashing and bond to wall substrates where required according to waterproofing manufacturer's written instructions.

1. Extend sheet flashings for a minimum of 4 inches (100 mm) onto perpendicular surfaces and items penetrating substrate.

3.5 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C 1471.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.

D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils (1.5 mm).
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft. (9.3 sq. m).

E. Cure waterproofing, taking care to prevent contamination and damage during application and curing.

3.6 MOLDED-SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall or deck substrate, according to manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections:

1. Testing agency shall verify thickness of waterproofing during application for each 600 sq. ft. (56 sq. m) of installed waterproofing or part thereof.

B. Manufacturer's Field Service: Engage a full-time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect.

C. If test results or inspections show waterproofing does not comply with requirements, remove and replace or repair the waterproofing as recommended in writing by manufacturer, and make further repairs after retesting and inspecting until waterproofing installation passes.

D. Prepare test and inspection reports.

3.8 PROTECTION

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION 071416

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

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. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Vapor retarder.
3. Roof insulation.

B. Section includes the installation of insulation strips in ribs of roof deck. Insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(e)12 and 16a-38k-4(b)4.
   a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
3. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
4. Section 077200 "Roof Accessories" for precast concrete splashblock to be installed as part of this section.
5. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
6. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
7. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Roofing Conference: Conduct conference at Project site.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. FM Global Requirements:

1. FM RoofNav Assembly Numbers
2. Application for Acceptance of Roofing: A copy of this document immediately follows this section.

D. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work, including:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

E. Samples for Verification: For the following products:

1. Sheet roofing, of color required.
2. Walkway pads or rolls, of color required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of compliance with performance requirements.

C. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency.

D. Research/Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field quality-control reports.

F. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For Thermoplastic Polyolefin (TPO) Roofing to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.

B. Warranty: For Thermoplastic Polyolefin (TPO) Roofing specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE SUBMITTALS

A. Manufacturers Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is FM Global approved for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, roof expansion joints and other components of roofing system.
2. Warranty Period: 30 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carlisle SynTec Incorporated.
2. Firestone Building Products.
3. GenFlex Roofing Systems.

B. Source Limitations: Obtain components including roof insulation fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. FM RoofNav Assembly Numbers: Equivalent to 294816-0-0 and 294815-0-0.

2. Design Criteria:
   a. 95 mph wind speed
   b. Ground Roughness Coefficient: C
   c. Wind Importance factor: 1.15

3. Fire/Windstorm Classification: Class 1-60
4. Hail-Resistance Rating: SH.

D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

E. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.3 TPO ROOFING

A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible TPO sheet.

1. Thickness: 80 mils (2.0mm), nominal.
2. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.

C. Bonding Adhesive: Manufacturer's standard, water based.

D. Slip Sheet: Manufacturer's standard, of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

F. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.

G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.

H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.5 SUBSTRATE BOARDS

A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation; GlasRoc Sheathing.
b. Georgia-Pacific CorporationDens Deck Prime.
c. USG Corporation; Securock Glass Mat Roof Board.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.

2.6 VAPOR RETARDER

A. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

1. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
2. Adhesive: Manufacturer's standard lap adhesive, FM Global approved for vapor-retarder application.

2.7 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Firestone Building Products.
b. Hunter Panels.
c. Johns Manville.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.8 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.

B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

1. Full-spread spray-applied, low-rise, two-component urethane adhesive.

C. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch (13 mm) thick.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corporation; GlasRoc Sheathing.
b. Georgia-Pacific Corporation; Dens Deck Prime.
c. USG Corporation; Securock Glass Mat Roof Board.

2.9 WALKWAYS

A. Walkway Membrane: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway and rolls where indicated, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

1. Size: 30 inches wide x 10 foot long strips.

B. Walkway Pad: Walkway pad consisting of overlapping strips of UV resistant, 100%TPO compound with embossed surface to provide slip-resistance equal to X-Tred; Firestone Products.

1. Size: 30 inches wide.x 10 foot long strips.

2.10 ROOF WARRANTY SIGNS

A. Materials: Materials: Provide cast (not extruded or continuous cast) methyl methacrylate monomer psi when tested according to ASTM D 790, with a minimum allowable continuous service temperature of 176 deg F and of the following general types:

1. Opaque Sheet: Provide plaque sign that is manufactured from 1/8” thick laminated engraving stock.
2. Engraved Copy: Engraved copy characters through the first background layer to expose the contrasting color of the inner core of the engraving stock.

a. Panel Size: 18”x20”, long side horizontal.
b. Engraving Stock Thickness: 1/8inch minimum.
c. Engraved Letter proportion: Letters and Numbers on signs shall have a width to height ratio between 3:5 and 1:1 and a stroke width to height ratio between1:5 and 1:10.
d. Engraved Letter Size: Characters shall be 5/8 inch high.
e. Background or first layer of engraving stock: Black
f. Inner core of engraving stock: White
g. Engraved letter style: Helvetica Medium with all upper case letters.
h. Mounting Methods: Mechanical mounting as indicated in PART 3.11 of this section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.3 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 SUBSTRATE BOARD INSTALLATION

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global's "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
2. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof.

3.5 VAPOR-RETARDER INSTALLATION

A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Continuously seal side and end laps.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
1. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and adhere to roof insulation.

1. Fasten cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

I. Install slip sheet over cover board and immediately beneath roofing if recommended by the roofing manufacturer.

3.7 ADHERED ROOFING INSTALLATION

A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.

B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.

E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.

F. Apply roofing with side laps shingled with slope of roof deck where possible.

G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.8 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars if required by roofing manufacturer.

3.9 WALKWAY INSTALLATION

A. Walkway Membrane: Install walkway rolls in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions. Provide 2 inch wide gap between rolls.

Walkway Pads: Install walkway pads in locations indicated. Thread strips of TPO through pad and heat weld strips to roof membrane according to roofing system manufacturer's written instructions. Space strips at a maximum of 36 inches on center on both sides of the pads and at the roll end. Provide 2 inch wide gap between pads.

3.10 SPLASHBLOCK INSTALLATION

A. Splashblocks: Install splashblocks in locations indicated. Install an additional protective layer of membrane below splashblocks extending a minimum of 6 inches beyond the perimeter of the splashblock. . Heat weld to substrate or adhere additional protective layer substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.11 INSTALLATION OF WARRANTY SIGN

A. The Roof Warranty Sign shall be permanently anchored to the facility in an extruded aluminum with clear anodized finish frame, with stainless steel fasteners, adjacent to the roof hatch ladder, unless otherwise directed by the Engineer. Panel sign shall include the following information:

1. NEW ROOF INSTALLATION WARRANTY
2. CTDOT (Project 0431-0006): (District Name, coordinate with CDDOT)
3. WARRANTY START DATE: (X/X/XX) (Date of the issuance of the Certificate of Compliance)
4. ROOF TYPE: (Type of roof installed), (i.e. JoeSmith International, Inc. PVC Membrane)
5. WARRANTY: (Manufacturer’s name and type of warranty), 20 yr NDL
6. WARRANTY NUMBER: (Actual Warranty number)
7. INSTALLER: (Contractor's name, town located, and telephone number.)
8. AFTER 2 YEARS CONTACT MANUFACTURER: (Manufacturer’s name and telephone number of warranty service).

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.

B. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

1. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm). Maintain 2 inches (50 mm) of clearance from top of base flashing.
2. Flood each area for 24 hours.
3. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

C. Perform pull-out test per ASTM E907.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.13 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075423

SECTION 099600 – HIGH PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and application of high-performance coating systems on the following substrates:

1. Exterior and Interior Substrates:
   a. Steel.
2. Interior Substrates:
   a. Concrete masonry units (CMU).

B. Related sections include the following:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4 and 16a-38k-4(b)5
   a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 051200 "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
3. Section 099123 "Interior Painting" for special-use coatings and general field painting.

1.2 DEFINITIONS:

A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and <u>NOTICE TO CONTRACTOR – SUBMITTALS.</u>

B. Product Data: For each coating system indicated.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

C. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.

D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

E. Samples for Verification: For each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat including block fillers and primers.. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.
3. Submit samples on the following substrates for Architect's review of color and texture:

a. Ferrous and Nonferrous Metal: Provide two 4-inch (100-mm) square samples of flat metal and two 8-inch (200-mm) long samples of solid metal for each color and finish.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Sample Areas

1. Apply sample areas of high performance coatings, approximately 50 sq.ft each, for each high performance coating type, where directed by the Architect, and receive approval prior to proceeding with remainder of work. Apply in stepped style showing each coat.
2. Approved areas will become standard of quality of work to follow.
3. Notify Architect when sample areas can be prepared and schedule time of application and examination with Architect.
4. Verify compatibility of primers, intermediate coats and topcoats with each other and with substrates prior to sample application. Verify that shop primers (if any) are as specified and/or appropriate for high performance coatings to be applied infield.

D. Workmanship shall be of the best quality. Apply all materials under adequate illumination, evenly spread and smoothly flowed on without runs or sags. Employ only skilled mechanics. Use materials only in accordance with the manufacturer’s labeled directions on the container, and/or manufacturer’s other written instructions.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45ºF (7ºC). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

C. Deliver coatings to the job site in quantities sufficiently large enough so that several different batches of the same color will not be required.

1.6 PROJECT CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50ºF and 95ºF.

B. Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85%; at temperatures less than 5ºF (3ºC) above the dew point; or to damp or wet surfaces.

1. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.
2. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL:

A. Material Compatibility:
1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by

manufacturers of topcoat for use in coating system and on substrate indicated.

3. Provide products of same manufacturer for each coat in a coating system.

2.2 BLOCK FILLERS:

A. Waterborne Cementitious Acrylic:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Tnemec Series 130 Envirofill.
2. VOC: 0.64 lbs/gallon.
3. Performance Criteria:
   a. Adhesion: ASTM D 3359, Method B, 5 mm Crosshatch. Not less than a rating of 5.
   b. Exterior Exposure: Exposed at 45 degrees facing south. Light industrial area. No blistering, cracking or loss of adhesion after three years exposure.
   c. Freeze Thaw: ASTM D 2246. No blistering, cracking or loss of adhesion after 30 cycles.
   d. Humidity: ASTM D 4585. No cracking, blistering or visable loss of film integrity after 1500 hours exposure.
   e. Steam Pressure Test: Pressure Pot @ 250^0 F (121^0 C) and 15 to 17 psi (1.0 to 1.2 bars). No blistering or cracking after 4 hours continuous exposure.
   f. Wind Driven Rain: TT-C-555B, 4.4.7.3. No cracking, blistering or visible damage to the substate or coating. No visible dampness on the backside of test specimen after 24 hours exposure.

2.3 METAL PRIMERS:

A. Primer, Zinc-Rich, Organic:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Tnemec Series H90-97 Tneme-Zinc.
2. VOC: (Unthinned) 2.67 lbs/gallon (320 grams/litre).
3. Performance Criteria:
   a. Adhesion: ASTM D 4541 (TTM-34) Type II Fixed Alignment Adhesion Tester. No less than 1,516 psi (10.46 MPa) adhesion, average of three tests.
   b. Adhesion: ASTM D4541 (TTM-34) Type V Self-Aligning Adhesion Tester. No less than 2,083 psi (6.89 MPa) pull.
   c. Exterior Exposure: ASTM D 1014. No blistering, cracking, rusting or delamination of film. No more than 1/64" rust creepage at scribe after 5 years light industrial exposure.
   d. Galvanic Protection: One coat aromatic urethane, zinc-rich coated steel panel containing several holidays is placed in a container of tap water. The panel's potential is measured by a voltmeter with the positive (+) pole attached to a bare spot on the panel above the water line and the negative (-) pole attached to an Ag/AgC1 referenced electrode immersed in the tap water. True theoretical galvanic action of the zinc having actual zinc-to-zinc contact would show a potential of 1100 millivolts. A range of 1100 millivolts to 750 millivolts would indicate galvanic action is occurring. The optimum potential is 850 millivolts. A potential of 500 millivolts or less would indicate that the coating is only acting as a barrier coating. The average measured potential of 90-97 is 878 millivolts.
   e. Humidity: ASTM D 4585. No blistering, cracking, rusting or delamination of film after 4,000 hours exposure.
   f. Salt Spray (Fog): ASTM B 117. No blistering, cracking, or delamination of film. No more than 1% rusting on plane and no more than 1/4" rust creepage at scribe after 20,000 hours exposure. No more than 1/32" rust creepage at scribe after 10,000 hours exposure. No more than 1/16 to 1/8" rust creepage at scribe and no

more than 1% rusting on plane after 50,000 hours.

g. Prohesion: ASTM G 85 Prohesion Cabinet Testing. No blistering, cracking, rusting or delamination of film. No more than 1/64" creepage at scribe after 15,000 hours.

h. Static Fatigue (Slip Coefficient & Tension Creep). Meets the requirements of a Class B surface with a mean slip coefficient no less than 0.50 and a tension creep not in excess of .005 inch (.13 mm).

2.4 EPOXY COATINGS:

A. Inorganic Hybrid Water-Based Epoxy:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Tnemec Series 27 WB Typoxy.
2. VOC: 0.10 lbs/gallon (11 grams/litre).
3. Performance Criteria:
   a. Abrasion: ASTM D 4060, (CS-17 Wheel, 1,000 grams load). No more than 175 mg loss after 1,000 cycles.
   b. Adhesion: ASTM D 3359, (Method B, mm Crosshatch). No less than a rating of 5.
   c. Humidity: ASTM D 4585. No blistering, cracking, rusting or delamination of film after 4,500 hours exposure.
   d. Salt Spray (FOG): ASTM B 117. No blistering, cracking, rusting or delamination of film after 6,000 hours.
   e. Immersion: ASTM D 870. No blistering, cracking, rusting or delamination of film after 2,000 hours.

2.5 SOURCE QUALITY CONTROL:

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION:

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions.
   1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).

E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
   1. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
   2. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION:

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

C. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 CLEANING AND PROTECTION:

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.5 ONE-YEAR INSPECTION:

A. Owner will set date for one-year inspection of coating systems.

B. Repair deficiencies in coating systems as determined by Architect in accordance with manufacturers' instructions.

3.6 INTERIOR - CONCRETE AND CONCRETE MASONRY UNITS:

A. CMU Walls:
1. System Type: Inorganic Hybrid Water-Based Epoxy/Ceramic-Modified Waterborne Aliphatic Polyurethane.
2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
3. Sealer Coat: Coverage rate 60 to 80 square feet per gallon.
4. Intermediate Coat: DFT 6.0 to 8.0 mils. or 200 to 267 SF^2/gal.5.
5. Finish Coat: DFT 2.0 to 3.0 mils. or 305 to 457 SF^2/gal.
6. Finish Color: As selected by Architect from manufacturer's standard colors.

3.7 EXTERIOR AND INTERIOR – COATING SYSTEMS FOR STEEL:

A. Exposed Steel, Columns, metal deck, bollards, tube railings:
1. System Type: Inorganic Hybrid Water-Based Epoxy/Ceramic-Modified Waterborne Aliphatic Polyurethane.
2. Surface Preparation for Steel: SSPC-SP 6/NACE 3.
3. Surface Preparation for Metal Deck: Light sweep sand blast with fine abrasive to achieve 1 mil.to 1.5 mil. Blast profile in field.
4. Shop Primer: DFT 2.5 to 3.5 mils. or 289 to 404 SF^2/gal.
5. Intermediate Coat: DFT 3.0 to 4.0 mils. or 401 to 535 SF^2/gal.
6. Finish Coat: DFT 2.0 to 3.0 mils. or 321 to 481 SF^2/gal.
7. Total DFT: 7.5 to 10.5 mils.
8. Finish Color: As selected by Architect from manufacturer's standard colors.

END OF SECTION 099600

SECTION 131200 - CANOPIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Freestanding, pre-engineered metal canopies including concrete foundation, steel framing, metal roof, roof drains and leaders, fascia components, and metal ceiling and accessories.

1.2 RELATED SECTIONS

A. Section 033000 – “Cast-In-Place Concrete”.

B. Section 055000 – “Metal Fabrications” for Pipe Bollards.

C. Section 079200 – “Joint Sealants”.

D. Division 11 – “Equipment” for fueling system equipment.

E. Division 21 – “Fire Suppression” for fire suppression system.

F. Division 26 – “Electrical” for electrical wiring and connections.

1.3 REFERENCES

A. American Institute of Steel Construction, Inc. (AISC): AISC 360 - Specification for Structural Steel Buildings (copyrighted by AISC, ANSI approved).

B. American Society of Civil Engineers (ASCE): ASCE 7 - Minimum Design Loads for Buildings and Other Structures (copyrighted by ASCE, ANSI approved).

C. American Welding Society (AWS): AWS D1.1 - Structural Welding Code - Steel (copyrighted by AWS, ANSI approved).

D. ASTM International (ASTM):
   1. ASTM A 36/A 36M - Standard Specification for Structural Steel.

E. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM MFM - Metal Finishes Manual.

F. National Fire Protection Association (NFPA): NFPA 70 - National Electrical Code (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide pre-engineered canopies capable of withstanding the effects of gravity loads and the following loads and stresses per the 2005 Connecticut Supplement with 2009 Amendment State Building Code:
   1. Uniform pressure as indicated on drawings - minimum design wind load per ASCE 7, CH. 6.

B. Thermal Movements: Provide pre-engineered canopies that allow for thermal movements resulting from the following maximum change (range) in ambient and

surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 degrees F (67 degrees C), ambient; 180 degrees F (100 degrees C), material surfaces.

1.5 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: Submit manufacturer's data sheets on each product to be used.

C. Shop Drawings: for the following metal canopy system components, including all design documents. Include plans, elevations, sections, details and attachments to other work:

1. Drawings shall show specific application to this Project, coordinate with minimum design criteria indicated on S-100 General Notes. Submit all required drawings in one submission, that shall be signed and sealed by Structural P.E. registered in state of Connecticut, except as noted.
   a. Erection Drawings: Manufacturer's complete erection drawings. Indicate manufacturer's identification marking for the components.
   b. Manufacturer's drawings showing base plate dimensions and foundation loads for all columns and /or rigid frames.
      1) Manufacturer's standard sheets showing loads or details for a multiple range of building spans, heights, and loadings will not be accepted.
   c. Foundation drawings showing dimensions and elevations of all piers, walls, and footings required. The foundation shall be designed by registered structural P.E per the project Geotech Report info, data, and directions.
   d. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach all columns and/or rigid frames to foundation. Indicate column reactions at each location.
   e. 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.
   f. Metal Canopy Panel Layout Drawings: Show layouts of metal panels including methods of support. Include details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and special details. Distinguish between factory- and field-assembled work; show locations of exposed fasteners.
   g. Anchor bolt and tie rod details.
   h. Accessory Drawings: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:8).
      1) Flashing and trim.
      2) Gutters.
      3) Downspouts.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:
   1. Metal Panels: Nominal 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other exposed panel accessories.
   2. Flashing and Trim: Nominal 12 inches (300 mm) long. Include fasteners and other exposed accessories.
   3. Accessories: Normal 12-inch-(300-mm)-ling Samples for each type of accessory.

E. Delegated-Design Submittal: For metal building systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, licensed in the State of Connecticut, responsible for their preparation.

F. Quality Control Submittals:
   1. Design Calculations: Manufacturer's design calculations signed and sealed by a professional engineer, licensed in the State of Connecticut, for the entire canopy structure and foundation.

G. Field quality-control reports.

H. Warranties: Sample of special warranties.

I. Maintenance Data: For metal panel finishes to include in maintenance manuals.

J. Certificates: Submit product certificates signed by the manufacturer certifying material compliance with specified performance characteristics and criteria, and physical requirements.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For Canopies to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.

B. Warranty: For Canopies specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in engineering and manufacturing pre-engineered canopies with a minimum documented experience of twenty years and with a quality assurance program utilizing a quality inspection for each system.
   1. Engineering Responsibility: preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

A. Welding: Qualify procedures and personnel according to the following:

1. Welding shall be in accordance with AWS D1.1 (with E70XX electrodes).
2. Steel shop connections shall be welded and field connections shall be bolted (unless otherwise noted on the Drawings). Shop welds may be changed to field welds with the approval of the project engineer.
3. Slag shall be cleaned from welds and inspected. Steel shall be painted with red oxide rust-inhibitive primer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Source Limitations: Obtain pre-engineered metal canopy through one source from a single manufacturer who shall manufacture and install the canopy.

D. Product Options:
1. Information on the Drawings and in the Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance. Do not modify intended aesthetic effects, as judged solely by the Architect, except with the Architect's approval. If modifications are proposed, submit comprehensive explanatory data to the Architect for review.
2. The Drawings indicate size, profiles, and dimensional requirements of pre-engineered metal canopies and are based on the specific system indicated. Do not modify intended aesthetic effects, as judged solely by the Architect, except with the Architect's approval. If modifications are proposed, submit comprehensive explanatory data to the Architect for review.

E. Coordination:
1. The Contractor shall conduct site meetings to verify project requirements, substrate conditions, utility connections, manufacturer's drawings and installation instructions.
2. The contractor shall prepare for and pour the concrete footers for the pre-engineered metal canopies. Manufacturer shall furnish recommended footing drawings and prints and rebar details for concrete footings, as well as provide anchor bolts to be embedded in concrete footer. Such items shall be delivered to project site in time for installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect components and accessories from corrosion, deformation, damage, and deterioration when stored at job site. Keep materials free from dirt and foreign matter.

1.9 PROJECT CONDITIONS

A. Field Measurements: The Contractor shall verify location and elevation of footings relative to finished grade, columns, and other construction contiguous with pre-

engineered metal canopies by field measurements before fabrication and indicate measurements on shop drawings.

B. Weather Limitations: Proceed with installation only when weather conditions permit metal panels to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Manufacturer shall warranty materials and products free of defects and leaks and for a period of 1 year from the date of shipment.

1. Finish warranty: 20 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide product by Austin Mohawk and Company, Inc.

2.2 MATERIALS

A. Structural Steel:
1. Material and work shall conform to the latest AISC 360.
2. Structural steel shall be painted with a rust inhibitive (red oxide) primer (std).

B. Sheet Metal:
1. Decking: 3 inch (76 mm) by 16 inch (406 mm) by 20 gage smooth white, ASTM A 653/A 653M GR40, Fy = 40 ksi, galvanized steel with baked enamel finish.
2. Center and Tapered Gutter: 24 gage hot-dip galvanized steel baked enamel finish.
3. Perimeter Gutter: 20 gage hot-dip galvanized steel baked enamel finish.
4. Internal Downspout: 3 inch (76 mm) diameter PVC.
5. External Downspouts: 3 inch (76 mm) by 4 inch (102 mm) by 24 gage hot-dip galvanized steel with baked enamel finish.

2.3 PRE-ENGINEERED METAL CANOPY

A. General: Provide a complete, integrated set of manufacturer's standard design canopy components to form a pre-engineered canopy. The pre-engineered metal canopy shall be designed to meet all structural wind, snow and seismic requirements.

B. Canopy Fascia:
1. Aluminum Composite Panel (ACM) with fluorocarbon paint finish, masked on one side. Shall be warranted for 20 years.

C. Canopy Finishes: Comply with NAAMM MFM for recommendations for applying and designating finishes.

1. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

D. Fabrication: Fabricate pre-engineered canopies completely in factory.

E. Seismic Performance: See structural drawings.

F. Wind-Uplift Resistance: See structural drawings.

G. Design Load: See structural drawings.

H. Maximum Deflection: See structural drawings.

I. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980 based on testing identical products by a qualified testing agency.

PART 3 EXECUTION

3.1 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicate 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 if 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.
   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 componants to indicate size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffners and other plates required for erection welded into place. Cut, form, patch, drill and weld secondary framing for bolted field connection 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.

3.2 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
   1. Examine supporting foundations and anchor bolts for compliance with manufacturer's requirements, including installation tolerances and other conditions affecting performance of supporting members.
   2. Verify the rough-in of required mechanical and electrical services prior to placement of the structure.
   3. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the installer.

3.3 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. 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.

3.4 INSTALLATION

A. A work area shall be required extending 10 feet (3 m) beyond buildings and canopies in all directions to the extent practical. The work area shall be flat, comprised of hard-packed soil or gravel, asphalt, or concrete, and free of open excavation, debris, construction equipment and construction workers. An additional flat work space a minimum of 25 feet (7.6 m) by 25 feet (7.6 m) or as practical shall be provided adjacent to the canopy and/or building for unloading and storing materials. Site to meet OSHA guidelines to allow lift equipment and scaffolding to maneuver the work area.

B. Set pre-engineered metal canopy plumb and aligned. Level base plates true to plane with full bearing on concrete bases.

C. Fasten pre-engineered metal canopy columns to anchor bolts and/or foundation bolts.

D. Provide anchor bolts as follows:
   1. Set anchor bolts or foundation bolts in strict accordance with approved shop drawings. Use of a plywood template is recommended. Remove template prior to column erection.
   2. Anchor bolts shall conform to ASTM A 307, and shall have a minimum of 7

inches (178 mm) of exposed thread and 23 inch (584 mm) minimum embedment with 1-1/4 inch (32 mm) nut and washer as embedment end.

E. Provide bolted connections as follows:
   1. Structural erection bolts shall conform to ASTM A 325/A 325M.
   2. Bolts shall be tightened to snug tight per latest RCSC specifications (unless otherwise specified).

F. Provide screws as follows:
   1. Fastening shall be performed per installation prints provided by the manufacturer.
   2. Self-drilling and self-tapping screws shall have a sufficient cut point and a 1/2 inch (13 mm) outside diameter dished metal-backed neoprene washer to be used in water sealing applications.

G. Provide pedestrian protection and warnings during construction which comply with local, Federal, and OSHA codes.

H. Prior to steel erection of any kind, the Contractor shall grade, backfill and otherwise prepare the job site to allow for rolling scaffold and ensure safe working conditions including the removal or relocation of overhead power lines.

I. Any grade or elevation situations which deviate from the approved manufacturer's plans shall be conveyed to the manufacturer prior to fabrication.

J. All anchor bolts and/or leveling plates shall be set within 1/4 inch (6 mm) tolerance on layout and grade level.

K. Temporary electrical power shall be provided.

L. Connect electrical power service to power distribution system according to requirements specified in Division 26 - Electrical.

M. Dumpster for trash and debris shall be provided by the Contractor.

3.5 ADJUSTING AND CLEANING

A. After completing installation, inspect exposed finishes and repair damaged finishes.
   1. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer’s written instructions.
   2. Touchup Painting: After erection, promptly clean, prepare and prime or re-prime field connections, rust spots and abraded surfaces if prime-painted structural framing, bearing plates and accessories.

B. Erect and install the canopy and appurtenances in accordance with the manufacturer’s printed instructions except as otherwise specified. Install the work of this Section so the structure is secure and weather tight and exposed materials are free of visible dents, scratches, tool marks, cuts and other imperfections. Install system free of rattles, wind whistles and noise due to thermal movement.

3.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION 131200

SECTION 262726 WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this section.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for all Electrical work. The administrative and procedural requirements included in this Section are to expand the requirements specified elsewhere.

B. Description of Work: Provide wiring devices and accessories as indicated.

C. Related Sections:

1. Division 01, High Performance Buildings Requirements Section 018113.13.

2. HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

1.4 INFORMATION SUBMITTALS

A. Qualification Data: For Installer and field testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For Wiring Devices to be included in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

B. Warranty: For Wiring Devices specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 GENERAL

A. All devices shall be UL-listed and meet all applicable ANSI, FS and NEMA standards.

2.2 DEVICE COLOR

A. As selected by Architect, Engineer or Owner.

2.3 GENERAL-USE SWITCHES

A. 20 amp, 120-277 volt, A.C. only, toggle type, and single pole, double pole, three-way or four-way as indicated.

B. Acceptable Manufacturers: Leviton;; Hubbell; Pass and Seymour.

2.4 KEY SWITCHES

A. Same as above, except operated by keyed cam lock. Furnish at least two keys per key switch.

B. Acceptable Manufacturer: Pass and Seymour; Leviton and Hubbell.

2.5 DIMMER SWITCHES

A. General: All dimmer switches must be compatible with the dimming ballast that it is controlling.

B. Incandescent Dimmers (120 Volts): Solid-state type, suitable for 120 volts incandescent control, with linear slide control, positive off position, high end trim, RFI filtering, circuitry that eliminates lamp flickering, single-pole or three-way switching as indicated, and matching finish for faceplates and slide controls. Sizes 600 watt to 2000 watt as indicated. Provide 1500 watt size unless indicated otherwise. Acceptable Manufacturer: Lutron, Leviton and Wattstopper.

C. Fluorescent Dimmers (120 Volts): Solid-state type, suitable for 120 volts fluorescent control, with linear slide control, positive off position, high end trim, RFI filtering, circuitry that eliminates lamp flickering, single-pole or three-way switching as indicated, and matching finish for faceplates and slide controls. Sizes 600 watt to 2000 watt as indicated. Provide 1500 watt size unless indicated otherwise. Acceptable Manufacturer: Lutron "NOVA" series, Wattstopper and Leviton.

2.6 GENERAL-USE RECEPTACLES

A. NEMA 5-20R configuration, 20 amp, 125 volt, A.C., duplex type as indicated, with wrap-around steel strap attached to back of receptacle and securely anchored into receptacle body near receptacle face, and with automatic grounding feature.

B. Acceptable Manufacturers: Leviton; Hubbell; Pass and Seymour.

2.7 GFI RECEPTACLES

A. Ground fault circuit interrupter, feed through, duplex receptacle, NEMA 5-20R configuration, 20 amp, 125 volt A.C. with solid-state ground-fault sensing and 5 MA trip level.

B. Acceptable Manufacturers: Leviton; Hubbell; Pass and Seymour.

2.8 SPECIAL RECEPTACLES

A. As indicated on the drawings by ratings and/or NEMA configuration. Furnish to the Owner, a matching 10' cord and plug set for each special receptacle. Provide submittals for each special receptacle type indicated.

B. Acceptable Manufacturers: Leviton; Hubbell; Pass and Seymour.

2.9 HAZARDOUS LOCATION DEVICES (CLASS I, DIVISION 1 and CLASS 1, DIVISION 2)

A. Devices approved for use in the specific classification in accordance with NEC Article 500.

B. Receptacles: NEMA 5-20R, dead front, delayed action circuit breaking type. Provide two matching NEMA 5-15P plugs for each receptacle and turn over to Owner.

C. Acceptable Manufacturers: Crouse-Hinds “ENR” & “ENP” Series, Leviton or Hubbell.

2.10 EMERGENCY POWER OFF (EPO) PUSHBUTTONS

A. Oil-tight, normally open, maintained contact pushbutton with red jumbo mushroom head and contacts rated at least 5 amps at 120 volts. Include stainless steel faceplate engraved with “EMERGENCY POWER-OFF” and suitable back box.

B. Acceptable Manufacturers: Square D Class 9001, Leviton or Hubbell.

2.11 ELECTRIC CAR CHARGING STATIONS

A. Necessary Components - Contractor shall provide all Electric Vehicle Supply Equipment (EVSE) components, hardware, software, and parts necessary for the proper assembly and operation of the EVSE. All EVSE components, hardware and parts must be new and unused.

1. Basis of design is based on the following manufacturer:

a. Control Module Inc., EVSE LLC, 2 Watt Point Dual Curbside model #3722-IG-1000-C/D with precast concrete base option to charge two vehicles.

B. Power

1. Leakage/Ground Current Protection: The EVSE must be equipped with leakage and ground current monitors with interruption capabilities.

2. Operates using 208 volts @ 30 amps, single phase to automatically charge Electric Vehicles (EV) by communicating with the vehicle’s battery management system.

3. Connector: SAE J1772 & NEC 635 Compliant.

4. Pilot: SAE 1772 Compliant.

5. Ground Fault: GFCI 20MA

6. Protection: Auto Test

7. Breaker Size: 40 amps

8. Overload: 40 amp trip at 30 amps

9. Protection: Reclosure, CCID

10. Ground Wire: Continual Test

C. Dimensions

1. Height to Lot Surface: 9 ft., 10 in. high
2. Concrete Pedestal: 16 in. wide by 18 in. high

D. Certifications

1. The EVSE must comply with the latest recognized edition of the NEC Article 625 and related articles and tables.

2. The EVSE electrical components, enclosures and mounting systems must be built to UL 2231 standards.

E. Physical Appearance, Function and Design

1. The EVSE must utilize tamper-resistant screws and design, but provide a locked or easy opening mechanism for service work.

2. EVSE Enclosure: The EVSE enclosure must be constructed for use outdoors in accordance with UL 50, Standard for Enclosures for Electrical Equipment, NEMA Type 3R.

3. Environmental: The EVSE must be capable of operating without any decrease in performance over an ambient temperature range of 0 to 122 degrees Fahrenheit with a relative humidity of up to 95 percent.

4. The EVSE must be capable of serving a minimum of 2 EV's.

5. Cord Management System: The EVSE must incorporate a cord management system or method to minimize the potential for cable entanglement, user injury or connector damage from lying on the ground and comply with NEC articles 625 as it applies to cord management systems.

6. Manual Reset: EVSE must include manual reset capabilities with instructions on the EVSE to enable the end user to reset the EVSE in the event of an abnormal shutdown.

7. The EVSE must have payment or access control options to allow users to authenticate using a credit card, RFID device, password, or other identifying method. This access needs to also have backend capabilities to collect payment or provide reporting mechanisms such that another system would be able to collect payment. If these functions aren't available, the EVSE supplier must provide an alternative method.

8. The EVSE must have an internal metering function to allow recording of energy usage

data. This may be accessed using a computer connected to the device or web based access to this information, but shall have sufficient storage capabilities to retain data for a minimum of 90 days.

2.12 COVERPLATES

A. General: Number of gangs, and openings to suit the number and type of devices.

B. General Use: Struck-up type, minimum .032" thick Type 430 stainless steel with U.S. #32D satin finish.

C. Dimmer Switch Coverplates: Plastic with no visible seams or screws, minimum 0.6" thick, white finish.

D. Weatherproof Coverplates: Suitable for the device indicated and type of outlet box used, cast aluminum or lexan. Receptacles installed in damp or wet locations shall comply with NEC 410-57.

E. Acceptable Manufacturers: Leviton, Hubbell and Lutron.

2.13 SURFACE METAL RACEWAYS AND MULTIOUTLET ASSEMBLIES

A. All components shall be UL listed, and be supplied from one of the following: Wiremold, Hubbell and Panduit.

PART 3 - EXECUTION

3.1 MANUFACTURERS

A. Use only one manufacturer for all switches and general use receptacles. Use only one manufacturer for each type of device.

3.2 GENERAL

A. Switches: Install single pole switches so that the circuit is on when the handle is up.

B. Receptacles: Install receptacles with ground pin up where vertically mounted, and on left when horizontally mounted.

C. Surface metal raceways and multi-outlet assemblies shall be installed per the NEC Articles 352 and 353, respectively.

3.3 GFI RECEPTACLES

A. For each receptacle designated or indicated to be “GFI,” provide a GFI receptacle. Do not substitute general use receptacle with feed-through GFI protection from upstream GFI receptacle. Do not use feed-through feature of any GFI receptacle.

3.4 ELECTRIC CAR CHARGING STATIONS

A. Install electric car charging stations per manufacturers written instructions and contract

documents. Coordinate exact wiring requirements with provided manufacturer and adjust branch circuits serving EVSE to suit manufacturer's requirements. Provide manufacturers authorized representative to inspect and certify installation is in compliance with manufacturer's installation instructions.

B. Provide a minimum of 4 hours of training for owner's personnel, for operation and maintenance of EVSE's.

3.5 CASEWORK AND WOODWORK

A. Do not cut openings for devices in casework or woodwork. Coordinate sizes and locations of cutting with casework or woodwork supplier. Furnish and install all electrical items indicated and necessary, except as noted. Conceal raceways and outlet boxes unless indicated otherwise.

3.6 GANGING

A. Where devices are shown adjacent (e.g. bank of light switches), mount all such adjacent devices under one multi-gang coverplate, unless indicated otherwise.

3.7 COVERPLATE INSTALLATION

A. Install coverplates tight to wall, plumb, and level. Install receptacles so that device face is flush with or slightly ahead of coverplate face minimum of 0.015 in (381 micrometers). Install blank fillers in coverplate openings not used. Grout or caulk as required to provide watertight seal for weatherproof coverplates.

3.8 CIRCUIT IDENTIFICATION

A. Refer to 260553- Electrical Identification.

END OF SECTION 262726

SECTION 300000 - FORM 816 SITE WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Description: This Section includes site work descriptions, materials and construction methods excerpted and edited from the State of Connecticut Department of Transportation, The Standard Specifications for Roads, Bridges and Incidental Construction, Form 816, 2004 including supplemental specifications. The work includes, but not limited to, the identified excerpted Sections.

B. Related Requirements:

1. State of Connecticut Department of Transportation, The Standard Specifications for Roads, Bridges and Incidental Construction, Form 816, 2004 including supplemental specifications; Division I, General Requirements and Covenants and Division III, Materials Section; exclusive of references to Method of Measurement and Basis of Payment.

2. Division 01, Construction Waste Management Section 017419.

3. Division 01, High Performance Buildings Section 018113.13 for credit 16a-38k-3(h) and 16a-38k-4(e15).
   a. The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 TABLE OF CONTENTS:

2.01 CLEARING AND GRUBBING
2.02 ROADWAY EXCVATION, FORMATION OF EMBANKMENT AND DISPOSAL OF SURPLUS MATERIAL
2.03 STRUCTURE EXCAVATION
2.05 TRENCH EXCAVATION
2.07 BORROW
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9.54 CONSERVATION SEEDING FOR SLOPES
12.09 PAINTED PAVEMENT MARKINGS

1.4 EXCERPTED SECTIONS

SECTION 2.01 - CLEARING AND GRUBBING

2.01.01 Description:

This work shall consist of clearing the ground of trees, stumps, brush, rubbish and all objectionable material in accordance with these specifications or as directed by the Engineer. This work shall also include the clearing of the ground necessary for the construction and installation of drainage, structures, ditches, channels, fences and other appurtenances. Included in this work shall be the preservation from injury or defacement of vegetation and objects designated to remain.

2.01.03 Construction Methods:

The Contractor shall mark all trees, shrubs and plants to be removed in accordance with the plans and these specifications. The Engineer shall have 7 days to field review the markings and make any adjustments prior to the start of the clearing operation. Within the excavation lines all trees shall be cut off and stumps removed to a depth of not less than 12 inches (300 millimeters) below the graded surface.

Within the fill lines where an embankment is to be made not more than 5 feet (1.5 meters) in depth, trees, stumps, roots, etc., shall be removed. Where the embankments to be made exceed 5 feet (1.5 meters) in depth, trees, stumps, roots, etc., shall be cut off to within 6 inches (150 millimeters) of the ground surface.

In areas where clearing is necessary for the construction and installation of various appurtenances, all trees and stumps shall be cut flush with the ground; and all dead or uprooted trees, brush, roots or otherwise objectionable material shall be removed as directed unless otherwise indicated on the plans. Prior to clearing operations, a meeting must be held. Those attending the meeting should include the Contractor, the Engineer, the designer, local tree warden or equivalent, and the District Environmental Coordinator. All clearing issues shall be resolved to the satisfaction of the Engineer before any trees are cut.

All trees scheduled to be removed outside of the proposed gutter or curb lines shall be visibly marked or flagged by the Contractor at least seven days prior to cutting of such trees.

The Engineer will inspect the identified trees within 7 days of the marking of the trees and verify the limits of clearing and grubbing prior to the Contractor proceeding with his cutting operation.

All branches of trees extending within the roadway shall be trimmed as directed to provide a 16-foot (5-meter) minimum vertical clearance including selective trimming of such trees as directed.

The Contractor shall dispose of all such trees, stumps, brush, etc., in a satisfactory manner and shall remove all rubbish and refuse from within the project limits.

All excavations made below subgrade surface by the removal of trees, stumps, etc., shall be filled with suitable material, which shall be compacted thoroughly in accordance with the provisions governing formation of embankments.

All fences, stonewall fences and ornamental and utilitarian domestic accessories, such as, but not limited to garden pools, arbors, stair railings, fireplaces, sheds and incinerators, within the project limits shall be removed as directed.

All road signs, mail boxes, etc., shall be removed and reset as directed.

SECTION 2.02 ROADWAY EXCAVATION, FORMATION OF EMBANKMENT AND DISPOSAL OF SURPLUS MATERIAL

2.02.01 Description:

Roadway excavation shall consist of the removal and satisfactory disposal, in the manner herein required, of all material taken from within the limits of the work contracted for, the removal of which is necessary for the construction of the roadway, subgrade, shoulders, slopes, entrances, retaining walls, gutters, channels, swales and other miscellaneous construction to the dimensions and limits shown on the plans or as ordered and shall include the necessary excavation for pervious structure backfill outside of structure excavation limits. It shall also include the formation of embankments, the disposal of surplus or unsuitable material, removal of old foundations, concrete or masonry walls, crib walls, bin walls, stone wall fences or farm wall fences and filling of cellar or other holes, and the shaping and cleaning of slopes and of shoulders.

1. Earth Excavation shall include all materials removed as indicated or directed except water, "Rock," "Channel Excavation—Earth," and "Channel Excavation—Rock."

2. Rock Excavation shall include rock in definite ledge formation and boulders, or the portion of boulders, 1 cubic yard (cubic meter) or more, in volume.

3. Channel Excavation—Earth shall include all materials other than water or "Channel Excavation Rock" removed from the existing new or temporary water courses as indicated on the plans or as directed.

4. Channel Excavation—Rock shall include rock in definite ledge formation and boulders of 1 cubic yard (cubic meter) or more in volume removed from existing, new or temporary water courses, as indicated on the plans or as directed.

2.02.03 Construction Methods:

Excavation shall be made in conformity with the requirements of the plans and as ordered by the Engineer. The Contractor shall, when necessary in excavation areas, provide and maintain ditches which are adequate to prevent free water from becoming incorporated in material to be used to form embankments, such ditching to be at the sole expense of the Contractor. Where buildings have been removed to clear the way for construction or where old foundations, concrete or masonry walls exist, they shall be removed to 2 feet (600 millimeters) below the directed or finished grading; and all cellar and other holes shall be filled with suitable material.

1. Sod and other organic matter shall be disposed of as directed by the Engineer. In the event the Engineer does not direct the disposal of unsuitable material in conformance with Subarticle 300000-2.02.03-8, the Contractor has the option of disposing of the unsuitable material as specified within Subarticle 300000-2.02.03-10.

2. Frozen material, otherwise suitable for formation of embankments, shall be placed on embankment slopes or dispose**d** of as directed by the Engineer. The Engineer may direct the removal of any portion of an accepted layer which has become frozen after placement and compaction. This frozen material shall be placed on embankment slopes or disposed of as directed by the Engineer. The removal and placement of frozen material shall be at the sole expense of the Contractor.

3. Topsoil shall be excavated within pavement and shoulder limits at grade points and to an elevation 3 feet (1 meter) below finish grade and elsewhere as directed. The material excavated may be used in the construction of embankments, if permitted by the Engineer, and shall be thus used if the Engineer so directs. In all cases, the use of topsoil in constructing embankments shall be restricted to locations where the surface of the underlying material is dry, its distance above the free water surface at the time of filling is more than 3 feet (1 meter), and its distance below finish pavement grade is more than 5 feet (1.5 meters).

4. Excavation of Rock: When rock is encountered, it shall be excavated to the slope lines and depths indicated on the plans.

   The Contractor shall presplit the rock along the proposed rock slopes to the lines and inclinations shown on the plans except as otherwise provided in the specifications. Presplitting will be required where the backslope is designed at an inclination one (vertical) on one (horizontal) or steeper or where the cut in rock is ten feet (3 meters) or more, measured on the inclination of the proposed slope from the bottom of excavation to the natural surface of sound rock. The maximum vertical height of slope face which can be presplit at any one time shall be 50 feet (15 meters).

   The presplitting holes shall follow the required rock slope lines and inclinations. Hole drilling shall commence only when solid rock is encountered and exposed to the satisfaction of the Engineer. Unless otherwise permitted by the Engineer, presplitting holes shall have a spacing of 3 feet (1 meter), center-tocenter, and a diameter not greater than 3 inches (75 millimeters). The holes shall be extended from the top of solid rock surface to the toe of finished rock slope, unless lesser depths are specified on the plans. The proper angle of drilling shall be maintained at all times so all presplit holes lie essentially in the same plane and are paralleled to each other. No holes shall deviate more than 6 inches (150 millimeters) at any place in the plane of the specified slope line nor in its vertical alignment. If any cut is presplit by vertical stages (lifts), the presplit holes may be offset, for each stage, a distance not more than 24 inches (600 millimeters) inside the previously presplit face. Presplit holes shall be lightly loaded with a continuous column charge manufactured especially for presplitting. All space in each hole not occupied by the explosive charge shall be filled with clean stone chips less than 3/8 inch (9 millimeters) in size or approved equal. Charges near the top of hole shall be reduced sufficiently to eliminate overbreak and heaving. The top charge shall not be less than 3 feet (1 meter) below the top of the drill hole. The methods of detonation shall be such that a uniform plane of rupture of the rock occurs from top to bottom and between presplit holes. If necessary, the Contractor shall adjust the methods as outlined above so as to result in a uniform plane of rupture in the rock.

   Unless otherwise approved by the Engineer, presplit holes shall be drilled at least 50 feet (15 meters) ahead of, and shall be detonated prior to the drilling and blasting, the general pattern holes within the section of any lift of rock to be excavated. The presplitting shall be performed so as to produce a uniform plane of rupture in the rock such that the resulting rock face will not be affected by subsequent blasting and excavation operations.

   In the general pattern, blasting following presplitting operations, no portion of any blast hole shall be drilled closer than 4 feet (1.2 meters) to the presplit face. No portion of any blast hole larger than 3 inches (75 millimeters) in diameter shall be permitted closer than 12 feet (3.5 meters) to the presplit face. The spacing of blast holes, distribution and type of explosives, methods of detonation, and the blasting techniques shall be adjusted by the Contractor according to the characteristics and structure of the rock encountered so as not to fracture the rock beyond the presplit face.

   Prior to any blasting, the Department will call a blasting conference at which the Contractor shall be represented to determine the methods to be used and the required protection to insure the utmost safe-

ty during blasting operations. The Contractor shall be responsible for all damage due either directly or indirectly to such operation.

The Contractor shall schedule his operations so that all rock excavation within a distance of 100 feet (30 meters) of bridge or other large structures, or any portion thereof, is completed to the required slope lines and depths before any structure work is started.

All loose and unstable material and all breakage and slices shall be removed as directed and as the excavation for each vertical stage (lift) progresses. It shall be, at all times, the responsibility of the Contractor to perform all phases of this work to produce the required rock slope faces to the satisfaction of the Engineer.

Where indicated on the plans or as ordered by the Engineer, rock shall be excavated without the use of explosives. Excavation methods by the use of drilling, splitting, wedging or other approved methods not involving the use of explosives shall be utilized. The method selected by the Contractor shall allow excavation to the slope line(s) and depth(s) as shown on the plans and shall not affect in any way the material or structures outside the excavation line or grade.

5. Placement of Embankment Material: All excavated material and reclaimed waste obtained within the limits of the project shall be used in the formation of embankments, except as provided elsewhere herein or as ordered by the Engineer.

Overhaul will not be allowed; but excavated material shall be transported where directed, provided the designated point of deposit is not more than 100 yards (100 meters) beyond the limits of the work contracted for, unless stated otherwise in the plans.

When embankments are to be constructed on slopes steeper than 1 vertical to 3 horizontal, the slope of the existing ground on which the embankment is to be placed shall be plowed deeply or cut into steps before the filling is begun.

Embankments shall be constructed of earth, rock, reclaimed waste or a mixture thereof containing no more than 2% by weight (mass) of asphalt cement. The embankment shall be constructed by depositing successive layers of fill for the full width of the embankment, unless a partial width is permitted by the contract documents or by the Engineer. If glass and/or clinker are included in reclaimed waste, their individual particles shall be no larger than 1 inch (25 millimeters) in size. Glass and/or clinker shall be thoroughly mixed with other embankment materials such that their content anywhere in the embankment shall not exceed 25% by weight (mass), with the exception that material placed within 5 feet (1.5 meters) from the face of the slope shall be free of glass and clinker. No embankment layer shall be deposited on surfaces of snow or ice, nor shall it be placed on frozen or unstable surfaces except under the conditions permitted elsewhere herein. If the Contractor is permitted to continue work, he shall remove, at no cost to the State, any frozen embankment material unless otherwise directed by the Engineer.

The depth of each layer, before compaction, shall not exceed 12 inches (300 millimeters) except as permitted hereinafter by these specifications, or with the permission of the Engineer.

The embankment shall be crowned or pitched to provide drainage at the close of each day's operations. Where filling in 12-inch (300-millimeter) layers is impracticable, as in the case of filling in water or over slopes too steep for the operation of equipment, the embankment may be constructed in one layer to the minimum elevation at which equipment can be operated, as determined by the Engineer; and above this elevation, the embankment shall be constructed as specified herein.

Embankments to an elevation 3 feet (1 meter) above the free water surface at the time of filling, shall be constructed of rock or free-draining material, or a mixture of both. Free-draining material shall conform to the requirements of Article M.02.07.

In fills where the top of the proposed pavement will be less than 4 feet (1.2 meters) above an existing flexible pavement, and the existing pavement is not required to be removed, it shall be scarified as directed by the Engineer.

In fills where the top of the proposed pavement will be less than 3 feet (1 meter) above an existing concrete pavement, including all bituminous resurfacing thereon, the concrete pavement shall be removed. In fills where the top of the proposed pavement will be between 3 and 4 feet (1 meter and 1.2 meters) above an existing concrete pavement, the concrete pavement shall be broken in such a manner that complete fractures are obtained. Intact fragments, undamaged after breaking, shall not be larger than 2 square feet (0.2 square meters).

When present pavement not in cut or fill is removed, as called for on the plans or directed, the area shall be backfilled with a suitable earth material which shall be free from admixture of subsoil, refuse, stumps, roots, rocks, brush, weeds and other material which will prevent the formation of a suitable seed bed. Wherever portions of existing concrete pavement are to be removed, such removals shall be made to neat lines. The areas in which such concrete surfaces are to be removed will be delineated by the Engineer before such work is done. Where no break or joint exists in the concrete pavement at the line of delineation, a kerf, at least 2 inches (50 millimeters), but no more than 3 inches (80 millimeters) deep, shall be made in the concrete with an approved concrete cutting saw. The concrete shall then be removed from within the delineated area exercising extreme care to avoid "breakbacks" beyond the kerf, break or joint. Concrete pavement remaining in place shall have vertical edges, and that portion below the kerf shall be reasonably smooth.

Wherever portions of existing bituminous concrete pavement are to be removed, they shall be removed to neat lines as shown on the plans or as directed by the Engineer. Where the delineated limits of the areas in which such bituminous surfaces are to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the line of delineation shall be cut by a method approved by the Engineer. When the embankment material consists predominantly of rock fragments and/or fragments of reclaimed waste of such size that material cannot be placed in horizontal layers of the thickness specified above without crushing or further breaking down the pieces resulting from the excavation methods, such material may be placed in the embankments in horizontal layers not exceeding 3 feet (1 meter) in thickness. Large stones or fragments of reclaimed waste shall not be placed in nests but shall be distributed over the area; and the interstices shall be filled with spalls, finer fragments or earth to form a solid, compact mass. The entire area of each layer shall be leveled off by suitable grading equipment and shall be compacted as hereinafter specified.

In portions of embankments where piles are to be driven, the Contractor shall not place any material which might interfere with pile driving operations. The correction of any condition which interferes with the pile driving operations in embankments constructed under the contract shall be made by the Contractor at no cost to the State.

No rock fill or reclaimed waste containing fragments over 12 inches (300 millimeters) in their greatest dimension shall be placed above an elevation which is 2 feet (600 millimeters) below the top of the embankment.

No particle over 5 inches (130 millimeters) in its greatest dimension shall be placed within 12 inches (300 millimeters) of the elevation of the top of the prepared subbase unless otherwise specifically au-

thorized. Prior to the formation of any embankment, the Contractor may submit a plan in a form acceptable to the Engineer for grading operations detailing the location of embankment material sources and points of deposit for the entire project.

6. Compaction: The entire area of each layer of the embankment and the subgrade in the excavated areas shall be uniformly compacted to at least the required minimum density by use of compaction equipment consisting of rollers, compactors or a combination thereof. Earth-moving and other equipment not specifically manufactured for compaction purposes will not be considered as compaction equipment. The dry density after compaction shall not be less than 95% of the dry density for that soil when tested in accordance with AASHTO T 180, Method D. Each layer of the embankment and the subgrade shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

7. Stability: If after full compliance with the requirements of these specifications with regard to excavation, placement and compaction density requirements, a stable embankment or subgrade has not been obtained, the Contractor shall proceed to perform such corrective work as is necessary to produce a stable embankment or subgrade. This work may include, but not necessarily be limited to control of moisture to within limits suitable for obtaining the required stability; blending with rock or granular material from project excavation or borrow, or free draining material or combination thereof; removal and replacement with acceptably compacted material or a combination of these methods approved by the Engineer. The foregoing methods may be supplemented by suspending embankment operations and allowing the material to dry.

8. Surplus Excavated Material: All surplus excavated material shall be used where directed by the Engineer, to uniformly widen embankments, to flatten slopes, to fill low places in the project limits, or for such other purposes as the Engineer may direct, provided the area designated for deposit does not conflict with Subarticle 300000-2.02.03-5.

   Any surplus or unsuitable material not required, nor permitted to be used for such purposes, shall be disposed of in accordance with Subarticle 300000-2.02.03-10.

9. Disposal of Unsuitable Material: When the Engineer has not directed otherwise, the Contractor has the option to dispose of unsuitable excavated material by one or both of the following methods:

   a) By removing such material from within the limits of the project and disposing of such material at point or points as the Contractor shall determine provided this does not create any detrimental effects to the project and the Engineer does not object to the area selected for disposal.

   b) By disposing of such material within the limits of the project in accordance with the details and requirements shown on the plans and the following requirements: Not less than 15 days prior to disposing of any such material within project limits, the Contractor shall submit to the Engineer for his approval a proposal delineating the locations and extent of the areas in which he intends to dispose of such material. The proposal shall describe the nature of the material and the methods to be employed in placing and covering the material. The proposal will be reviewed for its effects on the completed construction and the environment. The proposal shall be amended as required by the Engineer. No such material shall be disposed of within project limits until the proposal has been approved by the Engineer.

      All work shall be done in accordance with the approved proposal.

Suitable material excavated for the disposal of the unsuitable excavated material shall be placed in the embankment in accordance with the requirements of Section 300000-2.02 or shall be used to cover the unsuitable excavated material.

The State does not guarantee nor imply that the areas available for disposal of unsuitable excavated material within project limits will be adequate for the disposal of all unsuitable excavated material to be removed. The Contractor shall dispose of all unsuitable excavated material in excess of that which can be placed within the permitted areas.

10. Slopes: Earth slopes with a degree of slope from 2:1 to 5:1 shall be tracked unless the Engineer directs that they shall not be tracked. Tracking shall consist of traversing the slopes with cleated tracks so that the cleat indentations are horizontal. Where topsoil is to be placed on slopes, the tracking shall be done prior to the installation of the topsoil.

    Tracking is not to be construed to be used for slope compaction. Its sole purpose is to provide indentations in the slope to help reduce soil erosion. Other methods of achieving the desired results may be used, with the permission of the Engineer.

SECTION 2.03 STRUCTURE EXCAVATION

2.03.01—Description:

With the exceptions noted below, structure excavation shall include the removal of all material of whatever nature, the removal of which is necessary for the construction of foundations of bridges, box culverts, retaining walls, and other structures shown on the plans; the placing of all necessary fill with the exception of pervious structure backfill hereinafter specified; and the wasting of excavated material which is not required for backfilling or embankment, or which is unsuitable for that purpose.

This work shall also include dewatering; the design and construction of all cofferdams and related environmental controls used in dewatering operations required for the execution of the work; the repair, reconstruction and removal of cofferdams and related environmental controls used in dewatering operations; and the removal of all obstructions necessary for the construction of cofferdams. For "Cofferdam and Dewatering" the provisions of Section 300000-2.04 shall govern.

"Structure Excavation—Earth" or "Structure Excavation—Rock" are defined as follows:

1. "Structure Excavation—Earth" shall include removal of all materials, other than water or "Structure Excavation—Rock."

2. "Structure Excavation—Rock" shall include the removal of rock in definite ledge formation; boulders or portions of boulders that have a volume of 1 cubic yard (cubic meter) or greater; and masonry structures of 1 cubic yard (cubic meter) or more in volume.

2.03.03—Construction Methods:

1. Dimensions and Elevations of Footings: The elevations of the bottom of footings, as shown on the plans, shall be considered as approximate only; and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be necessary to secure a satisfactory foundation.

2. Preparation of Foundations: All rock or other suitable foundation material shall be cleared of all overlying material, cleaned and cut to a firm surface, either level, stepped or serrated, as directed by the Engineer. All seams shall be cleaned out and filled with concrete, mortar or grout. Any over-breakage in rock more than 6 inches (150 millimeters) below the plan grade for the bottom of the footing not authorized by the Engineer shall be replaced by the Contractor with Class "A" concrete at the Contractor's expense. When the structure is to rest on a material other than rock, special care shall be taken not to disturb the material below the bottom of the excavation; and the final removal of the foundation material to grade shall not be made until just before the forms for concrete or masonry are placed. Any foundation material disturbed below plan grade or revised plan grade shall be dressed and compacted at the Contractor's expense. This shall not apply, however, when a granular fill foundation course is required.

3. Cofferdams: If a cofferdam is required, it will be designed and constructed in accordance with the provisions of 300000-2.04.03—1 and 3.

4. Dewatering: If a cofferdam is required, dewatering will be performed in accordance with the provisions of Subarticle 300000-2.04.03—2.

5. Inspection: After each excavation is completed, the Contractor shall notify the Engineer; and no construction shall be started until the Engineer has approved the depth of the excavation and the character of the foundation material.

6. Fill Adjacent to Structures: All spaces excavated and not occupied by the abutments, piers, other permanent work or pervious structure backfill shall be filled to the surface of the surrounding ground with suitable material. Such backfill shall be thoroughly compacted and neatly graded.

Fill placed around arches, rigid frames, box culverts and piers shall be deposited on both sides of the structure to approximately the same elevation at the same time.

Each layer of backfill shall be spread to a thickness not exceeding 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by the use of power rollers or other motorized vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes or which is not in proper working order in all respects shall not be used within the area described above.

Special attention shall be given to compaction in places close to walls where motorized vehicular compaction equipment cannot reach. Within 3 feet (1 meter) of the back face of walls and within a greater distance at angle points of walls, each layer of backfill shall be compacted by mechanical rammers, vibrators or pneumatic tampers.

The dry density of each layer of backfill after compaction shall not be less than 95% of the dry density for that material when tested in accordance with AASHTO T180, Method D. In conducting this test, material retained on the 3/4-inch (19-millimeter) sieve size shall be replaced with material retained on the No. 4 (4.75- millimeter) sieve, as noted as an option in the specifications for this test.

Adequate provision shall be made for the drainage of all fill in accordance with the provisions of the plans, or as ordered by the Engineer.

Each layer of backfill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

No fill shall be placed against any structure until the Engineer has given permission to do so, and in no case until after the permitted time for removal of forms.

SECTION 2.05 TRENCH EXCAVATION

2.05.01—Description:

Trench excavation shall consist of the removal and satisfactory disposal of all materials, the removal of which is necessary for the proper completion of the work, to the dimensions shown on the plans or as ordered, and backfilling, all in accordance with these specifications for the following:

1) The construction of pipe culverts, endwalls, catch basins, drop inlets, manholes, underdrains and outlets, sewers, service pipes.

2) The removal of storm water drainage structures, storm water pipes and appurtenances beyond the limits of the roadway and structure excavation.

3) The removal of miscellaneous items such as abandoned underground tanks, pipelines, etc.

Classification:

(1) Trench excavation will be allowed only for the construction of the structures and the removals definitely specified above.

(2) Rock in Trench: Rock, insofar as it applies to trench excavation, shall be defined as rock in definite ledge formation, boulders, or portions of boulders, cement masonry structures, concrete structures, reinforced concrete pipe, Portland cement concrete pavement or base, of 1/2 cubic yard (0.5 cubic meters) or more in volume or removed as indicated.

2.05.03—Construction Methods:

Trench excavation shall be made in conformity with the requirements of the plans or as ordered. The Contractor shall furnish and employ such shores, braces, pumps, etc., as may be necessary for the protection of property, proper completion of the work and the safety of the public and employees of the Contractor and the Department. All bracing, etc., shall be removed when no longer required for the construction or safety of the work.

When a drainage structure is to be eliminated, it shall be completely removed and all pipes plugged with cement masonry or removed completely.

Where the plans or contract documents show that a drainage structure is to be abandoned, the structure shall be removed to a depth 2 feet (600 millimeters) below the subgrade or to the depth shown on the plan.

The floor of the structure shall be broken and all pipes shall be plugged with cement masonry.

Wherever portions of existing concrete pavement that would otherwise remain in place must be removed in conjunction with trench excavation, such removals shall be made to neat lines. The areas in which such concrete pavements are to be removed will be delineated by the Engineer before such work is done. Where no break or joint exist in the concrete pavement at the line of delineation, a full depth cut shall be made in the concrete with a concrete cutting saw approved by the Engineer. The concrete shall then be removed from within the delineated area, exercising extreme care to avoid “breakbacks” beyond the saw-cut or joint. Concrete pavement remaining in place shall have vertical edges.

Wherever the concrete pavement to be removed has been overlaid with bituminous concrete and the adjacent bituminous concrete pavement is to remain in place, the bituminous pavement shall be removed to a neat line that is 1 foot (300 millimeters) beyond the neat line for the concrete pavement removal.

Wherever portions of existing full-depth bituminous concrete pavement are to be removed in conjunction with trench excavation, they shall be removed to neat lines. Where the limits of the areas in which such bituminous pavement is to be removed are adjacent to existing bituminous concrete pavement that is to remain in place, the limits shall be cut by a method approved by the Engineer.

After the excavation is completed, the Contractor shall notify the Engineer; and no masonry, pipe or other material shall be placed in the excavated area until the Engineer has approved the depth of excavation and the character of the foundation material.

When backfilling is required, the material used shall be of a quality satisfactory to the Engineer and shall be free from large or frozen lumps, wood and other extraneous material. All backfill shall be placed in layers of not more than 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted by means of mechanical rammers or vibrators or by pneumatic tampers. Hand tampers shall be used only upon written permission of the Engineer. Unless otherwise ordered by the Engineer, the backfill shall be brought to the surface of the surrounding ground and neatly graded.

All suitable material removed in making the excavation shall be used for backfill if required. All surplus or unsuitable material shall be removed and disposed of as directed. Should additional material be required for backfilling, it may be obtained from the Project excavation or from borrow pits, gravel pits, or elsewhere as the Engineer may direct.

Each layer of backfill shall be compacted to optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Fill placed around pipes shall be deposited on both sides to approximately the same elevation at the same time. Rock fill or stones larger than 2 inches (50 millimeters) shall not be placed closer than 2 feet (600 millimeters) from the pipes on the sides as well as the top.

No backfill shall be placed against any structure until permission shall have been given by the Engineer.

SECTION 2.07 BORROW

2.07.01—Description:

When the amount of usable material excavated within the limits of the work contracted for is not sufficient to form the embankments and other features of the work, additional material shall be furnished by the Contractor from borrow pits obtained by him at his expense and located beyond the limits of the project. This material shall be known as borrow. Borrow shall include the furnishing, removing and satisfactory placing of the additional material necessary to complete the embankments and other features of the work.

Stockpiled hydraulically dredged and/or reclaimed waste material containing no more than 25% of glass or clinker by weight (mass) and no more than 2% by weight (mass) of asphalt cement may be used for part or all borrow requirements. Stockpiles shall be placed at locations arranged for and provided by the Contractor at his expense and will not be allowed within the project limits except at locations and under conditions stipulated by the Engineer. All permits, easements, rights or other requirements related to dredging and stockpiling shall be the obligation and responsibility of the Contractor.

2.07.02—Materials:

Borrow, excluding hydraulically dredged borrow, shall conform to all the requirements of Article 300000-2.02.03 for performance when incorporated in embankments. For purposes other than embankments, it shall be of a satisfactory quality as determined by the Engineer for the purpose intended. Hydraulically dredged borrow shall contain not more than 20% by dry weight (mass) of material passing the No. 200 (75-micron) sieve when placed in the embankment.

2.07.03—Construction Methods:

Borrow will be permitted only to the extent necessary to complete the embankments and similar details and only after all usable material from the excavation has been placed. With the approval of the Engineer, the Contractor may be permitted to place borrow before the excavation is completed; but he will be held responsible for the proper placing of all suitable excavated material. This permission may be revoked by the Engineer at any time if in his opinion satisfactory progress is not maintained on other operations.

The Contractor shall notify the Engineer at least 5 days prior to obtaining material from any borrow pits so that an examination may be made of the fitness of the material. The limits of the proposed borrow pit shall be shown to the Engineer, the Contractor shall be required to clear the area of all unsuitable material. No excavation shall be made within the confines of a borrow pit other than for material to be used in the formation of embankments or elsewhere as shown on the plans or as directed by the Engineer; except that material may be taken for contract work other than borrow with the permission of the Engineer under terms and conditions set forth in writing.

If the Contractor elects to obtain borrow from a commercial pit, it will be necessary for him to have a section of the pit set off for his use solely.

If the Contractor elects to obtain borrow from a stockpile of reclaimed waste, he shall obtain approval from the Engineer prior to removing any material from the stockpile to the job site. Once the stockpiles have been tested and approved, no additional material shall be added to them.

If the Contractor uses hydraulically dredged material, he shall, at his expense, employ effective dust control measures so that the public will not be adversely affected by dust from stockpiled material or such

material in transit. The Contractor shall also provide and maintain at his expense effective and adequate drainage for all dredging and stockpiling operations at all times, and he shall be solely responsible for all damages which result from dredging and stockpiling and for the continuing maintenance and final restoration of all drainage facilities affected by his operations.

Stockpiles of hydraulic material shall be reserved for exclusive use of the State.

Dredging to a stockpile and removing material there from simultaneously is expressly prohibited.

Borrow shall be placed where directed and in accordance with the provisions for the formation of embankments of Article 300000-2.02.03.

SECTION 2.08 FREE-DRAINING MATERIAL

2.08.01—Description:

Free-draining material shall consist of material conforming to the requirements stated elsewhere herein. This material shall be furnished and placed in accordance with these specifications and as indicated on the plans, or as ordered by the Engineer for the stabilization or embankments, or for fill in free water areas, or wherever specified.

2.08.02—Materials:

Material for this work shall meet the requirements of Article M.02.07.

2.08.03—Construction Methods:

The Contractor shall notify the Engineer at least 3 days prior to obtaining free-draining material from any source so that an examination may be made of the material.

The limits of the proposed source shall be shown to the Engineer and the Contractor shall be required to clear the area of all unsuitable material.

The Contractor may, with the approval of the Engineer, obtain free-draining material, if available, from within the roadway excavation limits subject to the provisions of Article 1.04.07.

If the Contractor elects to obtain free-draining material from a commercial pit, it will be necessary for him to have a section of the pit set off for his use solely.

If the Contractor elects to use stone from a quarry or reclaimed miscellaneous aggregate, the Contractor shall use only the materials from stockpiles which have been approved for use.

Free-draining material will be permitted only to the extent necessary to construct embankments to 3 feet (1 meter) above free water, or to promote free drainage in areas specified on the plans, or as directed by the Engineer.

Free-draining material shall be placed in accordance with the provisions for the formation of embankment of Section 300000-2.02.

SECTION 2.09 SUBGRADE

2.09.01—Description:

The area upon which the pavement structure and paved shoulders are placed, including the shoulder base courses and subbase, shall be known as the subgrade. This is the plane coincident with the bottom of the subbase and the edge of pavement, as shown on the plans and cross sections or as ordered by the Engineer. The work of formation of subgrade shall be performed at this plane.

Where precast concrete barrier curb is to be permanently installed, the work of formation of subgrade shall be performed on the area under the precast concrete barrier curb.

Where shoulders are to be reconstructed and the existing subbase is to remain, the work of formation of subgrade shall be performed at the plane coincident with the surface of the existing subbase.

After all grading has been substantially completed and all drains laid, the subgrade shall be brought to the lines, grades and cross-sections shown on the plans.

2.09.03—Construction Methods:

All soft and yielding material and other portions of the subgrade which will not compact readily shall be removed and replaced with suitable material.

In cut areas, the surface shall be uniformly compacted by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 pounds per linear inch (52.5 newtons/millimeter) of contact width and weigh not less than 10 tons (have a mass of not less than 9100 kilograms). Vibratory units shall have a static weight of not less than 4 tons (mass of not less than 3650 kilograms). The amount of compactive effort shall be as directed by the Engineer, but in no case shall be less than four (4) complete passes of the compacting equipment being used.

The dry density after compaction shall be as specified in Subarticle 300000-2.02.03-6.

Where more than one compacting unit is to be used, that unit which exerts the larger compactive effort shall make the initial passes. Any portion of the subgrade not accessible to larger compacting units shall be compacted, as directed by the Engineer, to a degree equal to that obtained on the other portions of the subgrade with equipment and by methods appropriate to the size of the inaccessible area.

After compacting, the subgrade shall be true to required line and grade.

The Contractor shall protect the completed subgrade from damage by exercising such precautions as the Engineer deems necessary. The subgrade surface shall be maintained in such condition as to permit proper drainage. It shall be checked and approved by the Engineer prior to placing any pavement structure and shoulders thereon.

SECTION 2.10 WATER POLLUTION CONTROL (SOIL EROSION)

2.10.01—Description:

This work shall consist of measures to control water pollution and soil erosion through the use of berms, dikes, dams, sediment basins, erosion control matting, gravel, mulches, grasses, slope drains, ditches, channels, riprap, grading to control surface runoff and other erosion control devices or methods.

If the Contractor proposes changes in construction or his scheduling which would affect the designed pollution controls, he shall submit plans before starting construction for revised pollution controls for the approval of the engineer.

The Contractor shall submit a plan showing erosion and sedimentation controls above and beyond those called for in the plans and/or specifications, necessitated by the proposed sequence of operations and/or construction activities. The construction shall not proceed until the erosion and sedimentation control plans have been approved by the Engineer. The Engineer may order additional control measures if the measures mentioned above prove insufficient.

Refer to Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-3(h).

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2.10.02—Materials:

The materials shall conform to the pertinent articles of the Standard Specifications and approved by the Engineer, or other materials approved by the Engineer, such as:

(a) Soil tackifiers, erosion control matting, burlap, and plastic sheets. All materials shall be clean and free from noxious weeds, contaminants, and debris deleterious to plant growth. Erosion control matting shall conform to Sections 300000-9.50 and M.13.

(b) Slope drains or ditches may be constructed of pipe, rubble, riprap, sod, burlap, plastic sheets, portland cement concrete, bituminous concrete, or other material approved by the Engineer.

(c) Seeding shall conform to Sections 300000-9.50 and M.13.

2.10.03—Construction Method:

The Engineer has the authority to control the surface area of earth material exposed by construction operations and to direct the Contractor to immediately provide permanent or temporary pollution control measured to prevent contamination of adjacent streams, watercourses, lakes, ponds or other areas of water impoundment. Every effort shall be made by the Contractor to prevent erosion on the site and abutting property.

All slopes shall be stabilized by mulching, seeding or otherwise protected as the work progresses to comply with the intent of this specification.

All seeding shall include mulch or other protective covering approved by the Engineer.

When hay is used as a mulch with seeding, it shall be a minimum of 2 inches (50 millimeters) deep and held down with a tackifier.

When wood fiber mulch is used, it shall be applied in a water slurry at a rate of 2000 pounds per acre (900 kilograms/4000 square meters) with or immediately after the application of seed, fertilizer and limestone.

All damaged slopes shall be repaired as soon as possible. The Engineer shall limit the surface area of earth material exposed if the Contractor fails to sufficiently protect the slopes to prevent pollution.

The Contractor shall at all times have on hand the necessary materials and equipment to provide for early slope stabilization and corrective measures to damaged slopes.

Temporary channels, ditches and outfalls shall be protected prior to directing water into them to prevent erosion.

The erosion control features installed by the Contractor shall be maintained by the Contractor, and he shall remove such installations if ordered by the Engineer. Maintenance of erosion control measures by the Contractor shall include the clean out of accumulated sediment.

The Contractor shall operate all equipment and perform all construction operations so as to minimize pollution. The Contractor shall cease any of his operations which will increase pollution during rain storms.

The Contractor shall give the Engineer sufficient notice of impending shutdowns to enable the Engineer and Contractor to examine the project and to implement erosion and pollution control work.

SECTION 2.12 SUBBASE

2.12.01—Description:

The subbase shall consist of a clean soil-aggregate mixture of bank or crushed gravel, crusher run stone, reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement or any combinations thereof, placed where shown on the plans or where directed by the Engineer and constructed in accordance with these specifications.

2.12.02—Materials:

All materials for this work shall conform to the requirements of Articles M.02.02 and M.02.06.

2.12.03—Construction Methods:

The prepared foundation for the subbase shall be carefully shaped to the required cross-section and compacted as specified in Article 300000-2.02.03. Where underdrains and outlets are specified on the plans or ordered by the Engineer, they shall be in place and functioning before any subbase material is placed.

The subbase material shall be spread uniformly upon the required grade, in courses not to exceed 6 inches (150 millimeters) in thickness after final compaction. However, if the required thickness of subbase does not exceed 8 inches (200 millimeters), it may be placed in one course.

After each course has been placed as specified above, its entire area shall be compacted with equipment specifically manufactured for that purpose. The sole use of hauling and spreading equipment shall not be considered as a substitute for compacting equipment. Compaction shall be continued until the entire course is uniformly compacted to the required minimum density. The dry density after compaction shall not be less than 95% of the dry density for that subbase material when tested in accordance with AASHTO T-180, Method D. If a subbase course is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this course shall not be less than 95% of the wet density for that subbase when tested in accordance with AASHTO T180, Method D.

Each layer of subbase shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Should the foundation material beneath the subbase become churned up and mixed with subbase material at any time, the Contractor shall, without additional compensation, remove the mixture and replace it with new subbase material to the required thickness shown on the plans or as previously required by the Engineer. Such replaced subbase material shall be compacted to the required minimum density.

SECTION 2.13 GRANULAR FILL

2.13.01—Description:

This material shall be used as a foundation for structures, to replace unstable material in slopes, as a foundation for sidewalks and culverts, in shoulders and elsewhere as indicated on the plans, required by the specifications or ordered by the Engineer. It shall consist of gravel or reclaimed miscellaneous aggregate containing no more than 2% by weight (mass) of asphalt cement conforming to the requirements of these specifications.

2.13.02—Materials:

Granular fill shall conform to the requirements of Article M.02.01

2.13.03—Construction Methods:

When granular fill is used for foundation for structures or to replace rock or unsuitable material in trenches, it shall be deposited in layers not over 6 inches (150 millimeters) in depth, with each layer thoroughly compacted before the addition of other layers.

SECTION 2.14 COMPACTED GRANULAR FILL

2.14.01—Description:

Work shall consist of furnishing and placing compacted granular fill as foundation for structures where shown on the plans or directed by the Engineer.

2.14.02—Materials:

Gravel or reclaimed miscellaneous aggregate shall conform to the requirements of Article M.02.02. Admixtures and surface protective materials used to prevent the gravel from freezing must meet the approval of the Engineer.

2.14.03—Construction Methods:

After all excavation has been completed, gravel or reclaimed miscellaneous aggregate shall be deposited in layers not exceeding 8 inches (200 millimeters) in depth over the areas. In exceptional cases, the Engineer may permit the first layer to be thicker than 8 inches (200 millimeters). Each layer shall be leveled off by the use of blade graders or bulldozers with adequate power for the work involved. The entire area of each layer shall be compacted by use of vibratory, pneumatic-tired or tread-type compaction equipment approved by the Engineer. Compaction shall be continued until the dry density over the entire area of each layer is not less than 95% of the dry density achieved by AASHTO T180, Method D. If a layer is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this layer shall not be less than 95% of the wet density for that compacted granular fill when tested in accordance with AASHTO T180, Method D.

Each layer of compacted granular fill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

In this test, material retained on the 3/4-inch (19-millimeter) sieve shall be replaced with material retained on the No. 4 (4.75-millimeter) sieve, as noted as an option in the specifications for this testing.

The embankment adjacent to the compacted granular fill shall be placed simultaneously with the compacted granular fill, and at no time shall there be a difference of more than 2 feet (600 millimeters) in elevation of the two classes of material. The embankment material to be placed simultaneously with the compacted granular fill shall extend at least 20 feet (6 meters) in every direction beyond the limits of the compacted granular fill, except that where a narrower width is shown on the plans, such narrower width of material shall be placed as prescribed above.

SECTION 2.16 PREVIOUS STRUCTURE BACKFILL

2.16.01—Description:

Pervious structure backfill shall include the furnishing, placing, and compaction of pervious material adjacent to structures.

2.16.02—Materials:

Pervious structure backfill shall conform to the requirements of Article M.02.05.

2.16.03—Construction Methods:

Pervious structure backfill shall be placed adjacent to abutments, retaining walls, box culverts, and elsewhere as called for. It shall be placed above a plane extending on a 2 to 1 slope from the upper edge of the footing to the top of the embankment, or as shown on the plans. Where the face of undisturbed material is above or beneath this slope plane, the amount of pervious structure backfill shall be decreased or increased accordingly, if ordered by the Engineer.

In filling behind abutments, retaining walls, box culverts, or other structures, the fill is placed against undisturbed material, or against compacted embankments having a length in a direction at right angles to the abutment wall or culvert not less than twice the height of the structure against which the fill is placed. The slope of the embankment on which the pervious structure backfill is to be placed shall be plowed deeply or cut into steps before and during the placing of pervious structure backfill so both types of material will be thoroughly bonded and compacted.

Each layer of pervious structure of backfill shall be spread to a thickness not exceeding 6 inches (150 millimeters) in depth after compaction and shall be thoroughly compacted as directed by the engineer by the use of power rollers or other motorized vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes and equipment which is not in proper working order in all respects shall not be used within the area described above.

Special attention shall be given to compaction in places close to walls where motorized vehicular equipment cannot reach. Within 3 feet (1 meter) of the back face of walls and within a greater distance at angle points of walls, each layer of pervious structure backfill shall be compacted by mechanical rammers, vibrators, or pneumatic tampers.

The dry density of each layer of pervious structure backfill formed from broken or crushed stone, broken or crushed gravel or reclaimed miscellaneous aggregate free of bituminous concrete shall have a dry density after compaction that is no less than 100% of the dry density for that material when tested in accordance with AASHTO T180, Method D. If a layer formed from reclaimed miscellaneous aggregate containing bituminous concrete is placed as pervious structure backfill, the wet density of this layer after compaction shall not be less than 100 percent of the wet density for that material when tested in accordance with AASHTO T180, Method D.

In this test, material retained on the 3/4-inch (19-millimeter) sieve shall be replaced with material retained on the No. 4 (4.75-millimeter) sieve, as noted as an option in the specifications for this test.

Each layer of the pervious structure backfill shall be compacted at optimum moisture content. No subsequent layer shall be placed until the specified compaction is obtained for the previous layer.

Where weep holes are installed, bagged stone shall be placed around the inlet end of each weep hole, to prevent movement of the pervious material into the weep hole.

SECTION 2.18 SEDIMENT CONTROL BALES

2.18.01—Description:

This work shall consist of furnishing, placing, maintaining and removing hay bales for sedimentation control as shown on the plans or as directed by the Engineer. Maintaining shall include the clean-out of accumulated sediment.

Refer to Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-3(h).

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2.18.02—Materials:

Bales shall be made of hay with 40 pounds minimum weight (18 kilograms minimum mass) and 120 pounds maximum weight (54 kilograms maximum mass). Wood stakes shall be a minimum of 1 inch x 1 inch (25 millimeters x 25 millimeters) nominal size by a minimum of 3 feet (1.0 meters) long.

2.18.03—Construction Methods:

Bales shall be placed by the Contractor in locations shown on the plans or as directed by the Engineer. They shall be placed lengthwise with ends of adjacent bales tightly abutting one another. All bales shall be installed so that bindings are oriented around the sides, rather than along the tops and bottoms. Bales shall be entrenched 4 inches (100 millimeters) and backfilled, with the backfilled soil placed toward the potential silt source. They shall be held in place by two wooden stakes in each bale, with loose straw inserted in voids between the bales. Bales shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Engineer. Clean out of accumulated sediment shall be accomplished when one-half of the original height of the bales as installed becomes filled with sediment or as directed by the Engineer.

SECTION 2.19 SEDIMENT CONTROL SYSTEMS

2.19.01—Description:

This work shall consist of furnishing, placing, maintaining and removing sedimentation control systems as shown on the plans or as directed by the Engineer. Maintaining shall include the clean out of accumulated sediment.

Refer to Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-3(h).

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

2.19.02—Materials:

Hay bales shall conform to Article 300000-2.18.02. Geotextile shall conform to Section 300000-7.55 and M.08.

2.19.03—Construction Methods:

Sedimentation Control Systems shall be installed by the Contractor in locations shown on the plans or as directed by the Engineer. When hay bales are used they shall be installed as specified in Article 300000-2.18.03. Geotextile sedimentation control systems may consist of either a prefabricated geotextile fence or a geotextile fence assembled by the Contractor in the field. Geotextile sedimentation control systems shall be installed so that the bottom 6 inches (150 millimeters) of the fabric is buried by either trenching or by laying the 6-inch (150-millimeter) section horizontally on the ground and burying by ramping the soil up to the control fence. All geotextile fences shall be at least 30 inches (760 millimeters) in exposed height as installed, with not less than a 2-degree and not more than a 20- degree inclination toward the potential silt source. Hardwood posts shall have a minimum cross-section size of at least 1.5 inches x 1.5 inches (38 millimeters x 38 millimeters) and a minimum length of 42 inches (1.1 meters). Steel posts shall be at least 0.5 pounds per linear foot (0.75 kilograms per meter) with a minimum length of 48 inches (1.2 meters). Spacing between posts shall not exceed 10 feet (3 meters), and all posts shall be driven a minimum of 12 inches (304 millimeters) into the ground. When joints between sections of geotextile sedimentation control systems are necessary, geotextile shall be spliced together only at a support post, with a minimum 6-inch (150-millimeter) overlap, and securely sealed.

The Contractor may use brush as a backing for the geotextile by piling the brush 2 to 3 feet (600 millimeters to 900 millimeters) high and then attaching the geotextile to the brush and burying the bottom 6 inches (150 millimeters) of geotextile as in the previous fence method.

The installations shall be maintained or replaced until they are no longer necessary for the purpose intended or are ordered removed by the Engineer. Clean out of accumulated sediment shall be accomplished when one-half of the original height of the sedimentation control system, as installed, becomes filled with sediment or as ordered by the Engineer.

The geotextile fence systems will be completely removed from the project at the completion of the project, unless specifically authorized by the Engineer to be left in place.

Hay bale systems will be allowed to remain in toe of slope areas unless ordered removed by the Engineer. Unless a specific type of sedimentation control system is indicated on the plans or directed by the Engineer, the type of system will be at the Contractor's option.

SECTION 3.04 PROCESSED AGGREGATE BASE

3.04.01--Description:

The base shall consist of a foundation constructed on the prepared subbase or subgrade in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross-section as shown on the plans.

3.04.02--Materials:

All materials for this work shall conform to the requirements of Article M.05.01.

3.04.03--Construction Methods:

Only one type of coarse aggregate shall be used on a project unless otherwise permitted by the Engineer.

Prior to placing the processed aggregate base, the prepared subbase or subgrade shall be maintained true to line and grade, for a minimum distance of 200 feet (60 meters) in advance of the work. None of the aggregate courses shall be placed more than 500 feet (150 meters) ahead of the compaction and binding operation on that particular course.

The processed aggregate base shall be spread uniformly by a method approved by the Engineer. The thickness of each course shall not be more than 4 inches (100 millimeters) after compaction, unless otherwise ordered.

After the aggregate is spread, it shall be thoroughly compacted and bound by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 pounds per lineal inch (52.5 newtons/millimeter) of contact width and shall have a weight (mass) not less than 10 tons (9100 kilograms). Vibratory units shall have a static weight (mass) of not less than 4 tons (3650 kilograms). Water may be used during the compaction and binding operation and shall be applied from an approved watering device. The compacting and binding operation shall begin at the outside edges, overlapping the shoulders for a distance of not less than 6 inches (150 millimeters) and progress towards the middle, parallel with the centerline of the pavement. The work shall cover the entire surface of the course with uniform overlapping of each preceding track or pass. Areas of super-elevation and special cross slope shall be compacted by beginning at the lowest edge and proceeding towards the higher edge, unless otherwise directed by the Engineer. The compacting and binding operation shall be continued until the voids in the aggregates have been reduced to provide a firm and uniform surface satisfactory to the Engineer. The amount of compactive effort shall in no case shall be less than four (4) complete passes of the compacting and binding operations. All aggregate shall be completely compacted and bound at the end of each day's work or when traffic is to be permitted to operate on the road. The dry density of each layer of processed aggregate base after compaction shall not be less than 95 percent of the dry density for that material when tested in accordance with AASHTO T180, Method D.

Should the subbase or subgrade material become churned up or mixed with the processed aggregate base at any time, the Contractor shall, without additional compensation remove the mixture. The Contractor shall add new subbase material, if required, and reshape and recompact the subbase in accordance with the requirements of Article 300000-2.12.03. New aggregate material shall be added, compacted and bound, as hereinbefore specified, to match the surrounding surface.

Any surface irregularities which develop during, or after work on each course, shall be corrected by loosening material already in place and removing or adding aggregate as required. The entire area, including

the surrounding surface, shall be re-compacted and rebound until it is brought to a firm and uniform surface satisfactory to the Engineer.

SECTION 4.01 CONCRETE PAVEMENT

4.01.01—Description:

This pavement shall consist of Portland cement concrete, with or without reinforcement, in conformity with the lines, grades, thickness, and typical cross section as shown on the plans.

Refer to Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-4(d)9 and 16a-38k-4(d)11.

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

4.01.02—Materials:

The materials for this work shall conform to the requirements for concrete pavement under M.03. Reinforcing steel shall conform to M.06.01.

4.01.03—Construction Methods:

A. Composition: The composition of the concrete shall be in accordance with the requirements of Section M.03 — Portland Cement Concrete, as well as the applicable sections of ACI 211 and ACI 318. The Contractor shall submit all concrete mix designs to the Division of Materials Testing for review and approval prior to production of the design. At the option of the Contractor, other approved cementitious material may be used to replace a portion of the required Portland cement in accordance with the requirements of Section M.03.

Since the yield is theoretical, the Department will not be responsible for any variation in yield as actually obtained on the job. Consistency of the concrete shall be uniformly maintained within the allowable range of slump. The slump shall be measured in accordance with AASHTO Method T119.

The concrete shall be air-entrained and shall contain an air content of 6% ± 1 1/2% at the time the concrete is deposited on the grade. Air entrainment shall be obtained by use of an approved air-entraining admixture added to the concrete at the time of mixing.

The air content of the plastic concrete shall be determined in accordance with AASHTO Method T152, Pressure Method. No alternative method will be accepted.

The temperature of the concrete at the time of placement shall not be less than 60 F (15.5 C) or greater than 90 F (32 C). For pumped concrete, the temperature shall be determined at the placement end of the pump line. The temperature of the concrete shall be determined in accordance with ASTM C1064.

No change in the source or character of the materials shall be made without due notice to the Engineer, and no new material shall be used until the Engineer has accepted such materials and has designated new proportions based upon tests of new trial mixes as provided hereinbefore.

B. Material Storage: Each cementitious material shall be stored in a separate, weatherproof compartment clearly identified.

Sites for aggregate stockpiles shall be reasonably smooth, hard, well-drained areas. Aggregates from different sources and of different gradation shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used.

C. Batching Plant and Equipment: Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. After approval, the Contractor shall maintain all equipment and tools in a satisfactory working condition until the completion of the work.

1. General: The batching plant shall include storage bins, weighing (mass determining) hoppers, scales, and metering equipment as required. A separate scale for cementitious materials shall be used.

2. Scales: Scales for measuring concrete ingredients may be horizontal beam-type, springless scales or electronic devices and shall conform to the applicable requirements of the NIST Handbook 44 except as otherwise specified herein.

Weight (mass)-indicating devices shall be in full view and near enough to be read accurately by the operator while charging the hoppers. The operator shall have convenient access to all controls.

When beam-type scales are used, a "tell-tale" dial shall be provided for indicating to the operator that the required load in the weighing (measuring) hopper is being approached. A device on measuring beams shall indicate critical positions clearly. The dial faces of springless dial scales shall be of a material not affected by moisture. The graduated dial scale shall be provided with the required number of suitable markers in front of the dial face which may be set at the required positions of the indicator for predetermined weights (masses).

Methods for weighing (measuring) (electric, hydraulic, load cells, etc.) other than the methods noted above, which meet the required weighing (measuring) tolerances may be approved by the Engineer.

3. Ten certified standard 50-pound weights (22.7-kilogram masses) shall be available at the batching plant for checking the accuracy of the scales. Weights (masses) shall be certified by the Department of Consumer Protection.

4. The Contractor shall notify the Engineer 2 days in advance that the scales are in proper adjustment and ready to be sealed. The bins shall be filled sufficiently to perform the tests required, and the Contractor shall have available a man skilled in making any adjustments necessary to seal the scales. The Engineer may request that the scales, after checking with a 500-pound weight (227-kilogram mass), be resealed at any time, if in his opinion the scales are out of adjustment. Scales shall be "sealed" at the expense of the Contractor by the "Sealer of Weights and Measures." Scales shall be inspected and sealed at least once every 12 months.

5. Automation: All plants shall be equipped with an approved automatic cycling and monitoring system installed as part of the batching equipment, unless otherwise indicated in the plans or specifications or in the opinion of the Engineer, job conditions warrant otherwise. The system shall include equipment for accurately proportioning the various components of the mixture by weight (mass).

Admixtures and water may be measured volumetrically. The automatic proportioning system shall be capable of consistently delivering each constituent within the tolerances specified.

There shall be auxiliary interlock cutoff circuits to interrupt and stop the automatic batching operations whenever an error exceeding the acceptable tolerance occurs in proportioning for all material components except water. Zero return tolerance shall be equal to that of the delivery tolerances for the minimum batch size.

When the aggregate sizes are weighed (When the masses of the aggregate sizes are taken) cumulatively, the tolerance for each bin draw weight (mass) shall be based on the total aggregate batch weight (mass). If aggregate sizes are weighed (measured) separately, the percentage shall apply to each scale weight (mass). When the other approved cementitious material is weighed (measured) cumulatively with the cement, the other approved cementitious material shall be last in the weighing (measuring) sequence, and the batching delivery tolerance for each material draw weight (mass) shall be based upon the total weight (mass) of cement plus other approved cementitious material.

The electrical circuits used to check delivery tolerances may be set at any span within the full allowable tolerance for any approved batch size. For plants not equipped to automatically adjust tolerances, the tolerance span shall be set for the minimum approved batch size whenever varying batch sizes are being produced.

Batching Delivery Tolerances:
Cementitious materials ± 1% (by weight (mass))
Aggregate ± 2% (by weight (mass))
Water ± 1% (by weight (mass) or volume—applies
at central mix plants only)

Admixtures ± 3% (by weight (mass) or volume—or ± 1 ounce (30 milliliters), whichever is greater)

The automatic proportioning system shall be capable of rapidly selecting and proportioning at least 3 classes of concrete. In addition, the system shall have the capability of batching materials in at least 2 batch sizes. These provisions will not be required for project-site plants batching only 1 class of concrete for a project. The system shall be interlocked during the batching of cement and aggregates so that:

No inlet gate can be opened while the weigh (measuring) hopper discharge gate is open.

No weigh (measuring) hopper discharge gates can be opened

(a) While the hopper is being filled.
(b) Until the full batch weight (mass) is within the delivery tolerance.

No new batch can be measured until the hopper is entirely empty of the previous batch and the scale has returned to "zero."

When the manual batching is permitted, the constituents shall be batched within the indicated delivery tolerances for the automatic proportioning system.

6. Slump Control: Controls shall be provided so that the batch plant operator can produce concrete of the slump required by the paving operation. Included shall be a moisture compensation system, a slumpmeter, and a slump-adjust control. The moisture compensation control can be automatically or manually set for the amount of moisture in the fine aggregate. A moisture compensation system shall compute the adjustment to the water and the fine aggregate components of the concrete to be measured by the automatic batching plant. The actual amounts of each material batched shall be recorded in the manner required elsewhere in these specifications.

7. Batch Recording Instruments: All concrete batching plants shall be equipped with digital or graphical recording instruments approved by the Engineer. The recording instruments shall be designed to record the quantities of each aggregate component, cement, other approved cementitious materials (when used), water (at central mix batch plants), and the presence of admixture for each batch of concrete produced. All records of batches shall show the batch number, the day, the month, the year, and the time of day to the nearest minute for each batch. This information shall be imprinted on the record so that each batch may be permanently identified. The Department shall be provided with a clear and legible copy of all batch records for concrete supplied to the Department.

Cement, other approved cementitious material, and aggregate component weights (masses) shall be recorded separately. Water at central mix plants may be recorded by weight (mass) or volume. When a digital tape or ticket recorder is used, weights (masses) shall be recorded as indicated on the batching scale or meter within an accuracy of ± 1 scale or meter graduation. The minimum resolution of digital recorders shall be equivalent to the minimum graduation on the scale meter, unless otherwise approved by the Engineer.

If graphical recorders or multiple recorders, either digital or graphical, are used, they shall be subject to the approval of the Engineer.

The control system shall include a mixer timer which is interlocked with the mixer discharge control, such that the concrete will be mixed for the approved time.

If any of the above equipment fails to operate satisfactorily, the Engineer shall be notified immediately, and the Engineer will assign an inspector to the plant to monitor plant operation. Only if job conditions warrant, the Engineer may allow concrete to be delivered to the project without an inspector at the plant to monitor plant operation. When the plant is permitted to operate by manual control during periods of automatic equipment failure, a manually written ticket providing all the specified batch information required from the automatic "batch recording instrument" will be required for each batch supplied to the Department.

The plant shall be returned to compliance with these specifications within 2 working days of the equipment failure. After that period, concrete will not be accepted by the Department. No costs will be incurred by the Department for any production loss, or delays due to the enforcement of this requirement.

D. Mixing Equipment:

1. General: Concrete may be mixed at the site of construction or at a central point. Truck-mixed or transit-mixed concrete may be used with the permission of the Engineer for limited amounts of pavement and for other exceptional cases. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

2. Mixers at site of construction or at a central point: Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mixture without segregation.

3. Mixing time: The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (meters), as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

E. Hauling Units:

1. Truck mixers and truck agitators: Truck mixers used for mixing and hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of Article 300000-6.01.03-3, "Transportation and Delivery of Concrete."

2. Nonagitator trucks: Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, non-aluminum metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection.

3. Hauling central mix concrete: Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick stiffening of concrete, the maximum allowable time may be reduced by the Engineer.

4. Addition of water in truck mixers: When mixed concrete is transported in approved truck mixers, water may be added to the concrete at the delivery site, with the permission of the Engineer, to achieve the required slump, provided the specified water-cement ratio for the concrete is not exceeded and the concrete is mixed for at least thirty additional revolutions at mixing speed to ensure thorough mixing of the water into the concrete. Further addition of water to the concrete after the initial slump adjustment will not be permitted.

F. Placing Concrete: All forms, slip form pavers, and other equipment used in the placing, curing, and finishing of concrete shall be of a design acceptable to the Engineer.

1. Forms: Forms shall be set by the Contractor to true line and grade.

The specified grade shall be set and compacted prior to the setting of forms. Conditioning of Subgrade or Base Course: The subgrade or base course shall be brought to proper cross section. High areas shall be trimmed to proper elevation. Low areas shall be filled and compacted to a condition similar to that of surrounding grade. The finished grades shall be maintained in a smooth and compacted condition until the pavement is placed.

2. Slip Form Paving: When slip form paving, the subgrade, or the surface of the subbase over which the tracks of the slip form paver will travel shall not vary more than ± 3/16 inch (+5 millimeters) from the grade established by the Engineer.

Except when the Contractor elects to place reinforcement in a two-layer procedure, the slip form paving equipment shall spread, consolidate, screed and float finish the freshly placed concrete in 1 pass in a manner such that a minimum of hand floating will be required. The operations of depositing, spreading, consolidating and finishing shall be such that, insofar as possible, continuous operation of the paver will be maintained. Frequent starting and stopping of the paver should be kept to a minimum.

3. Placement: Where concrete is to be placed adjoining a previously constructed pavement, and hauling units and mechanical equipment will be operated upon that previously constructed pavement, that pavement shall have attained the strength specified for opening the pavement to vehicular traffic. If only finishing equipment is carried on the existing pavement, paving in adjoining lanes may be permitted after the concrete is tested in accordance with Article 300000-4.01.03(I) and has attained a modulus of rupture of 400 psi (2800 kilopascals).

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

Concrete shall be deposited as close to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket or hopper on to a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete.

4. Placing Reinforcement: If mechanical means are used to place pavement reinforcement and/or pavement fabric, the mechanical placement equipment shall be capable of positioning the reinforcement or fabric within the tolerances specified.

When reinforced concrete pavement is placed in 2 layers, the entire width of the bottom layer shall be struck off and consolidated to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded.

Any portion of the bottom layer of concrete which has been placed more than 45 minutes without being covered with a top layer shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in 1 layer, the reinforcement may be positioned in advance of concrete placement or it may be laced in plastic concrete after spreading, by mechanical or vibratory means.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust, which could impair bond of the steel with the concrete.

5. Finishing:

(a) Sequence: The sequence of operations shall be the strike-off and consolidation floating and removal of laitance, and final surface finish. Work bridges or other devices necessary to provide access to the pavement surface for the purpose of finishing, straight-edging, and making corrections as hereinafter specified, shall be provided by the Contractor.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surfaces is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(b) Finishing at Joints: The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material, under and around all load transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated.

(c) Hand Finishing: Unless otherwise specified, hand finishing methods will not be permitted except under the following conditions:

i. In the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade when the breakdown occurs.

ii. Narrow widths or areas of irregular dimensions where operations of the mechanical equipment is impractical may be finished by hand methods.

Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used.

A second screed shall be provided for striking off the bottom layer of concrete if reinforcement is used.

(d) Floating: After the concrete has been struck off and consolidated it shall be further smoothed, trued, and consolidated by means of a float.

(e) Final Finish: When all irregularities have been removed, and the edges of the slabs and joints given their initial edging, the pavement shall be subjected to the following 2-stage texturing treatment:

i. Dragging with Burlap: The burlap shall be at least 3 feet (1.0 meter) wide and a length of 2 feet (0.6 meter) greater than the width of the lane or lanes being placed. The burlap shall not have frayed edges and shall be kept wet and clean of accumulations of dried concrete particles or other foreign materials, which might leave distinctive undesirable marks. The burlap shall be drawn longitudinally along the surface in a slow manner so as to have an even texture. When not in use, the burlap shall not be allowed to rest on the pavement.

ii. Texturing with Tines: As soon as possible, after the pavement surface has been dragged with the burlap, mechanical equipment shall be used to texture the surface with deep transverse grooves.

The equipment shall consist of a self-propelled device capable of applying a textured finish transverse to the centerline of the pavement. The texturing shall be done with tines 0.03 inch (0.75 millimeter) thick, 0.08 inch (2.0 millimeters) wide, and 4 to 6 inches (100.0 millimeters to 150.0 millimeters) in length with an average spacing of 1/2 inch (12.0 millimeters) on centers.

The transverse grooving shall be performed when the condition of the concrete is optimum. This condition will prevail when the grooves can be formed to a depth of 1/8 inch (3.2 millimeters) to 1/4 inch (6.4 millimeters) with relative ease and without the walls of the grooves closing back in on each other. Other adjustments to the tining procedure may be permitted by the engineer to obtain grooves of the proper width and depth.

The tined grooving shall extend from edge to edge of the pavement, and shall be perpendicular to the centerline of the pavement. The tining mechanism shall be aligned so as to prevent overlapping of grooves in

any two successive passes. The depth of the grooves formed in the surface by the tines shall be checked randomly with a tire tread depth-measuring gage furnished by the Contractor to ensure compliance with the required limits of 1/8 inch to 1/4 inch (3.2 millimeters to 6.4 millimeters). The original surface of the concrete shall serve as the datum for the depth measurements.

(f) Edging at Forms and Joints: After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, formed joints, transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to the radius required by the plans.

A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straight edge before the concrete has set, and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

6. Joints: Joints shall be constructed of the type and dimensions, and at the locations required by the plans or specifications. All joints shall be protected from the intrusion of injurious foreign material until sealed.

(a) Longitudinal Joint: Deformed steel tie bars of specified length, size, spacing and material shall be placed perpendicular to the longitudinal joints; they shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement. Tie bars shall be coated with epoxy conforming to AASHTO M284. When shown on the plans and when adjacent lanes of pavement are constructed, steel side forms shall be used which will form a keyway along the construction joint. Tie bars may be bent at right angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is placed, or in lieu of bent tie bars, approved two-piece connectors may be used.

Longitudinal formed joints shall consist of a groove or cleft, extending downward from, and normal to, the surface of the pavement. These joints shall be effected or formed by an approved mechanically or manually operated device to the dimensions and line indicated on the plans and while the concrete is in a plastic state. The groove, or cleft, shall be filled with either a pre-molded strip or poured material.

The longitudinal joint, however formed, shall be continuous. There shall be no gaps in either transverse or longitudinal joints at the intersection of the joints.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width and line shown on the plans. Suitable guidelines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. The longitudinal joint shall be sawed within 36 hours of placement and before any other equipment or vehicles are allowed on the pavement. The sawed area shall be thoroughly cleaned and the joint shall immediately be filled with sealer.

(b) Transverse Expansion Joints: The expansion joint fillers shall be continuous from edge to edge, shaped to the subbase and to the keyway along the edge. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved by the Engineer.

The expansion joint filler shall be held in a vertical position. An approved installing bar, or other device shall be used if required to secure preformed expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall not deviate more than 1/4 inch (6.4 millimeters) in the horizontal alignment from a straight line. If joint fillers are assembled in sections, there shall be no offsets between adjacent units. No plugs of concrete shall be permitted anywhere within the expansion space.

(c) Transverse Contraction Joints: Transverse con-traction joints shall consist of planes and of weakness created by forming or cutting grooves in the surface of the pavement and, when shown on the plans, shall include transfer assemblies.

i. Formed grooves shall be made by depressing an approved tool or device into the plastic concrete. The tool or device shall remain in place until the concrete has attained its initial set and shall then be removed without disturbing the adjacent concrete, unless the device is designed to remain in the joint.

ii. Sawed contraction joints shall be created by sawing grooves in the surface of the pavements of the dimensions and at the spacing and lines shown on the plans with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. All joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence. If extreme conditions exist, which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed prior to initial set of concrete as provided above. The Engineer will review and approve procedures and methods to correct random cracking.

iii. Transverse formed contraction joints shall comply with the requirements for the longitudinal formed joint.

(d) Transverse Construction Joints: Transverse construction joints shall be constructed when there is an interruption of more than 30 minutes in the concreting operations. No transverse joint shall be constructed within 10 feet (3.0 meters) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10 feet (3.0 meters) long, the excess concrete back to the last preceding joint shall be removed and disposed of as directed.

(e) Load Transfer Devices: Load transfer devices shall conform to the requirement of Subarticle M.03.08.

(f) Sealing Joints: Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including the Contractor's equipment. Just prior to sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound and the joint-faces shall be clean and surface dry when the seal is applied.

The sealing material shall be applied to each joint opening to conform to the details shown on the plans or as directed by the Engineer. Material for seal applied hot shall be stirred during heating so that localized overheating does not occur. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. The use of sand or similar material as a cover for the seal will not be permitted. Poured joint-sealing material shall not be placed when the air temperature in the shade is less than 50oF (10°C), unless approved by the Engineer.

Preformed elastomeric gaskets for sealing joints shall be of the cross sectional dimensions shown on the plans. Seals shall be installed by suitable tools, without elongation, and secured in place with an approved lubricant adhesive which shall cover both sides of the concrete joints. The seals shall be installed in a compressed condition and shall at time of placement be below the level of the pavement surface by approximately 1/4 inch (6.4 millimeters). The seals shall be in one piece for the full width of each transverse joint.

7. Curing: Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the methods below. Liquid Membrane - Forming Cure is the preferred method of curing. Moist curing and cover sheet curing must be approved by the Engineer prior to paving operations.

In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 30 minutes between stages of curing or during the curing period.

When concrete is being placed and the air temperature may be expected to drop below 35oF (2°C) a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the work and any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. During the period of time such protection, the Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

(a) Liquid Membrane-Forming Cure: The liquid curing compound shall conform to Subarticle M.03.04-3. When resin-based curing compound is used, it shall be applied following the final finishing immediately after the disappearance of the water sheen and before any surface checking or marked dehydration of the concrete occurs.

When water-soluble, linseed oil-based compound is used, it shall be applied immediately following the final finishing.

The compound shall be applied by an approved self-propelled mechanical pressured sprayer delivering a fine, even spray with uniform coverage. This equipment shall be provided with a suitable device for adequate agitation of the compound to prevent settlement. For the sides of concrete pavement exposed after removal of the forms and for areas where the use of self-propelled equipment is not practical, approved hand-held spray bars delivering a fine, even spray may be used; and the compound shall be drawn from a tank equipped with an approved device to prevent settlement or by a method which will prevent settlement.

If the compound is applied in two applications, the second application shall follow the first application within 30 minutes. The compound shall be applied in a continuous, uniform film at not less than one gallon for 150 square feet (one liter for 3.7 square meters).

If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of material to the affected areas equal in curing value to that specified for the original coat. The treated surface shall be protected by the Contractor from injury for a period of at least 7 days. All traffic, either foot or otherwise, will be considered as injurious to the film of the applied compound.

The Contractor shall have on the project sufficient approved cover sheet or cotton mats for the protection of the pavement in case of rain or breakdown of the spray equipment. The cotton mats shall be maintained in a wet condition during the period of use, as elsewhere herein specified.

Transverse joints shall be protected from the compound by means or methods approved by the Engineer.

(b) Moist Curing: After the surface of the concrete has been given its final finish, it shall be protected by covering it with moist mats of the size and quality specified in Article M.03.04-2. These mats shall be laid longitudinally over the surface of the finished pavement by unrolling from the supported roll so as not to bring an excessive weight (mass) upon or to mar the new surface of the pavement. After placing, these mats shall be saturated and kept saturated for a period of 7 days, at the end of which time they may be removed, and no further wetting or artificial curing will be required.

(c) Cover Sheet Curing: As soon as practicable after the finishing operations, paper or polyethylene cover sheets conforming to Article M.03.04-4. shall be placed in such a manner that the surface of the concrete shall not be marred. The adjoining covers shall overlap at least 18 inches (500 meters), and the lap shall be securely fastened down to form a closed joint. On removal of the forms, the edges shall be covered down to the bottom of the pavement. The cover sheets shall remain in place for a period of 7 days. In the event that hair-checking develops before the cover can be placed, the procedure set forth shall be modified at the direction of the Engineer. Moist curing mats shall then be used for the initial 24 hours of the curing period, and the cover sheets placed for the remainder of the curing period.

Before reusing paper or polyethylene covers, they shall be checked for holes or tears, and any such perforations shall be repaired. Covers which have become unserviceable will be rejected by the Engineer.

G. Protection of Pavement: The Contractor shall protect the pavement and its appurtenances against public traffic and traffic caused by his own employees and agents until the pavement is opened to traffic.

Any damage to the pavement occurring prior to the opening of the pavement to traffic by the State shall be repaired or the pavement replaced.

H. Riding Surface Tests:

1. Surface Test (Straightedge) and Corrections: As soon as the concrete has hardened sufficiently, the pavement surface shall be tested by the Contractor with an approved 10-foot (3-meter) straightedge placed both transversely and longitudinally to the centerline at sufficient intervals to check the surface profile. Areas showing high spots of more than 1/8 inch (3.2 millimeters), exclusive of tining corrugations, shall be marked by the Engineer and removed by the Contractor to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch (3.2 millimeters) when tested with a 10-foot (3-meter) straightedge. Correction of surface irregularities and resulting surface finish shall conform to the requirements specified herein for mainline pavement.

I. Flexural Testing of Concrete: The flexural strength of the concrete pavement shall be monitored by the evaluation of compressive strength cylinders. The compressive strength specimens shall be cast and cured in the field in accordance with ASTM C 31 (AASHTO T 23). After proper curing, these cylinders shall be transported to the Division of Materials Testing for strength evaluation.

J. Opening to Traffic: Vehicular traffic shall be excluded from the pavement until sufficient curing has taken place. The pavement shall be opened to traffic with the attainment of a compressive strength of 3,500 psi (25 megapascals).

Any damage to the pavement from traffic or any other causes, occurring prior to acceptance of this contract, shall be repaired by the Contractor at his own expense.

If the Contractor wants to increase the early strength of the pavement in order to facilitate his plan for the paving sequence, he may substitute TYPE III Portland Cement, or use a concrete with a higher cement factor. The mix design for this concrete must be approved by the Engineer.

SECTION 5.06 RETAINING WALLS, ENDWALLS AND STEPS

5.06.01—Description:

Under this heading shall be included all concrete and masonry retaining walls, endwalls, steps and other miscellaneous structures. All such structures shall be built in the locations indicated or directed, conforming to the lines, grades, dimensions and details shown on the plans and in accordance with the provisions of these specifications for the various elements which constitute the completed structure.

Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-4(d)9 and 16a-38k-4(d)11.

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

5.06.02—Materials:

The materials furnished and used in the work shall be those prescribed herein which constitute the completed structure.

Unless otherwise noted, concrete shall be Class "F" Concrete conforming to Article M.03.01, except that the concrete for steps and copings shall be Class "C" Concrete conforming to Article M.03.01.

The concrete shall be air-entrained and shall contain an air content of 6% ± 1 1/2% at the time the concrete is deposited. Air entrainment shall be obtained by use of an approved air-entraining admixture added to the concrete at the time of mixing.

5.06.03—Construction Methods:

All construction methods for endwalls, retaining walls, steps and other miscellaneous structures shall be in accordance with the detailed requirements prescribed for the construction. All requirements relative to concrete structures that are pertinent shall apply equally to work covered by this section.

1. Foundations shall be excavated to the depth shown on the plans, unless the character of the material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Should suitable material not be encountered at depths to which it is practicable to excavate, piles shall be driven or other special treatment employed as the Engineer may direct. Piles shall be driven in conformity with the requirements of the plans and shall be either vertical or battered, as the Engineer may require. Special treatment of foundations shall conform to the requirements of the plans; or if not specified therein, shall be as directed by the Engineer and may be classed as extra work or additional work. No construction material shall be placed in any foundation until the Engineer has examined the material encountered and approved its character and the depth of the excavation.

2. Endwalls shall be built in the location and to the dimensions and details shown on the plans; or as ordered, and they shall be neatly and accurately finished, true to the lines and grades given. Pipes shall be of sufficient length to extend to the exposed face of the endwall, and the end shall be finished to provide neat, watertight joints. The ends of pipe culverts which enter endwalls on a skew shall be cut to the angle of the skew; or the short side of the pipe may be built out with adequate forms, if this method is approved by the Engineer.

3. Retaining Walls shall be built in the location and to the dimensions and details shown on the plans or as ordered. Drainage of retained material shall be provided as specified in Section 300000-2.16 and as shown on the plans.

4. Steps shall be built where indicated or directed to the dimensions and details shown on the plans or as ordered and in accordance with the requirements of these specifications.

SECTION 5.07 CATCH BASINS, MANHOLES AND DROP INLETS

5.07.01—Description:

Under this heading shall be included the construction of all catch basins, junction boxes, manholes and drop inlets (and also the alteration, reconstruction or conversion of such existing structures) all in conformity with the lines, grades, dimensions and details shown on the plans, or as ordered, and in accordance with the provisions of these specifications for the various materials and work which constitute the completed structure.

When it becomes necessary to increase the horizontal dimensions of manholes, catch basins, junction boxes and drop inlets to sizes greater than those shown on the plans in order to provide for multiple pipe installations or large pipes or for other reasons, the Contractor shall construct such manholes, catch basins and drop inlets to modified dimensions as directed by the Engineer.

5.07.02—Materials:

The materials to be used in the construction shall be those indicated on the plans or ordered by the Engineer and shall conform to Article M.08.02. Protective compound material shall conform to Subarticle M.03.01-11. Galvanizing shall conform to Article M.06.03.

Mortar shall conform to Article M.11.04.

Pervious material shall conform to Article M.02.05.

Geotextile shall be of a type appearing on the Department's Approved Products List for Geotextiles, referred to in Subarticle M.08.01-19 Geotextiles.

5.07.03—Construction Methods:

These structures shall be constructed in accordance with the requirements contained herein for the character of work involved. The provisions of Article 300000-6.02.03 pertaining to bar reinforcement shall apply except that shop drawings need not be submitted for approval, unless called for on the plans or directed by the Engineer. Welding shall be performed in accordance with the applicable sections of the AWS Structural Welding Code, D1.1.

The surfaces of the tops of all catch basins, junction boxes and drop inlets shall be given a coat of protective compound material immediately upon completion of the concrete curing period at the rate of .04 gallons per square yard (0.2 liter per square meter).

All masonry units shall be laid in full mortar beds.

Metal fittings for catch basins, junction boxes, manholes or drop inlets shall be set in full mortar beds or otherwise secured as shown on the plans.

Inlet and outlet pipes shall extend through the walls for a sufficient distance beyond the outside surface to allow for satisfactory connections, and the concrete or masonry shall be constructed around them neatly to prevent leakage along their outer surfaces. The pipe shall be cut flush with the inside face of the wall, or as shown on the plans.

When constructing a new drainage structure within a run of existing pipe, the section of existing pipe disturbed by the construction shall be replaced with new pipe of identical type and size extending from the drainage structure to the nearest joint of the existing pipe.

Pervious material shall be used for backfilling the upper portion of the excavation made for catch basins and drop inlets down to the elevation of the invert of the outlet pipe but in no case to a depth greater than 3 feet (1 meter) below the top of the structure. Drainage openings shall be formed in the four walls of the structure at or immediately above the bottom of the pervious backfill to convey subsurface drainage. The openings shall be covered with geotextile. Depending on the masonry used in the walls, such openings shall be formed by the insertion of 2-inch (50-millimeter) pipes, omission of a header brick or by leaving two open vertical joints in the masonry.

Frames, covers and tops which are to be reset shall be removed from their present beds, the walls or sides shall be rebuilt to conform to the requirements of the new construction and the tops, frames and covers reset, or the grates or covers may be raised by extensions of suitable height approved by the Engineer.

Extensions shall not be used on catch basins or drop inlets at pavement low points or where adjacent curbing is being raised. Extensions for catch basins or drop inlets shall be tack welded to the frame in four locations approximately at the mid points of each side of the frame. If the frames, covers or tops are broken or so damaged as to be unfit for further use, they shall be replaced with new, sound material conforming to the above requirements for the material involved.

SECTION 6.01 CONCRETE FOR STRUCTURES

6.01.01—Description:

Work shall include concrete for use in bridges and culverts, walls, retaining walls, catch basins, drop inlets and other miscellaneous construction as required. See division 03 for all concrete pertaining to the building structure. The concrete shall be composed of Portland cement, fine and coarse aggregate, admixtures if ordered, and water, prepared and constructed in accordance with these specifications, at the locations and of the form dimensions and class shown on the plans, or as directed by the Engineer.

The concrete shall be of three classes, Class "A," "C" and "F". The class to be used shall be as shown on the plans or designated herein, or as directed.

The use of truck-mixed or transit-mixed concrete is permitted for all Class "A," "C" and "F" concrete.

6.01.02—Materials:

The materials for this work shall conform to the requirements of Article M.03.01.

Material for stay-in-place metal forms shall be made of zinc-coated (galvanized) steel sheet conforming to ASTM Specification A653, Structural Steel (SS) Grade 33 through 80 (ASTM Specification A653M, Structural Steel (SS) Grade 250 through 550). The minimum gauge thickness shall be 20 gauge. Coating weight shall conform to ASTM A924, Class G235 (ASTM A924M, Class Z700) and shall otherwise meet all requirements relevant to steel stay-in-place metal forms and the placing of concrete as specified herein and as noted on the contract drawings.

Material for the form supports shall be fabricated from the same material and conform to the same material requirements as the forms themselves or they shall be fabricated from structural steel conforming to the requirements of ASTM A36 (ASTM A36M) which shall be hot-dip galvanized in accordance with ASTM A123 (ASTM A123M).

Lightweight filler material shall be as recommended by the form’s manufacturer.

6.01.03—Construction Methods:

1(a) Equipment: All equipment and tools used in the handling of materials, trucks used for transporting the batched material, the batching equipment, and concrete mixers used for the mixing of concrete shall comply with the requirements of Article 300000-4.01.03. When permitted by the Engineer, mixers of the batch type design with a minimum rated capacity of a 2-bag batch, may be used.

(b) Truck Mixed and Transit Mixed Concrete:

Definitions: Truck mixed concrete shall be construed to mean concrete mixed completely in a truck mixer after its arrival at the point of placement. Transit mixed concrete shall be construed to mean concrete mixed completely in a truck mixer while en route to the point of placement.

General Requirements: The location and capacity of the batch plant and complement of truck mixers for truck or transit mixed concrete shall be adequate for continuous placement of concrete in the forms. If in the opinion of the Engineer, undue delay in deliveries do occur, and concrete already in place takes initial set, all such material in place may be rejected.

The batch plant, truck mixers and related equipment will be inspected by the Engineer; and these, as well as all methods of operation related thereto, shall be approved before the concrete is batched.

The concrete shall be discharged within one and one-half hours from the time the dry aggregates are loaded into the truck mixer; otherwise the concrete shall be disposed of by the Contractor at his expense.

With each delivery of concrete, the Contractor shall furnish a ticket indicating the proportionment of the batch and stamped by an approved time clock indicating the time the batch is placed in the truck mixer.

This ticket shall be presented to the Engineer or his authorized representative before discharge of the concrete will be permitted.

After each time the drum of any mobile mixer is washed, the Contractor shall, at his own expense, add one-half cubic foot (0.02 cubic meter) mixture of sand and cement for each cubic yard (cubic meter) of concrete being placed in the drum of the mixer. The same proportions as specified for the concrete shall be used, and the mixture shall be introduced immediately before or at the time of batching.

Truck Mixers: The capacity of truck mixers shall be in accordance with the manufacturer's ratings, except that the maximum permissible capacities, expressed as percentages of the total volume of the drum or container, shall not exceed 63.25%.

Each truck mixer shall have an attached metal standard rating plate on which are stated the capacities, in terms of volume, of mixed concrete, for the various uses applicable to the equipment. When the manufacturer's ratings of capacity are less than the limit indicated above, the manufacturer's ratings shall govern.

Further, truck mixers shall be equipped with a suitable means by which the number of revolutions of the drum or blades may be readily verified.

Truck mixers shall be of standard type, size and manufacture and shall be either of the horizontal axis revolving-drum type, the inclined axis revolving-drum type, or the open-top revolving blade or paddle type.

Truck mixers must be inspected and approved by the Engineer.

Loading, Water and Transportation: The mix shall be in the proportions required for the work and placed in the drum of the mixer. Water shall be added to the mix, and the mixing conditions shall be in accordance with one of the following methods:

Truck-Mixed Concrete: Water shall be introduced into the mixing drum only after arrival at a level area on the site where the concrete is to be placed and under the supervision of the Engineer. The water shall be measured accurately by volume or mass by an approved adjustable measuring device which shall measure the required quantity under all operating conditions within a tolerance of 1 quart (1 liter) or 1%, whichever is greater. The device shall be such that the flow of water shall be stopped automatically when the required quantity has been delivered. The mixer shall be equipped with an approved device which shall record the number of revolutions of the drum or blades during mixing. The mixing procedures shall be carried out at the site as hereinafter specified.

Transit-Mixed Concrete: Water shall be introduced into the mixing drum while the mixer is at the batch plant. The water shall be measured and controlled as specified above. The mixing procedure shall be carried out during transportation as hereinafter specified. Each truck mixer shall be equipped with a readily visible device that will record accurately the number of revolutions of the drum or blades at mixing speed

from the moment of batching. This equipment shall be set into operation only at the batch plant by the inspector and shall be so constructed as to show evidence of any tampering or misoperation.

Any one of the following shall be sufficient cause for the rejection of any load of truck-mixed or transitmixed concrete: when the elapsed time exceeds that which is permitted, when the mixing revolutions exceed 100, when the recording device has been tampered with or misoperated after the batching, when, at the time of placing, the air content or slump are not within specified ranges, when there is evidence of segregation or when initial set has taken place.

Mixing Procedure and Delivery: When the truck mixer is loaded in excess of 50% of the gross volume of the drum or container, the mixing period shall consist of not less than 60 revolutions of the drum or blades at mixing speed, after the water is added; if loaded to not more than 50%, the mixing period shall consist of not less than 40 revolutions of the drum or blades at mixing speed.

For the revolving drum type mixers the mixing speed shall be not less than 4 revolutions per minute of the drum nor greater than a speed which will produce a peripheral velocity of the drum of 225 feet per minute (1.14 meters per second). For the revolving blade type mixers the mixing speed shall be not less than 4, nor more than 16, revolutions per minute of the mixing blades.

Agitating speed for both the revolving drum and revolving blade type of mixers shall be not less than 2, nor more than 6, revolutions per minute of the drum or the blades.

In no case shall mixing exceed 100 revolutions at mixing speed. Mixing beyond 100 revolutions shall be done at agitating speed.

In discharging truck mixers, the direction of rotation of drum or blades shall be manipulated so as to avoid segregation.

Slump: When the slump does not meet the specification requirements, modification of the concrete mix may be permitted if, in the opinion of the Engineer, no harmful effect upon the structural qualities or appearance of the concrete will result. If permitted by the Engineer, modifications shall be limited to the addition of not more than 50 pounds (30 kilograms) of Portland cement per cubic yard (cubic meter) of concrete to decrease the slump or to the addition of water to increase the slump. The amount of water or cement added shall be further limited to the minimum needed to meet slump requirements. The cost of additional material and the work connected with each modification shall be borne by the Contractor. The addition of cement or water, or both, for the purpose of re-tempering concrete will not be permitted.

(c) Vibrators: Not less than two vibrating units, including source of power, shall be available on the work and shall be of the mechanical immersion type, in good operating condition at each pouring of concrete in order to insure satisfactory and uninterrupted vibration during placing. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4,500 impulses per minute. Vibrators shall be used only when directed by the Engineer.

(d) Trucking Equipment: Trucks used for the transporting of the batched material from the batcher plant to the mixer shall conform to the requirements of Subarticle 300000-4.01.03-E.

2. Falsework and Centering: All falsework and centering required shall be adequate for the type of construction involved. Details of this construction shall be proposed by the Contractor and unless otherwise authorized shall be submitted to the Engineer for his information before construction is started. Approval of the plans or methods proposed for such construction shall not serve to relieve the Contractor of any of his responsibility for the successful completion of the project.

Suitable provision shall be made to secure the permanent camber required in the superstructure, and means of adjustment shall be provided so as to correct any possible settlement or deflection during construction. The method of adjustment shall be such as to permit the gradual lowering of the falsework or centering when these are to be removed. Falsework and centering shall remain in place for a period as

stated in Subarticle 300000-6.01.03-20. No falsework or centering shall be removed without the permission of the Engineer.

3. Forms: Forms shall be built true to lines and grades designated, shall be strong, stable, firm, mortartight and adequately braced or tied, or both. They shall be designed and constructed to withstand all loads and pressures including those imposed by plastic concrete, taking full account of the stresses due to the rate of pour, effect of vibration and conditions brought about by construction methods. Where necessary, forms shall be constructed to compensate for variations in camber of supporting members and allow for deflections.

Internal voids may be formed by the use of heavy paper or fiber forms especially made for this purpose, or with an alternate acceptable to the Engineer. These forms must be of substantial construction and adequately waterproofed in order to maintain their shape during the entire construction cycle. The end caps shall also be of similar construction. These forms shall be held in place against uplift or lateral displacement during the pouring and vibrating of the concrete by substantial wire ties or other satisfactory means. Before incorporating the forms in the work, a sample 4 feet (1 meter) in length with end caps shall be furnished the Engineer for approval. These forms shall not be incorporated in the work until the Engineer has approved the sample submitted.

If requested, form work plans shall be submitted to the Engineer by the Contractor before form work is started. The furnishing of such plans, however, shall not serve to relieve the Contractor of any of his responsibility for the successful completion of the work.

Forms shall be filleted at all sharp corners, unless otherwise ordered or permitted, and shall be given a slight bevel or draft in the case of projections to insure satisfactory removal.

Materials for forms and their supports, ties and bracing, shall be of the type, quality and strength to achieve the foregoing requirements without impairment to the structural qualities or appearance of the concrete structure. Form material in contact with concrete shall be of a quality to provide the hereinafter required concrete surface smoothness; and, unless otherwise authorized, the contact surface shall be oiled with a light, clear paraffin base oil which will not damage, discolor or adhere to the concrete; or, as an alternate, the form may be lined with an approved composition form lining.

Materials and workmanship for forms for concrete to remain exposed in the finished work shall be such as to provide a smooth concrete surface of good appearance and texture, free of voids, indentations, protrusions or bulges and within tolerances consistent with good trade practices. If panels are used, they shall be evenly placed in columns or rows if their positioning is to be visible after the concrete is finished.

These same requirements shall apply to forms for concrete not to remain exposed in the finished work except that minor irregularities where form boards or panels join and variations in form pattern will be acceptable.

Metal ties and anchors to hold the forms in alignment and location shall be so constructed that the metal work can be removed to a depth of at least 2 inches (50 millimeters) from the concrete surface without damage to the concrete. All cavities resulting from the removal of metal ties shall be filled with cement mortar of the same proportions used in the body of the work and the surface finished smooth and even,

and if exposed in the finished work, shall conform to the texture and color of adjacent surfaces. With permission of the Engineer, the Contractor need not remove from the underneath side of bridge decks portions of metal devices used to support reinforcing steel providing such devices are of material, or are adequately coated with material, that will not rust or corrode.

Date of Completion: The year in which each structure is completed shall be shown in at least two places on each concrete superstructure unless otherwise ordered by the Engineer. Usually the date shall be placed in diagonally opposite ends of the bridge parapets adjacent to traffic. The numerals will be furnished by the Contractor. They shall be carefully set by the Contractor; and their subsequent removal after the concrete is placed and the finishing shall be carefully done so that the impression of the numerals in the concrete is clear and sharp, with no broken edges or other imperfections.

Ornament or Reverse Moulds: Ornamental work, when so noted on the plans, shall be formed by the use of reverse moulds. These moulds shall be produced by a qualified manufacturer approved by the Engineer. They shall be carefully built by the most approved modern methods and in accordance with the general dimensions shown on the plans. Additional details necessary to construct the moulds shall be worked out by the manufacturer and shall be such as to produce ornaments having the appearance indicated on the plans. The manufacturer shall prepare all detailed drawings that he may require for his guidance, and all such drawings as well as all models or carvings that he may prepare shall be approved by the Engineer before the moulds are made.

Moulds shall be carefully handled, shipped and stored so as to prevent all damage to the ornaments. They shall be delivered at the site of the work completely assembled and of the required size and shape in order to facilitate their proper placing. The Contractor shall be responsible for their condition at all times, and he will be required to remove and replace any damaged or defective moulds at his own expense.

The moulds shall be fitted into the surrounding form work so that they will act as a substitute for the ordinary forms which would be required in the area.

The surfaces of the moulds shall be given a coating of grease or lubricant to prevent the adherence of concrete. Any material which will adhere to or discolor the concrete shall not be used.

Utility Installations: On any structure where it becomes necessary to install any public utility, i.e., telephone, electric light or power conduits; gas, water or sewer pipes; pneumatic, oil or any other lines, the utilities concerned will furnish, delivered at the site, all material necessary for such installation.

Unless specifically otherwise ordered, the Contractor shall erect or install such equipment or material as shown on the plans; or if not shown thereon, he shall comply with the Engineer's instructions.

Whether or not the presence of any public utilities is mentioned on the plans, the Contractor shall, by any means at his disposal, apprise himself of the location of any and all of them. He shall use every effort to protect them from damage of any nature whatsoever, which might result from carelessness or negligence in any of his operations. He shall be held solely and strictly responsible for any damage resulting from such negligence or carelessness.

In cases where any utilities are to be installed on, under or within the construction limits of any structure—and the Contractor does not participate actively in the work—he shall arrange his operations as to cause no inconveniences or interruption to the progress of such installation. The Contractor shall extend his fullest cooperation to the construction forces of any utility company which may be operating within the limits of the contract.

Stay-in-Place Metal Form System: Stay-in-place metal forms shall have a minimum depth of form valley equal to two inches (50 millimeters). The forms shall have closed tapered ends. Lightweight filler material shall be used in the form valleys.

The metal forms shall be designed on the basis of dead load of the form, reinforcement and the plastic concrete, including the additional weight of concrete due to the deflection of the metal forms, plus 50 pounds per square foot (2.40 kilopascals) for construction loads. The allowable stress in the corrugated form and the accessories shall not be greater than 0.725 times the yield strength of the furnished material and the allowable stress shall not exceed 36,000 psi (250 megapascal). The span for design and deflection shall be the clear distance between edges of the beams or girders less two inches (50 millimeters) and shall be measured parallel to the form flutes. Maximum deflection of the forms under the weight of the plastic concrete, reinforcement, and forms shall not exceed 1/180 of the form span or 0.5 inches (13 millimeters), whichever is less. The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

Form support angles shall be designed as a cantilever. The horizontal leg of the form's support angle shall not be greater than 3 inches (75 millimeters).

Before fabricating any material, the Contractor shall submit working drawings to the Engineer for review in accordance with Article 1.05.02-2, Working Drawings. These drawings shall include the proposed method of form construction, erection plans including weld procedure(s), material lists, material designation, gage of all materials, and the details of corrugation. Also, copies of the form design computations shall be submitted with the working drawings.

Form supports shall be used and no stay-in-place metal forms shall be placed over or be directly supported by the top flanges of beams or girders. The form supports may be supported by or be attached to the top flanges. Stay-in-place metal forms shall not be used in bays where longitudinal slab construction joints are located. Stay-in-place metal forms shall not be used under cantilevered slabs such as the overhang outside of fascia members.

Welding to the top flanges of steel beams and girders is not allowed in the areas where the top flanges are in tension, or as indicated on the plans. Alternate installation procedures shall be submitted addressing this condition.

Drilling of holes in prestressed concrete beams or the use of power-actuated tools on the prestressed concrete beams for fastening of the form supports to the prestressed concrete beams will not be permitted. No welding will be permitted on the reinforcing steel in the prestressed units.

All edges of openings cut for drains, pipes, and similar appurtenances shall be independently supported around the entire periphery of the opening.

All fabricated stay-in-place metal forms shall be unloaded, stored, and handled in such a manner as to preclude damage to the forms. Damaged material shall be replaced at no additional cost. Any exposed form or form support metal where the galvanized coating has been damaged, shall be thoroughly cleaned, wire brushed, then coated with two coats of a zinc dust-zinc oxide primer, FS No. TT-P-641d, Type II, as directed by the Engineer.

All fabricated stay-in-place metal forms shall be stored at the project site at least four inches (100 millimeters) above the ground on platforms, skids or other suitable supports and shall be protected against corrosion and damage.

Forms shall be installed from the topside in accordance with the manufacturer's placing plans, recommended details, and printed instructions. Forms shall be constructed to the lines, grades, shapes, and dimensions shown on the plans, unless otherwise directed by the Engineer. Form supports shall ensure that forms retain their correct dimensions and positions during use at all times. Form supports shall provide vertical adjustment to maintain design slab thickness at the crest of corrugation, to compensate for variations in camber of beams and girders, and to allow for deflections.

Field cutting of form sheet metal shall be made by a steel cutting saw. Supports, closures and cut-outs shall be cut with shears or saw. No flame cutting will be permitted.

All welding shall be accomplished by Connecticut certified welders in accordance with Subarticle 300000-6.03.03 – 6, Welding.

The steel form supports shall be placed in direct contact with the flange of stringer or floor beam flanges and attached by bolts, clips, welding where permitted, or other approved means. Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Forms shall be securely fastened to form supports with self-drilling fasteners and shall have a minimum bearing length of one inch (25 millimeters) at each end.

In the areas where the form sheets lap, the form sheets shall be securely fastened to one another by fasteners at a maximum spacing of eighteen inches (450 millimeters). The ends of the form sheets shall be securely attached to the support angles with fasteners at a maximum spacing of eighteen inches (450 millimeters) or two corrugation widths, whichever is less. Welding of forms to supports is not allowed. The depth of the concrete slab shall be as shown on the plans and the corrugated forms shall be placed so that the top of the corrugation will coincide with the bottom of the deck slab. No part of the forms or their supports shall protrude into the slab. All reinforcement in the bottom reinforcement mat shall have a minimum concrete cover of one inch (25 millimeters) unless noted otherwise on the plans.

The completed stay-in-place metal form system shall be sufficiently tight to prevent leakage of mortar or concrete.

Where forms or their installation are unsatisfactory in the opinion of the Engineer, either before or during placement of the concrete, the Contractor shall correct the defects before proceeding with the construction work. The cost of such corrective work shall be at the sole expense of the Contractor.

4. Handling Material: The requirements of Subarticle 300000-4.01.03-B shall apply.

5. Composition: The requirements of Subarticle 300000-4.01.03-A shall apply except for the proportionment of the concrete mix which shall be in accordance with Article M.03.01, and the air content for Class "C" or Class "F," as the case may be, used for bridge decks, including curbs, sidewalks and railings attached there on or attached thereto. This concrete shall contain not less than 5% nor more than 7% entrained air at the time the concrete is deposited in the forms. For pumped concrete, the percentage of entrained air shall be determined at the placement end of the pump line.

Unless otherwise directed by the Engineer, all concrete for bridge decks shall contain a retarder admixture which the contractor shall add to the concrete mix in predetermined amounts varying with the temperature and other working conditions.

On any one structure, the admixture for a specific purpose shall be the particular product of one manufacturer only. When admixtures for different purposes are used together, the Contractor shall submit proof of their compatibility prior to use.

6. Consistency: The consistency shall be determined by the AASHTO Method T 119. A uniform consistency shall be continuously maintained. When Class "A" and Class "C" concrete is not to be vibrated, the allowable range of slump shall ordinarily be not less than 2 nor more than 4 inches (50 millimeters nor more than 100 millimeters). When Class "A" and Class "C" concrete is to be consolidated by vibration, the slump shall be not more than 2 1/2 inches (60 millimeters); and for Class "F" concrete, the slump shall be not more than 3 inches (75 millimeters). Slumps outside these limits shall be used when, in the opinion of the Engineer, conditions are such that satisfactory workability cannot be obtained within such limits. Concrete mixes designed by the Contractor so as to be pumpable, shall not be subject to the above conditions. The desired slump shall be indicated on the mix design submitted for approval. The slump shall be determined at the placement end of the pump line.

7. Mixing Concrete: Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (cubic meters), as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

Failure of the water measuring device or of the timing device shall result in suspension of mixing until correction has been made, except that, with prior approval of the Engineer, operations may be allowed to continue for the balance of the day if secondary controls can be demonstrated.

Truck mixed or transit mixed concrete may be used with the written permission of the Engineer for limited amounts or other exceptional cases. If its use is so allowed, the provision of Section 300000-6.01 relating to truck mixers and truck mixed and transit mixed concrete shall fully apply.

The first batch of concrete materials placed in the mixer shall contain an additional quantity of sand, cement, and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing shall not be permitted except in cases of emergency and with the permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform, and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the

stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed 1/2 cubic yard (0.5 cubic meter) in volume. Hand mixing will not be permitted for concrete to be placed under water.

8. Placing Concrete: Concrete, except for central plant-mix, truck or transit-mixed, shall be placed in the forms immediately after mixing; and in no case shall concrete be used which does not reach its final position in the forms within 60 minutes after the time that water is first added to the mix, except that the Engineer reserves the right to alter this time by as much as one-half when necessary to achieve the requirements related to set and plasticity.

The temperature of the concrete at the time of placement shall not be less than 60 F (15.5 C) or greater than 90 F (32 C). For pumped concrete, the temperature shall be determined at the placement end of the pump line. The temperature of the concrete shall be determined in accordance with ASTM C1064.

The use of long chutes and troughs for conveying concrete from the mixing plant to the forms will be permitted only on authority from the Engineer. If such conveyors are allowed and the quality of concrete as it reaches the forms or the method of placing or working it therein are not satisfactory, the Engineer may order their use discontinued and the substitution of a satisfactory method of placing. Where steep slopes are required, chutes and troughs shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

During placing operations, the concrete shall not come in contact with any aluminum.

Unless permission is obtained from the Engineer, concrete shall not be dropped a distance of more than 5 feet (1.5 meters); and special care shall be taken to fill each part of the forms by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and the concrete forced around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred; and no strain shall be placed on the ends of projecting reinforcement.

Concrete shall be placed in horizontal layers. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set, to prevent injury to the green concrete and to avoid surfaces of separation between the layers.

Concrete shall be compacted by continuous working with suitable tools or by vibrating as ordered by Engineer. The number and type of vibrators required, the length of the vibrating period and the location of the vibrators shall be as required by the Engineer.

Special care shall be taken in placing and compacting concrete around ornamental moulds, and vibrating equipment shall be used with caution. The vibrator shall not touch the moulds at any time. A gentle vibration shall be used, sufficient to assure the proper flow of the materials and to bring the mortar into complete contact so that all contours of the ornaments will be sharp. Tarpaulins or heavy paper shall be hung over the moulds, the bottom of which shall be kept constantly immersed in the fresh concrete, in order to prevent splashing the surfaces of the moulds.

When the placing of concrete is temporarily discontinued, the necessary keys or joints shall be formed as shown on the plans or as ordered, and the concrete after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.

Joints shall be formed only in the locations shown on the plans or as permitted by the Engineer.

Featheredges at construction joints will not be permitted.

Immediately following the discontinuance of the placing of concrete, all accumulations of mortar splashed upon reinforcing steel and the surface of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If accumulations are not removed prior to the concrete becoming set, care shall be taken not to injure or break the concrete-steel bond, at and near the surface of the concrete, while cleaning the reinforcing steel.

9. Depositing Underwater Concrete: Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the Engineer and under his immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

The Contractor shall design and submit to the Engineer a concrete mix that he proposes to use. The mix shall be designed in accordance with the applicable sections of ACI 211 and ACI 318.

During placing operations, the concrete shall not come in contact with any aluminum.

Concrete deposited under water shall be carefully placed in a compacted mass in its final position by means of a tremie, a bottom dump bucket or other approved method and shall not be disturbed after being deposited. Special care must be exercised to maintain still water at the point of deposit. No concrete shall be placed in running water, and all form work designed to retain concrete under water shall be watertight.

The consistency of the concrete shall be carefully regulated, and special care shall be exercised to prevent segregation of the materials. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Concrete deposited under water shall be placed continuously from start to finish whenever possible, and each succeeding layer shall be placed before the preceding layer has taken initial set.

When a tremie is used, it shall consist of a suitable hopper and a tube having a diameter of not less than 10 inches (254 millimeters). If the tube is constructed in sections, it shall have watertight couplings. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the area of the work and shall be such as to permit it to be rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be plugged at the start of the work to prevent water from entering the tube. It shall be entirely sealed at all times, and the tremie tube kept full of concrete to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the work is complete.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than one cubic yard (0.8 cubic meters). The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly as the concrete is discharged, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Before placing substructure concrete, all laitance or other unsound material shall be removed from the surface of the underwater concrete.

10. Concreting in Cold Weather: During the period from October 15 to April 15 of the subsequent year, cold-weather concreting procedures shall be employed by the Contractor, unless otherwise directed by the

Engineer. Cold-weather concreting practices shall include taking measures to ensure that the temperature surrounding the structure is kept above 60°F (16°C) for a period of 5 days after placing the concrete, and above 40°F (5°C) for an additional nine days. The temperature shall then be gradually lowered to that of the surrounding atmosphere. Concrete test specimens prepared during the period noted shall be cured in the same manner as the structure that they represent, in accordance with ASTM C 31 (AASHTO T 23). If tests performed on the specimens indicate that sufficient strength has been achieved, the Engineer may reduce the amount of time that the structure must be protected and heated.

Sufficient heating apparatus of the kind approved by the Engineer, such as stoves, salamanders, or preferably steam equipment, and fuel to furnish all required heat, shall be supplied. All water used for mixing concrete shall be heated, but shall not exceed a temperature of 150°F (65°C).

The temperature of the mixed concrete shall not be less than 60°F (16°C) at the time of placing in the forms.

If aggregates are heated either by steam or by dry heat, the temperature of the aggregate shall be not less than 50°F (10°C), nor more than 100°F (37°C). The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material.

In case of extreme weather conditions, the Engineer may at his discretion vary the temperature limitations for water, aggregate and mixed concrete.

Except for deck slabs and thin wall sections, form insulation may be substituted for a heated enclosure, provided it can be demonstrated to the satisfaction of the Engineer that the insulation material proposed for use will keep the concrete within the above specified temperature limits for the specified periods of time. When the use of form insulation is permitted, sufficient provision shall be made by the Contractor so that the surface and interior temperature of the concrete may be determined. If the thermometric readings indicate that the required temperature is not being maintained, the structure shall be promptly enclosed and heat furnished as provided hereinabove.

When form insulation is substituted for a heated enclosure, forms shall not be stripped until permission is granted by the Engineer.

11. Anchorages: Anchor bolts and similar materials which are to be placed either at the time the substructure is built, or during the erection of the superstructure, shall be carefully and accurately set to the requirements of the plans or as ordered at such time as the Engineer may approve or direct.

(a) Setting Anchorages at time of Placing Substructure Concrete: When noted on the plans or ordered by the Engineer, the anchor bolts and similar materials shall be accurately set prior to placing concrete for the bridge seat.

(b) Setting Anchorages in Formed Holes: When indicated on the plans, the anchor bolts and similar materials shall be accurately set in formed holes in accordance with details and dimensions shown. The space around the anchorage material shall be completely filled with non-shrink, non-staining grout conforming to the requirements of Subarticle M.03.01-12.

(c) Setting Anchorages in Drilled Holes: When the Contractor is not required to set anchorages at the time of constructing the substructure, he may set the anchorages as in (a) and (b) above, or he may drill holes having a diameter of 4 inches (100 millimeters) and a depth suitable to receive the bolts in the correct locations perpendicular to the plane of the bridge seat. Anchor bolts shall be grouted into clean drilled holes in accordance with the requirements of "Setting Anchorages in Formed Holes." When anchorage

material is to be furnished by the Contractor for the superstructure and placed by the Contractor of the substructure, the necessary material shall be fabricated and delivered to the site of the work at such times as it may be required for proper inclusion in the substructure construction.

In locating anchor bolts in relation to slotted holes in expansion shoes, due consideration shall be given to the temperature at the time of erection.

Anchor bolt holes shall be clean and free of dirt, moisture or other foreign materials at the time of setting anchor bolts. Precaution shall be taken to prevent damage to concrete due to freezing of water in anchor bolt holes.

12. Construction Joints: Construction joints other than those shown on the plans will not be permitted without prior approval of the Engineer. When the placing of concrete is to be interrupted and a construction joint formed, provision shall be made for interlocking with the succeeding layer by roughening the surface and providing keyways, dowels or similar construction shown on the plans or as ordered.

In joining fresh concrete to concrete that has already set, the work already in place shall have its surface cut over thoroughly with a suitable tool to remove all loose and foreign material. This surface shall then be washed and scrubbed with wire brooms and thoroughly drenched with water until saturated. It shall remain saturated until the new concrete is placed. Immediately prior to the placing of the new concrete, all forms shall be drawn tight against the concrete already in place.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, a baffle strip of copper, zinc, sheet lead or other approved materials shall be inserted. This strip shall be placed not less than 3 inches (75 millimeters) from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2 inches (50 millimeters).

13. Expansion Joints: Expansion joints shall be built in the locations and to the dimensions and details shown on the plans.

Sliding surfaces of metal shall be planed true and smooth, the marks of the plane paralleling the movement of the joint. Expansion plates shall be well anchored as shown on the plans. All sliding surfaces of expansion plates shall be thoroughly coated with graphite or other approved lubricant just before being placed in position and special care taken to avoid placing concrete in such manner as to interfere with their free action.

Open joints shall be placed at locations designated on the plans and shall be formed by the insertion and subsequent removal of templates of wood, metal or other suitable material. The templates shall be so constructed that their removal may be readily accomplished without injury to the work.

Filled joints shall be made with a joint filler, the materials for which shall conform to the requirements of the plans and of these specifications.

Mortise joints shall be as shown on the plans and, in general, shall consist of a tenon of concrete or metal sliding in a suitable concrete or metal socket or mortise. The construction shall be such as to permit freedom of movement and such as to be, as far as possible, watertight and rust proof. Metal flashing shall be used as shown on the plans or when ordered by the Engineer.

Special types of expansion joints shall conform to the dimensions and details shown on the plans.

14. Curing Concrete: Concrete surfaces exposed to conditions causing premature drying shall be protected by covering, within 2 hours of placing. Concrete shall be cured as specified in Subarticle 300000-4.01.03-F.7 except Liquid Membrane-Forming Curing shall not be used. Other means of curing may be used provided that by either field or laboratory demonstration it can be shown that the material, or method used, sufficiently supplies necessary moisture to the concrete or causes the concrete to retain moisture, is not injurious to concrete and is not toxic.

Curing shall continue for a period of not less than 7 days after placing the concrete. Other precautions to insure the development of strength or to prevent injury shall be taken as the Engineer may direct.

15. Removal of Forms: The forms for any portion of the structure shall not be removed until the concrete is strong enough to avoid possible injury from such removal. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to take up the stresses due to its own mass uniformly and gradually.

If field operations are controlled by flexural-strength tests, the flexural strength of the concrete in the structure shall be monitored by the penetration-resistance tests, except in cases where the Engineer directs the use of third-point loading of test beams or splitting-tensile tests of cylinders. In this case, the Engineer shall be guided by the following considerations: penetration-resistance tests will be valid only for concretes containing coarse traprock aggregate with a top size to 1 1/2 inches (38 millimeters); beam tests will be valid for concrete containing all types and sizes of coarse aggregates; and, splitting-tensile tests will be valid for concrete containing any size of traprock aggregate.

If field operations are controlled by cylinder tests, the removal of forms, supports and housing and the discontinuance of heating and curing may be begun when the strengths reach the values which shall be fixed by the Engineer.

If field operations are not controlled by one of the above tests, the following period, exclusive of days when the temperature is below 40°F (5°C), may be used as a guide for the removal of forms:

Arch Centers	14 to 28 days
Centering Under Beams	14 to 28 days
Floor Slabs	7 to 14 days
Walls	24 hours to 4 days
Columns	2 to 7 days

To facilitate finishing, side forms carrying no load may be removed after 24 hours with the permission of the Engineer, but the curing process must be continued for seven days.

Ornament moulds shall be removed in the same manner as the usual form work. In case a portion of the plaster work remains in the concrete after the mold is removed, this material shall be carefully removed with a wood chisel, wood mallet or wire brush, using a chipping action wherever possible, and taking care that no damage is done to the concrete. No work of this nature shall be started until at least ten days after the forms have been removed.

16. Surface Finish: The external surface of all concrete shall be thoroughly worked during the operation of placing by means of tools of an approved type. The working shall be such as to force all coarse aggregate from the surface and thoroughly work the mortar against the forms to produce a smooth finish free from water and air pockets, segregated materials, or honeycomb. Unless otherwise authorized by the Engineer, the surface of the hardened concrete shall be finished immediately after the removal of the forms. All voids and honeycomb on the surface shall be filled and finished to conform to the surrounding con-

crete surface immediately after the forms are removed and before the finishing process is started. The finish shall be governed by the "Table of Finishes" shown elsewhere herein.

Float Finish: This finish shall be formed by placing an excess of material in the form and removing or striking off of such excess with a template, forcing the coarse aggregate below the mortar surface. There shall be created no concave surfaces in which water will be retained. After the concrete has been struck off as above described, the surface shall be thoroughly worked and floated with a wooden, canvas or cork float, the operation to be performed by skilled and experienced concrete finishers. Before this last finish has set, the surface shall be lightly stripped with a fine brush to remove the surface cement film, leaving a fine grained, smooth, but sanded texture. Curing, as specified elsewhere, shall follow.

Grout Clean-Down Finish: As soon as all cavities have been filled as required elsewhere and the cement mortar has set sufficiently, grout clean-down shall be performed as follows:

(1) All burrs, unevenness, laitance, including that in air holes, and any other material which will adversely affect the bond of the grout to the concrete, shall be removed by approved methods. This cleaning shall be done from the top or uppermost part of the surface to be finished to the bottom.

(2) A mixture of a fine aggregate and Portland cement shall be thoroughly blended while dry. The proportions shall be such that when mixed with the proper amount of water, the color will match that of the concrete to be finished. The proportions shall be determined by trial panels. Water shall be added to this mixture in an amount which will bring the grout to a workable thick paint-like consistency.

(3) The surface to be treated shall be thoroughly wetted with a sufficient amount of water to prevent the absorption of water from the grout. Grout shall then be applied to the wetted surface before setting of the grout occurs. Grout which has set, shall not be re-tempered and shall be disposed of by the Contractor at his expense.

The grout shall be uniformly applied by brushes, spray gun, or sponge rubber float over the entire surface, completely filling all air bubbles and holes. Immediately after applying the grout, the surface shall be floated with a cork, or other suitable float, scouring the surface vigorously. While the grout is still plastic, the surface shall be finished with a sponge rubber float, removing all excess grout but without removing grout from holes or depressions.

(4) The surface shall be allowed to dry thoroughly, and shall then be rubbed vigorously with burlap to remove completely any dried grout. No visible film of grout shall remain after this rubbing.

Operations (3) and (4) shall be completed in one and the same day for the area treated.

(5) Curing of the concrete so treated shall then be resumed as specified elsewhere or, if completed, for at least 1 more day.

Rubbed Finish: The entire surface shall be thoroughly wet with a brush and rubbed with a No. 16 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth, dense surface without pits or irregularities. The paste formed by the rubbing as above described may be finished by carefully stripping with a clean brush, or it may be spread uniformly over the surface and allowed to reset. After the concrete has set for 7 days or such period as the Engineer may direct, the surface shall be rubbed again, with a carborundum stone, until a uniform even color is obtained. No mortar shall be used during this second rubbing. Curing, as specified elsewhere, shall be completed in all cases.

TABLE OF FINISHES

STRUCTURE	TYPE OF FINISH				
	PART	AREA	FLOAT	GROUT CLEAN DOWN	RUBBED
BRIDGE	Abutment	Exposed		X	
	Wings	Top	X		
		Exp Sides		X	
	Piers	Top	X		
		Exp Sides		X	
		Top	X		
		Sides			X
	Median		X		
	Seat		X		
	Bearing Areas*		X		
	Sidewalks	Top	X		
	Curbs	Top	X		
		Sides			X
BOX CULVERT	Wings	Top	X		
		Exp Sides		X	
	Curbs	Top	X		
		Sides			X
	Ends	Exp		X	
	Median		X		
	Parapets & Fascia	Top	X		
		Sides			X
CATCH BASINS**		Exp			X
CURBING			X		
DROP INLETS**		Exp			X
ENDWALLS		Top	X		
		Exp		X	
GUTTERS		Exp	X		
PRECAST PILES***		Exp			X
RETAINNG WALLS		Top	X		
		Exp		X	
SHOTCRETE		Exp	X		
SLOPE PAVING		Exp	X		
STEPS & COPING		Top	X		
		Exp Sides			X

* See Subarticle 300000-6.01.03-14 for finish following floating.
** Precast units excepted; See Subarticle M.08.02-4.
*** When required.

16. Testing Apparatus and Test Specimens:

(a) The flexural strength of the concrete for structures shall be monitored by the evaluation of compressive strength cylinders. The compressive strength specimens shall be cast and cured in the field in accordance with AASHTO T 23. After proper curing, these cylinders shall be transported to the Division of Materials Testing for strength evaluation.

(b) Cylinders for 28-Day Compressive Strength: The concrete necessary to cast several cylinders for 28-day compressive-strength determinations shall be furnished by the Contractor from each day's pour. The necessary personnel and forms for casting these specimens will be furnished by the Department and the number of specimens required will be specified by the Engineer. These cylinders shall be cured in an approved concrete cylinder box, or boxes, as described in Section 300000-6.12.

17. Opening to Traffic: Vehicular traffic shall be excluded from the structure until the concrete has developed a compressive strength of 4,000 psi (28 megapascals), or until the Engineer authorizes its opening to traffic. Use of equipment applying loads greater than the design capacity of the bridge or structure shall not be allowed.

18. Joint Seal: The Contractor shall seal joints where shown on the plans and elsewhere where directed by the Engineer. Before placement of the sealing material, the joints shall be thoroughly cleaned of all scale, loose concrete, dirt, dust or other foreign matter. Projections of concrete into the joint space shall be removed. The joint shall be clean and dry before the sealing compound is applied.

The joint sealant shall be prepared and placed in accordance with the manufacturer's directions and with the equipment prescribed by the manufacturer. Any material improperly mixed or likely to set up before placement into the joints will be rejected and shall be replaced at the Contractor's expense.

The joints shall be sealed in a neat and workmanlike manner, free from all dust and foreign matter.

When the work is completed, the joints shall effectively seal against infiltration of moisture and water.

The sealing compound shall be flush with, or not more than 1/8 inch (3 millimeters) above the adjacent

surface of concrete. Where directed by the Engineer, the joint shall be smoothed and leveled to the adjacent surface by cutting off all excess compound after the application. Any joint material which does not adhere or bond with the concrete surface of the joint shall be immediately removed and replaced at the Contractor's expense.

SECTION 6.02 REINFORCING STEEL

6.02.01—Description:

Work shall consist of furnishing and placing reinforcing steel and splicing materials, of the type and size designated, as shown on the plans, as directed by the Engineer and in accordance with these specifications.

6.02.02—Materials:

The materials for this work shall conform to the requirements of Article M.06.01.

6.02.03—Construction Methods:

1. Shop Drawings: Prior to fabricating any materials, the Contractor shall submit shop drawings of the reinforcing steel and splicing materials, with material lists, material designations, placement diagrams, bending diagrams and manufacturer's literature for mechanical connections, for review and approval, in accordance with Article 1.05.02. Any expenses incidental to the revision of materials furnished in accordance with shop drawing and order lists to make them comply with the requirements of the plans or specifications shall be borne by the Contractor.

2. Fabrication:

(a) Cutting and Bending: Bar reinforcement shall be cut and bent to the shapes shown on the plans. Fabrication tolerances shall be in accordance with the requirements of ACI 315. All bars shall be bent cold, unless otherwise permitted.

Coated bars shall not be field cut, unless permitted by the Engineer. Field cutting of coated bars should be performed using hydraulic-powered cutters or friction cutting tools to minimize coating damage and field touch-up. Flame cutting of coated bars will not be permitted. Field cut coated bars shall be repaired immediately.

Bars partially embedded in concrete shall not be field bent, except as shown on the plans or permitted by the Engineer.

(b) Hooks and Bend Dimensions: The dimensions of hooks and the diameters of bends measured on the inside of the bar shall be as shown on the plans. When the dimensions of hooks or the diameter of bends are not shown, they shall be in accordance with the ACI 318, "Building Code Requirements for Reinforced Concrete" as amended by ASTM A767M for galvanized bars.

(c) Identification: Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the CRSI "Manual of Standard Practice".

3. Handling, Storing and Surface Condition of Reinforcement: Steel reinforcement shall be stored above the surface of the ground on platforms, skids, or other supports and shall be protected as far as practical from mechanical injury and surface deterioration caused by exposure to conditions producing rust.

Epoxy-coated and galvanized reinforcing steel shall be handled and stored by methods that will not damage the coating. All systems for handling coated reinforcement shall have adequately padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong

back, multiple supports, or platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. Bars or bundles shall not be dropped or dragged. Coated reinforcing steel shall be transported and stored on wooden or padded supports. Epoxy-coated reinforcing steel, stored at the job site, shall be protected by covering with opaque polyethylene or other suitable protective material. Provisions shall be made for adequate ventilation to prevent condensation under the covering. Since the epoxy coating is flammable, the epoxy coated reinforcing shall not be exposed to any fire or flame.

Prior to placement of concrete, all reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other materials that would reduce bond. Reinforcement shall be free from injurious defects such as cracks and laminations. Bonded rust, surface seams, surface irregularities, or mill scale will not be cause for rejection, provided the minimum dimensions, cross section area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel specified.

4. Placing and Fastening

(a) General: Steel reinforcement shall be accurately placed as shown on the plans and firmly held in position during the placing and setting of concrete. Bars shall be tied at all intersections except where the spacing is less than 12 inches (300 millimeters) in each direction when alternate intersections shall be tied.

Bars shall be tied at all intersections around the perimeter of each mat.

Bundled bars shall be tied together at not more than 6-foot (1800-millimeter) centers. Lap splices shall have a minimum of 2 ties or be tied 12 inches (300 millimeters) apart for the length of the splice, whichever requires the greater number of ties. For epoxy-coated reinforcement, tie wires and metal clips shall be epoxy, plastic or nylon coated. For galvanized reinforcement, tie wires and metal clips shall be plastic coated or galvanized.

With the exception of tie down bars, welding (tack welding) will not be permitted for assembly of reinforcement, unless shown on the plans. Tie down bars shall be placed as shown on the plans and a top longitudinal reinforcing bar tied to these bars. When welding coated bars an appropriate protective mask must be worn, safety equipment used and suitable ventilation provided.

If wire fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

(b) Support Systems: Reinforcing steel shall be supported in its proper position by use of precast mortar blocks, wire bar supports, supplementary bars (tie-down bars), side form spacers or other approved devices. Such devices shall be sufficiently strong and properly placed at frequent intervals so as to maintain the cover between the reinforcing and the surface of the concrete. The reinforcing steel cover shall be no less than that shown on the plans and no greater than that shown plus 1/4 inch (6 millimeter).

Platforms for the support of workers and equipment during concrete placement shall be supported directly on the forms and not on the reinforcing steel.

(c) Precast Mortar Blocks: Precast mortar blocks shall have a compressive strength not less than that of the concrete in which they are to be embedded. The face of the blocks in contact with forms for exposed surfaces shall not exceed 2 inches x 2 inches (50 millimeters x 50 millimeters) in size and shall have a color and texture that will match the concrete surface. Precast mortar blocks shall not be used on exposed surfaces of precast concrete members. When used on vertical or sloping surfaces, such blocks shall have an embedded wire for securing the block to the reinforcing. When used in slabs, either such a tie wire or, when the weight of the reinforcing is sufficient to firmly hold the blocks in place, a groove in the top of

the block may be used. For epoxy-coated bars, such tie wires shall be epoxy, plastic or nylon coated. For galvanized bars, such tie wires shall be plastic coated or galvanized.

(d) Wire Supports: Wire bar supports, such as ferrous metal chairs and bolsters, shall conform to industry practice as described in the CRSI "Manual of Standard Practice of the Concrete Reinforcing Steel Institute." All bolsters or chairs which bear against the forms for exposed surfaces shall be equipped with snug fitting, high density, polyethylene tips which provide 1/2-inch (12-millimeter) minimum clearance between the metal and any exposed surface. For epoxy-coated reinforcement, all wire bar supports and bar clips shall be epoxy or plastic coated. For galvanized reinforcement, chair and bar supports shall be hot-dip galvanized, after fabrication, in accordance with ASTM A123.

The maximum spacing of slab bolster rows and high chair rows for concrete deck slabs shall be 4 feet (1200 millimeters) unless otherwise directed by the Engineer.

(e) Repair of Coated Reinforcing Steel:

Epoxy-coated Reinforcing Steel - In addition to the requirements of ASTM D3963M, all damage (i.e., scratches, nicks, cracks) to the epoxy coating of the bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or placement shall be repaired by the Contractor at the job site with approved patching material. Ends of bars that have been sheared, saw cut or cut by other means shall be coated with approved patching material. The areas on the bars and tie down bars damaged by welding shall be repaired with approved patching material.

Patching of damaged areas shall be performed in accordance with the patching material manufacturer's recommendations. Any singular damaged surface area (prior to repair with approved patching material), shall not exceed 2% of the total surface area of the bar. The total bar surface area covered by patching material shall not exceed 5% of the total surface area of the bar. Should either of these limits be exceeded the bar shall be removed from the work and replaced with an acceptable bar. All patching material shall be fully cured prior to placing concrete.

The patching material shall be compatible with the epoxy coating, inert in concrete, and suitable for repairs in the field. The patching material shall be prequalified, as required for the coating material, and shall be either identified on the container as meeting the requirements of Annex A1 of ASTM D3963M or shall be accompanied by a Materials Certificate certifying that the material meets the requirements of said Annex A1.

Galvanized Reinforcing Steel - All damage (i.e. scratches, nicks, cracks) to the galvanized coating on bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or placement shall be repaired by the Contractor at the job site in accordance with ASTM A780, Annex A2 - "Repair using Zinc-Rich Paints". Ends of bars that have been sheared, saw cut or cut by other means shall be coated with zinc-rich paint. The area on the bars and tie down bars damaged by welding shall be repaired with zinc-rich paint.

Field coating of damaged areas shall be performed in accordance with the zinc-rich paint manufacturer's recommendations. The zinc-rich paint shall conform to FS TT-P-641, Type 1 and shall be brush applied to achieve a dry film thickness from 3 - 6 mils. All touchup paint shall be fully cured prior to placing concrete.

5. Splicing of Bars:

(a) General: All reinforcement shall be furnished in the full lengths indicated on the plans unless otherwise permitted. Except for splices shown on the plans, splicing of bars will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible.

(b) Lapped Splices: Lapped splices shall be of the lengths shown on the plans. In contact lap splices, the bars shall be placed in contact and tied together in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

In non-contact lap splices, the bars shall be placed as shown on the plans and tied to adjacent bars in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

(c) Welded Splices: Welded splices shall be used at the locations shown on the plans. Welding shall conform to AWS publication "Structural Welding Code, Reinforcing Steel, AWS D1.4"

Welded splices shall not be used on epoxy-coated or galvanized bars. No welding shall be performed close enough to epoxy-coated or galvanized bars to cause any heating of the coating.

(d) Splices made with Dowel Bar Mechanical Connections: Splices made with dowel bar mechanical

connections shall be used at the locations shown on the plans. The minimum size of the bars and the length of the lap splices for the dowel bar mechanical connections shall be as shown on the plans.

The mechanical connections shall be installed in accordance with the manufacturers recommendations. All tools and equipment required to install and field inspect the connections shall be provided by the Contractor. The Contractor shall take all measures necessary to prevent concrete from adhering to the threaded portions of the mechanical connections.

After installing the coated mechanical connectors, all damaged areas on the coated connectors shall be repaired in accordance with Section 300000-6.02.03-4(e).

6. Splicing of Welded Wire Fabric: Welded wire fabric reinforcement shall be lap spliced as shown on the plans.

7. Substitutions: Substitution of different size bars will be permitted only when authorized by the Engineer. The substituted bars shall have an area equivalent to or larger than the area shown on the plans.

8. Inspection: Reinforcement in any member or component shall be placed, inspected and approved by the Engineer before placing of concrete begins. Concrete placed prior to approval of the reinforcement may be rejected and its removal required.

SECTION 6.51 CULVERTS

6.51.01—Description:

Work shall consist of furnishing and installing new pipe culverts, new pipe-arch culverts and relaying existing pipe and pipe-arch culverts of the type, size and length called for on the plans or as ordered, at the locations and to the lines and grades designated on the plans, or as directed by the Engineer, and in conformity with these specifications. Work shall also consist of furnishing and installing slotted drain pipes to the dimensions, details and of the size, length and location shown on the plans or ordered by the Engineer.

Work shall also include furnishing and installing culverts, either circular or arched, composed of structural plates, fabricated in the field in accordance with the details shown on the plans, or as ordered. Substructures and incidental construction shall comply with the requirements of the specifications for the various elements which constitute the completed structure.

Work shall further include the furnishing and installing of corrugated metal pipe elbows of the type and size shown on the plans, at the location, to the lines and grade designated, or as ordered by the Engineer and in conformance with these specifications.

6.51.02—Materials:

The materials for this work shall conform to the following: Pipes of the type indicated on the plans and joint sealant shall conform to the requirements of Article M.08.01. Bedding material shall conform to the requirements of Article M.08.03. Granular fill shall conform to the requirements of Article M.02.01.

6.51.03—Construction Methods:

Unless otherwise directed by the Engineer, all new or re-laid pipe culverts, including culverts composed of structural plates, shall be installed in pipe bedding in accordance with the details as shown on the plans and in conformance with these specifications.

Pipe with an internal diameter of less than 48 inches (1200 millimeters) and pipe-arch of an equivalent horizontal span shall be installed in a Type I installation, and pipe of 48 inches (1200 millimeters) internal diameter or more, including pipe-arch of equivalent horizontal span shall be installed in a Type II installation.

Type I installation shall consist of installing the pipe, or pipe-arch, in bedding material with a thickness directly under the pipe of 4 inches (100 millimeters) and pre-shaped to a height of 10% of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height of 25% of the total height of the pipe.

Type II installation shall consist of installing the pipe or pipe-arch in bedding material, with a thickness directly under the pipe of 4 inches (100 millimeters) and pre-shaped to a height of 10% of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height of 12 inches (300 millimeters) above the top of the pipe.

Methods of backfilling shall be in conformance with the pertinent sections of Article 300000-2.05.03. Where pipe is to be laid below the ground line, a trench shall be excavated to the required depth, the bottom of which shall be graded to the elevation of the bottom of the bedding material or to afford a uniform firm bearing for the pipe throughout its entire length, whichever the case may be. When rock is encoun-

tered, it shall be excavated to not less than 12 inches (300 millimeters) below the bottom of the pipe; and this depth shall be refilled with bedding material which shall be thoroughly tamped.

Where pipe is to be laid in a fill area, the embankment shall be placed and compacted to an elevation 12 inches (300 millimeters) above the top of the proposed pipe, whereupon the trench excavation shall be made and the pipe installed.

Where the nature of the foundation is poor, the culvert shall be relocated in firm material if possible. Where this cannot be done, the poor material shall be removed and replaced with a layer of granular fill of such depth as the Engineer may direct; or special construction of the character shown on the plans, or as ordered by the Engineer, may be employed.

Normally, the placement of pipe shall start at the downstream end and progress upstream. All pipe shall be carefully laid, true to the lines and grades given, hub ends upgrade and with the spigot ends fully entered into the adjacent hubs.

Joints in concrete and vitrified clay pipe shall be sealed with either cold-applied bituminous sealer, preformed plastic gaskets or flexible, watertight, rubber-type gaskets conforming to the requirements of Article M.08.01. Portland cement mortar shall not be used for sealing pipe joints except by permission of the Engineer, and if permitted shall conform to the requirements of Article M.11.04.

When cold-applied bituminous sealer is used, the bell and spigot or tongue and groove pipe shall be wiped clean and dry before applying the bituminous sealer to the pipe joint. Before the pipes are placed in contact with each other, the spigot or tongue end shall be completely covered with an excess of bituminous sealer; then the pipe shall be laid to line and grade so the inside surface of the abutting pipes are flush. The joints shall be completely filled with bituminous sealer. All excess joint sealant shall be removed from inside of the pipe.

Metal pipe and pipe-arches shall be carefully jointed and firmly clamped together by approved connecting bands, which shall be properly bolted in place before any backfill is placed.

Corrugated structural plate pipe, plate-arches and plate pipe-arches shall be constructed in conformity with the plans, or as ordered, shall be true to lines and grades given, and shall have a protective bituminous coating applied by an approved method on the inside and outside of the plates. The coating material shall meet the requirements of Subarticle M.08.01-5. Before applying the coating, the metal shall be cleaned to the extent possible of all dust, dirt, oil, unbonded or incompatible paint, grease, acids, alkalies or other foreign matter.

If so ordered by the Engineer, any pipe which is not in true alignment, or which shows any settlement or distortion after laying, shall be taken up and re-laid or corrected, to the satisfaction of the Engineer without additional compensation.

Where indicated on the plans or directed by the Engineer, existing pipe culverts shall be taken up and relaid or extended and renewed in the same manner as specified herein for new pipe culverts.

Where shown on the plans or directed by the Engineer, the Contractor shall connect the proposed drainage system with existing drainage structures or pipes. This work shall be performed in a workmanlike manner.

Where shown on the plans or directed by the Engineer, the Contractor shall plug existing pipes with cement masonry.

For Slotted Drain Pipe: All slotted drain pipe and related fittings shall be handled and assembled in accordance with the manufacturer's instructions except as modified in the contract documents or as ordered by the Engineer.

Placement of concrete shall conform to Article 300000-6.01.03. The Contractor shall ensure all voids are filled with the concrete.

Care shall be taken in placing concrete backfill immediately adjacent to the interceptor drain pipes to avoid damage to the pipe and to prevent pipe misalignment. The concrete shall be thoroughly consolidated using internal vibrators. Sufficient hold-downs shall be provided by the Contractor to prevent the interceptor drain from floating during concrete placement.

The Contractor shall make sure the surface of the concrete shall be sloped towards the slotted drain pipe detailed in the contract documents. The Contractor shall provide a suitable cover for the wall openings to prevent the concrete backfill or any other foreign debris from entering the pipe or sealing the opening during the installation and subsequent curing periods.

Transverse contraction joints shall be either formed or sawed in the concrete backfill at 20-foot (6-meter) intervals unless the concrete abuts concrete curbs. In this case, the transverse joints shall be 3/8 inch (9 millimeters) wide and 2 1/2 inches (65 millimeters) deep. Sawing shall be done within 24 hours after placement. Care shall be taken not to saw into the interceptor drain pipe.

One expansion joint shall be provided in the concrete backfill for every 500 feet (150 meters) of continuous interceptor drain pipe installed or at every location where the concrete backfill abuts a drop inlet, manhole, or other similar structure. This joint shall be formed for the full depth of the backfill concrete and shall be a minimum of 3/4 inch (19 millimeters) in width.

A longitudinal joint shall be provided if the concrete backfill is placed adjacent to a concrete pavement. This joint shall be either formed or sawed 1/4 inch (6 millimeters wide) and 2 1/2 inches (65 millimeters) deep. Finish of concrete will be similar to burlap drag finish.

After curing, the transverse, expansion, and longitudinal joints shall be thoroughly cleaned to remove any contaminants or laitance remaining from forming or saw cutting. Before sealing, a backer rod bond breaking material such as closed cell polyurethane rod shall be placed so that a sealer width to depth ratio of 1:1 will be achieved. The joints shall then be sealed with an elastomeric polymer sealer. The methods and materials used to construct the various joints shall be chosen by the Contractor subject to the approval by the Engineer.

Movement of construction equipment and all other vehicles and loads over and adjacent to any slotted drain pipe shall be done at the Contractor's risk. Any pipe or backfill which becomes damaged or disturbed through any cause shall be replaced or repaired as directed by the Engineer at the expense of the Contractor and at no cost to the State. Suitable temporary crossovers consisting of steel plate or other materials approved by the Engineer shall be employed for a minimum of 7 days following concrete backfill operations in all areas where vehicular traffic must be maintained or until such time as the pipe installation will withstand loading without damage. All concrete surfaces shall receive a protective coating.

End cap installation shall be as recommended by the manufacturer.

SECTION 6.52 CULVERT ENDS

6.52.01—Description:

Work shall consist of furnishing and installing reinforced concrete culvert ends conforming to the details shown on the plans or to commercial details providing equal lengths and a similar shape, and having generally comparable hydraulic characteristics. These reinforced concrete culvert ends shall be placed where and as shown on the plans, or as directed by the Engineer.

Work shall also include furnishing and installing new metal culvert ends at the locations shown on the plans or as directed by the Engineer. These culvert ends shall be of the size, gage and general shape shown on the plans.

6.52.02—Materials:

The materials for this work shall conform to Subarticle M.08.01-11 for Reinforced Concrete Culvert End, Subarticle M.08.01-6 for Metal Culvert End, Article M.11.04 for Mortar and Article M.02.01 for Gravel Fill.

6.52.03—Construction Methods:

Reinforced concrete culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill and accurately aligned as shown on the plans. The joints shall be sealed as specified in Article 300000-6.51.03.

Metal culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill. After the attachment of the culvert end to the culvert, backfill shall be placed around both sides of the unit up to the prescribed surface, exercising caution to avoid displacement or deformation of the unit.

SECTION 7.03 RIPRAP

7.03.01—Description:

Riprap shall consist of angular shaped stones used to protect foundations of piers, abutments, walls, slopes of embankments and waterways from water damage.

7.03.02—Materials:

1. Stone: The stone for this work shall be the type called for on the plans and shall conform to the requirements of Article M.12.02.

2. Bedding: The bedding material for riprap shall conform to the specifications of the material indicated on the plans.

7.03.03—Construction Methods:

The area to be protected by riprap shall be accurately shaped prior to placing of any bedding material or riprap. Where bedding material is called for, it shall be placed on the prepared area and compacted to the depth, lines and grades indicated on the plans.

The riprap shall be placed to its full course thickness in one operation in such a manner as to produce a reasonably well-graded mass of rock without causing displacement of the underlying material. The finished surface shall be free from pockets of small stones and clusters of larger stones. Placing this material by methods likely to cause segregation of the various sizes of stone will not be permitted. Rearranging of individual stones by mechanical or hand methods will be required to the extent necessary to obtain a reasonably well-graded distribution of the specified stone sizes. The completed course shall be of the specified thickness and to the lines and grades as shown on the plans or as ordered by the Engineer.

SECTION 7.08 DAMP-PROOFING

7.08.01—Description:

Damp-proofing of concrete or masonry work shall consist of a coating of asphalt as indicated on the plans and in accordance with these specifications.

7.08.02—Materials:

The materials for this work shall conform to the requirements of Article M.12.05.

7.08.03—Construction Methods:

The surface to which the damp-proofing coating is to be applied shall be cleaned of all loose and foreign material and dirt and shall be dry. Where necessary, the Engineer may require the surface to be scrubbed with water and a stiff brush, after which the surface shall be allowed to dry before the application of the primer.

Concrete, brick or other surfaces which are to be protected by damp-proofing shall be thoroughly clean and dry before the primer is applied. One (1) coat of primer and one (1) coat of sealer shall be applied using methods, application rates and temperature constraints as recommended by the manufacturer of each product.

Care shall be taken to confine all applied material to the areas to be damp-proofed and to prevent disfigurement of any other parts of the structure by dipping or spreading.

SECTION 7.51 UNDERDRAIN AND OUTLETS

7.51.01—Description:

Underdrains shall consist of pipe pervious to water, laid in a trench refilled with pervious material. They shall be of the dimensions and details as indicated on the plans. They shall be classed as "Underdrains," "Foundation Underdrains," "Slope Underdrains" or "Structure Underdrains."

Outlets for underdrains shall consist of pipe laid in a trench and refilled with earth. The size and type of outlet pipe shall be the same as that of the underdrain to which it is connected, except that it shall not be pervious to water.

7.51.02—Materials:

(1) Pipe: The pipe of underdrains and outlets shall conform to the requirements of Article M.08.01. The kind of pipe to be installed shall be at the option of the Contractor unless a specific type of pipe is indicated on the plans.

(2) Aggregates: The aggregates specified for filling the trench shall meet the requirements of Article M.08.03.

(3) Joint Sealants: The materials for sealing and coupling of joints shall conform to the requirements of Article M.08.01.

(4) Geotextile: Geotextile shall conform to Subarticle M.08.01-19 Geotextiles.

7.51.03—Construction Methods:

The trench for the underdrain shall be excavated in conformity with the requirements of Article 300000-6.51.03 for pipe culverts. The dimensions of the trench shall be as indicated on the plans or as ordered. Where the bottom of the trench is unstable or in rock, the trench shall be excavated 6 inches (150 millimeters) deeper and an additional 6 inches (150 millimeters) layer of granular fill or aggregate similar to that used to fill the trench shall be placed and compacted in the trench.

Where the perforations are to be at the bottom of the pipe, the aggregate for filling the trench shall then be placed to a depth of 3 inches (75 millimeters) and tamped true to grade. The pipe shall be placed and firmly bedded on the aggregate. This aggregate shall be placed whether the pipe is encased with geotextile or not.

When the pipe used has a bell, the pipe shall be installed with the bell end upgrade with the spigot end entered fully into the adjacent bell.

When clay or concrete pipe is used, the joints will not have to be filled with a joint sealant or fitted with a gasket.

When metal, bituminized fiber, plastic, polyethylene or asbestos cement pipe is used, the pipe shall be carefully butted together and held by bands or other approved means so as to prevent any displacement of the joint.

After the pipe has been installed as described above, the aggregate shall be placed carefully around and over the pipe to a height of 12 inches (300 millimeters) above the top of the pipe. The remainder of the

trench shall be filled with aggregate and tamped in layers as shown on the plans. When the underdrain pipe is used with the holes in an upward position, and in all cases where sand is used instead of the aggregate described hereinbefore, a protective 3-inch (75-millimeter) minimum layer of 3/8-inch (Size No. 8) aggregate shall be placed over the pipe and around all of the holes. Geotextile may be substituted for the 3- inch (75-millimeter) layer of aggregate. When geotextile is used, the entire length of each drain pipe shall be wrapped with the fabric and the seams lapped and welded or bonded. Where the seams of the geotextile are not welded or bonded, they shall be lapped to a minimum width equal to the diameter of the pipe for 6- inch (150-millimeter) pipe and larger and a minimum of 6 inches (150 millimeters) for smaller pipe.

In all cases where subbase material or gravel is to be placed over the underdrains, a layer of at least 6 inches (150 millimeters) of subbase material or gravel shall be placed over the underdrain immediately after its completion.

For outlets, the trench shall be excavated and the pipe installed in conformity with the requirements of Article 300000-6.51.03.

Where shown on the plans or directed by the Engineer, the Contractor shall connect underdrains or outlets to existing or proposed drainage systems or structures.

This work shall be performed in a workmanlike manner satisfactory to the Engineer by installation of tees or wyes branches or by providing a hole in the main line underdrain.

Where the upgrade end of the underdrain does not enter a structure, it shall be capped or plugged as directed.

SECTION 7.55 GEOTEXTILE

7.55.01—Description:

Work shall consist of furnishing and installing geotextile in the locations and to the dimensions shown on the plans as directed or as approved by the Engineer.

7.55.02—Materials:

Geotextile shall conform to the requirements of M.08.01-19 Geotextiles. Materials incidental to and necessary for the installation of the geotextile, such as, but not limited to sewing thread, staples, pins, etc., shall conform to the requirements of the manufacturer of the geotextile.

7.55.03—Construction Method:

The geotextile shall be installed at the locations and to the dimensions shown on the plans or as directed by the Engineer. Geotextile shall be installed as recommended by the manufacturer for the specific use or purpose intended, or as otherwise approved by the Engineer.

SECTION 8.11 CONCRETE CURBING

8.11.01—Description:

Work shall consist of concrete curbing constructed on the prepared subbase in accordance with the dimensions and details shown on the plans or as ordered and in conformity with these specifications.

Refer to Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-4(d)9 and 16a-38k-4(d)11.

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

8.11.02—Materials:

The concrete for cast-in-place or slip formed curbing shall be Class "C" concrete conforming to the requirements of Article M.03.01. Joint filler shall conform to the requirements of Article M.03.01. The concrete for precast concrete curbing shall have a minimum 28-day compressive strength of 4,000 psi (28 megapascals) and shall contain 5 to 7% entrained air unless otherwise approved by the Engineer. The material for the precast concrete shall conform to Article M.03.01, except the coarse aggregate gradation may be varied with the approval of the Engineer.

8.11.03—Construction Methods:

Construction methods for concrete curbing shall conform to the requirements of Article 300000-6.01.03 for concrete for structures, as supplemented by the following requirements:

1. Excavation: Excavation shall be made to the required depth, and the base upon which the curbing is to be set shall be compacted to a firm, even surface.

2. Placing of Concrete: The concrete shall contain not less than 5% nor more than 7% entrained air at the time the concrete is deposited within the forms. Concrete shall be placed only on a moist base. Concrete shall not be placed on a soft, muddy or frozen base.

Slip form equipment may be used if the resulting product conforms with the plans. Precast concrete curbing may be used if the resulting product conforms with the plans except for the length of each curb unit. Precast concrete curbing units shall be constructed in 6-foot (2-meter) or longer lengths for straight sections.

Where slip form equipment or precast concrete curbing is not used, the concrete shall be placed in forms, struck off with a template, compacted by approved means, and finished to a smooth, even surface. Vibration will not be required.

The concrete curbing shall be constructed in sections having a uniform length of approximately 10 feet (3 meters), unless otherwise directed, so arranged that a joint in the curbing shall come opposite a joint in the adjoining concrete pavement slab and be similar to it. The length of these sections may be varied slightly where necessary for closures, but no section less than 6 feet (2 meters) in length will be permitted. These sections shall be separated by an approved method at the time of placing of the concrete.

3. Forms: Where forms are used, they shall be so constructed that the form for exposed faces may be removed before the concrete has taken final set in order to permit correction of surface irregularities.

4. Curing and Protection: Concrete curbing, except precast curbing, shall be cured and protected in conformity with the requirements of Article 300000-4.01.03 for concrete pavement. Precast curbing shall not be shipped to the project until the 28-day compressive strength is acquired. Precast curbing that has been damaged shall be removed from the project at the Contractor's expense.

5. Backfilling: After the concrete has set sufficiently, the grading shall be completed to the lines shown on the plans, or as ordered, by refilling to the required elevation with approved material which shall be placed in layers of not over 6 inches (150 millimeters) in depth and compacted until firm and solid.

SECTION 9.10 METAL BEAM RAIL

9.10.01—Description:

Work shall consist of the installation of or conversion to a single or double line of steel rail elements fastened to wood or steel posts with or without rubrail, and the appropriate treatment at bridge parapets, barriers, or other fixed objects as shown on the plans. Work shall include metal beam rail types: w-beam, thrie-beam and box-beam. It shall be installed or converted in the locations indicated and fabricated in conformity with the lines, designations, dimensions, and details on the plans or as ordered by the Engineer.

9.10.02—Materials:

The material for metal beam rail shall meet the requirements of Article M.10.02 and the following:

1. Chemical anchoring material shall meet the requirements of Subarticle M.03.01-15.
2. Metal beam rail delineators shall meet the requirements of Subarticle M.18.09-02 and Article M.18.13.
3. When converting rail, the Contractor shall reuse any undamaged existing rail elements, appropriate posts, delineators, and lap bolts within the project limits as approved by the Engineer to construct the converted rail. The Contractor shall use new materials when any components of the existing railing are damaged or missing and cannot be obtained from other rail systems being removed or converted within the Project limits.

9.10.03—Construction Methods:

Steel posts shall be driven. The Contractor shall use suitable driving caps and equipment to prevent damage to the posts during driving. Where rock, boulders or debris are encountered while driving the posts, the obstruction shall be removed to make each hole large enough to permit driving of the posts. Each hole shall then be backfilled with suitable material and thoroughly compacted before driving the posts. Any surplus or unsuitable material remaining after the completed installation shall be removed and disposed of by the Contractor.

Wood posts shall be set in holes, and the area adjacent to the posts shall be backfilled with suitable material and thoroughly compacted. Any surplus or unsuitable material remaining after the completed installation shall be removed and disposed of by the Contractor.

The Contractor is cautioned that underground utilities, which may be energized, may be present within the Project limits.

The posts shall be located as shown on the plans, set plumb and in alignment with the rail or rail treatments. Where required, the blockouts, brackets, rubrails, back-up rails and rail elements shall then be erected to produce a smooth continuous rail as shown on the plans. The terminal connectors, rubrails, and rail elements shall be lapped in the direction of traffic.

Whenever metal beam rail or rail treatments are being constructed adjacent to areas open to traffic, the Contractor shall complete the installation up to and including the designated terminal treatment at the close of each day's work.

On long runs or other locations when it is not practical to complete the installation up to and including the designated terminal treatment by the end of the workday, the Contractor shall use temporary methods to terminate the metal beam rail.

Prior to any rail installations, the Contractor shall submit to the Engineer for review its proposed methods for temporarily terminating the end section.

The Contractor shall furnish posts of sufficient length where field conditions warrant to obtain the depth in the ground shown on the plans.

When existing metal beam rail is being converted, the Contractor may punch or drill a hole in the flange of the existing post to facilitate attachment of the blockout and rail element to the post. No other methods shall be used to create this hole.

End anchorages not needed for the converted rail shall be removed in their entirety.

In the welding of steel plates to the steel posts, the welds shall be of the size and type shown on the plans and shall conform to the applicable requirements of the AWS and supplemented by the following:

1. The Engineer will make a visual inspection of welds. All welds found unacceptable by the Engineer shall be corrected by the Contractor at no additional cost.

Before final erection, all galvanized elements which have been cut or worked so as to damage the zinc coating and cause the base metal to be exposed shall have the exposed base metal thoroughly cleaned and brush coated with two coats of zinc-rich touch-up material in conformance with Subarticle M.10.02-8.

SECTION 9.11 METAL BEAM RAIL ANCHORAGES

9.11.01 - Description:

This work shall consist of installing metal beam rail end anchorages of the type shown on the plans or as ordered by the Engineer.

9.11.02 - Materials:

The materials for this work shall conform to the requirements of Subarticle M.10.027.

Non-shrink grout shall conform to the requirements of Subarticle M.03.01-12.

9.11.03 - Construction Methods:

Anchorages, channels, rails, w-beam terminal elements, and fittings shall be installed as indicated on the plans. The excavated area for the anchorages shall be backfilled with suitable material and compacted in 6-inch (150 millimeters) layers. Any surplus material remaining after the completed installation shall be removed by the Contractor.

When the rail is anchored to rock, preparation of the rock including rock removal and the drilling of holes shall be as shown on the plans. The diameter of the holes shall be sufficient to permit the placement of the bolts and the non-shrink grout, but shall not exceed twice the diameter of the bolts. The bolt holes shall be blown clean with an air jet prior to installing the bolts and non-shrink grout. Spalled areas behind the steel plate shall be filled with non-shrink grout.

The rail elements shall be lapped in the direction of traffic.

Before final erection, all galvanized elements which have been cut or worked so as to damage the zinc coating and cause the base metal to be exposed shall have the exposed base metal thoroughly cleaned and brush coated with zinc-rich touch-up material in conformance with Subarticle M.10.02-8.

SECTION 9.12 REMOVE AND RESET POSTS, RAIL AND RAIL ANCHORAGES

9.12.01 - Description:

This work shall consist of removing or resetting existing single posts, anchorages, cable guide rail and a single or double line of metal beam rail in the locations indicated on the plans or as ordered by the Engineer.

9.12.02 - Materials:

When resetting rail, the Contractor shall reuse any undamaged existing rail elements, appropriate posts, delineators, and lap bolts within the Project limits, as approved by the Engineer to construct the reset rail. The Contractor shall use new materials conforming to the requirements of M.10 to replace any parts of the existing rail system that are damaged or missing and cannot be obtained from other rail systems being removed or reset within the Project limits.

9.12.03 - Construction Methods:

The Construction Methods for Section 9.10 and 9.11, when applicable, shall apply to the resetting of existing rail systems.

Prior to commencement of work, the Contractor and Engineer shall inventory the existing rail systems within the Project limits to determine which materials are suitable for reuse.
If resetting or removing railing, the Contractor must complete that work, including any required grading and any replacement of materials, by the end of each day's work. When it is not practical to complete such rail work by the end of the day's work, the Engineer may allow the Contractor to temporarily attach the existing rail to the new rail, concrete barrier curb or temporary terminal treatment.

SECTION 9.13 CHAIN LINK FENCE

9.13.01—Description:

Work shall consist of furnishing and installing woven wire fencing and gates of the type and height specified and supported by metal posts erected where indicated on the plans or as ordered and in conformity with these specifications.

9.13.02—Materials:

The materials for this work shall conform to the requirements of Article M.10.05.

When aluminum-coated steel fabric is used, the posts and hardware will be galvanized.

When aluminum fabric is used, the posts and hardware will be aluminum.

When polyvinyl chloride-coated steel fabric is used, the posts and hardware will be polyvinyl chloridecoated.

Where the term "Chain Link Fence" is called for, the Contractor shall have the option of using either aluminum chain link fence or aluminum-coated chain link fence. However, only one type of chain link fence shall be used on the project.

9.13.03—Construction Methods:

The posts shall be spaced in line of fence not further than 10 feet (3meters) on centers. Intermediate or line posts, except where indicated on the plans, may be driven by mechanical means. A suitable driving cap shall be used to insure that no damage is caused to the post, galvanization or polyvinyl chloride coating. Posts not driven, and all other type posts shall be set in portland cement concrete acceptable to the Engineer.

In earth, the hole for the concrete footing shall extend at least 4 inches (100 millimeters) below the bottom of the post but not less than 9 inches (225 millimeters) in diameter for all line posts and 12 inches (300 millimeters) in diameter for terminal, pull or corner posts. The tops of the concrete footings shall be crowned to shed water.

When ledge rock is encountered, the posts shall be set in holes drilled into rock at least 12 inches (300 millimeters) in depth and grouted or otherwise firmly held in correct position.

For fence 5 feet (1.5 meters) in height or less where runs of fence are 100 feet (30 meters) or over, end posts shall be braced. All corner posts where runs are over 100 feet (30 meters) in either direction shall have two braces. For fence more than 5 feet (1.5 meters) in height, end posts shall be braced; and corner posts shall have two braces.

Pull posts with two braces shall be provided for all heights where changes in horizontal or vertical alignment of ten (10) degrees or more occur.

Where braces are required, they shall be spaced as indicated on the plans.

Braces shall be securely fastened to posts by suitable connections and trussed from line post back to post requiring bracing with 3/8-inch (9.5-millimeter) round rod, having a turnbuckle adjustment.

Where a top rail is used, it shall pass through the base of the line post cap and form a continuous brace from end to end of fence. The rail shall be provided with couplings approximately every 20 feet (6 meters).

The couplings shall be of the outside-sleeve type and at least 7 inches (175 millimeters) long, one coupling in every five to have a heavy spring to take up expansion and contraction in the top rail.

Fabric shall be fastened to line posts with bands or wire clamps of No. 6-gage aluminized or PVC coated steel wire 4 3/4 inches (120 millimeters) long. These bands shall be spaced approximately 14 inches (350 millimeters) apart. The fabric shall be fastened to the top rail with tie wires. These tie wires shall be 6 1/4 inches (160 millimeters) long, spaced approximately 24 inches (600 millimeters) apart.

If a top rail is not specified, a top tension wire shall be provided. The tension wire shall be one continuous length between pull posts. Sufficient tension shall be applied to provide a wire without a visible sag between posts. Tension wires shall be tied or otherwise fastened to end, gate, corner or pull posts by a method acceptable to the Engineer. Ties or clips shall be provided for attaching the tension wire to the fabric at intervals not exceeding 2 feet (600 millimeters).

Where it is not practicable to conform the fence to the general contour of the ground, as at ditches, channels, etc., the opening beneath the fence shall be enclosed with chain link fabric and sufficiently braced to preclude access, but not to restrict the flow of water.

Fabric shall be fastened to the end of the gate frames by stretcher bars and fabric bands, and to the top and bottom of the gate frames by tie wires in the same manner as specified for the chain link fence fabric.

The drop bar locking device for the gate shall be provided with a footing of portland cement concrete crowned at the top to shed water and provided with a hole to receive the locking bar. A heavy-duty padlock with 2 keys shall be furnished by the Contractor for each gate or set of double gates. The size of the footing and depth of penetration of the locking bar into the footing shall be as specified by the manufacturer of the locking device.

SECTION 9.21 CONCRETE SIDEWALKS

9.21.01—Description:

Work shall consist of concrete sidewalks constructed on a gravel or reclaimed miscellaneous aggregate base course in the locations and to the dimensions and details shown on the plans or as ordered and in accordance with these specifications.

9.21.02—Materials:

Materials for this work shall conform to the requirements of Article M.03.01 for Class "C" Concrete.

Air-entraining Portland cement and air-entraining admixtures shall conform to Article M.03.01

Gravel or reclaimed miscellaneous aggregate for base shall conform to Article M.02.01 for granular fill.

The concrete sidewalk constructed as a pad adjacent to a traffic control foundation, shall conform to the requirements of Article M.03.01 for Class "A" Concrete.

9.21.03—Construction Methods:

1. Excavation: Excavation, including removal of any existing sidewalk, shall be made to the required depths below the finished grade, as shown on the plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.

When connecting new concrete sidewalk to a section of existing concrete sidewalk, the connection point shall be at the nearest joint in the existing sidewalk.

2. Gravel or Reclaimed Miscellaneous Aggregate Base: The gravel or reclaimed miscellaneous aggregate base shall be placed in layers not over 6 inches (150 millimeters) in depth and to such a depth that after compaction it shall be at the specified depth below the finished grade of the walk. The base shall be wetted and rolled or tamped after the spreading of each layer.

3. Forms: Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the pressure of the concrete. If made of wood, they shall be of 2-inch (38-millimeter) surfaced plank except that at sharp curves thinner material may be used. If made of metal, they shall be of approved section and shall have a flat surface on the top. Forms shall be of a depth equal to the depth of the sidewalk. Forms shall be securely staked, braced and held firmly to the required line and grade and shall be sufficiently tight to prevent leakage of mortar. All forms shall be cleaned and oiled or wetted before concrete is placed against them. Sheet metal templates 1/8 inch (3 millimeters) in thickness, of the full depth and width of the walk, shall be spaced at intervals of 12 feet (4 meters) or as directed. If the concrete is placed in alternate sections, these templates shall remain in place until concrete has been placed on both sides of the template. As soon as the concrete has obtained its initial set, the templates shall be removed.

4. Concrete: The concrete shall be proportioned, mixed, placed, etc., in accordance with the provisions of Section 6.01 for Class "C" Concrete, except as modified herein.

The concrete shall contain not less than 5% or more than 7% entrained air at the time the concrete is deposited in the forms.

Air-entrainment shall be obtained and the concrete cured in accordance with the provisions of Article 300000-4.01.03 for Concrete Pavement.

5. Finishing: The surface of the concrete shall be finished with a wood float or by other approved means. The outside edges of the slab and all joints shall be edged with a 1/4-inch (6-millimeter) radius edging tool. Each slab shall be divided into two or more sections by forming dummy joints with a jointing tool as directed.

6. Backfilling and Removal of Surplus Material: The sides of the sidewalk shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk. All surplus material shall be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer.

SECTION 9.39 SWEEPING FOR DUST CONTROL

9.39.01—Description:

Work shall consist of furnishing a pickup sweeper and accessory equipment and utilizing it for the removal of earth and/or other dust producing materials from paved surfaces for the purpose of allaying dust conditions.

9.39.03—Construction Methods:

The Contractor shall have available and maintain in operable condition equipment capable of efficiently sweeping up earth and/or other materials from paved surfaces.

This equipment shall include suitable provisions for the application of water ahead of the sweeping brooms to prevent dusting, for the pickup, internal storage and removal of sweepings, and for the cleaning of areas of heavy accumulation beyond the capacity of the sweeper.

The sweeping operations shall be under the control of the Engineer at all times. Sweeping shall take place at locations and times directed by the Engineer. The disposal of all sweepings shall meet with the approval of the Engineer.

SECTION 9.43 WATER FOR DUST CONTROL

9.43.01—Description:

Work shall consist of furnishing water equipment, water, and applying it for the purpose of allaying dust conditions.

9.43.03—Construction Methods:

The application of water shall be under the control of the Engineer at all times. It shall be applied only at locations at such times, and in the amount as may be directed by the Engineer.

The Contractor shall have available and maintain in an operable condition at all times, sufficient equipment for the purpose of applying water for dust control. This equipment shall consist of pipelines, tanks, tank-trucks, pumps, meters, hose, distributors or other devices approved by the Engineer. A suitable device for a positive shutoff and for regulating the flow of water shall be located so as to permit positive operator control.

SECTION 9.44 TOPSOIL

9.44.01—Description:

This work shall consist of furnishing, placing and shaping topsoil in areas shown on the plans or where directed by the Engineer. The topsoil shall be placed to a depth of 4 inches (100 mm) unless stated otherwise in the contract.

Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-4(d)9 and 16a-38k-4(d)11 .

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

9.44.02—Material:

The material shall conform to the requirements of Subarticle M.13.01-1.

9.44.03—Construction Methods:

The Contractor shall notify the Engineer of the location of the topsoil at least 15 calendar days prior to delivery. The topsoil and its source shall be inspected and approved by the Engineer before the material is delivered to the project. Any material delivered to the project, which does not meet specifications or which has become mixed with undue amounts of subsoil during any operation at the source or during placing and spreading, will be rejected and shall be replaced by the Contractor with acceptable material at no cost to the State.

The areas on which topsoil is to be placed shall be graded to a reasonably true surface. Topsoil shall then be spread and shaped to the lines and grades shown on the plans, or as directed by the Engineer. The required depth to which the topsoil is to be placed is to be the depth after settlement of the material has taken place. All stones, roots, debris, sod, weeds and other undesirable material shall be removed. After shaping and grading, all trucks and other equipment shall be excluded from the topsoiled area to prevent excessive compaction. The Contractor shall perform such work as required to provide a friable surface for seed germination and plant growth prior to seeding.

During hauling and spreading operations, the Contractor shall immediately remove any material dumped or spilled on the shoulders or pavement.

It shall be the Contractor's responsibility to restore to the line, grade and surface all eroded areas with approved material and to keep topsoiled areas in acceptable condition until the completion of the construction work.

SECTION 9.49 FURNISHING, PLANTING AND MULCHING TREES, SHRUBS, VINES AND GROUND COVER PLANTS

9.49.01—Description:

The work shall consist of furnishing, planting and mulching trees, shrubs, vines and ground cover plants of the type and size indicated on the plans. It shall also include all incidental operations, such as the care of the living plants and the replacement of dead and unsatisfactory plants or unsatisfactory materials before final acceptance of the contract.

Division 01, High Performance Buildings Requirements Section 018113.13 for credit 16a-38k-4(d)9 and 16a-38k-4(d)11 .

The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

9.49.02—Materials:

The material for this work shall conform to the requirements of Section M.13.

9.49.03—Construction Methods:

Construction methods shall be performed in accordance with these specifications.

The Contractor is cautioned that within the limits of any project, buried cable for illumination or utilities, which may be energized, may be present.

1. Planting Season: Unless otherwise shown on the plans or directed by the Engineer, the planting seasons shall be those indicated below. No planting shall be done in frozen ground or when snow covers the ground, or the soil is otherwise in an unsatisfactory condition for planting.

Deciduous Material

Spring: March 1st to May 1st (inclusive) except for balled and burlapped material, the planting of which will terminate on May 15th.

Fall: From October 15th until the ground freezes. Such plants, as may be designated elsewhere in the contract documents, shall be planted in the spring planting season only.

Evergreen Material

Spring: March 1st to June 1st (inclusive).

Fall: August 15th to October 1st (inclusive).

2. Protection: Plants received by the Contractor shall be kept moist, fresh and protected against exposure to sun, wind and freezing temperatures whether in the receiving yard, in transit, while being handled or in temporary storage on the job site awaiting planting. Bare-root plants, which are not planted immediately upon receipt, shall be heeled-in in trenches with the bundles opened, the plants separated and all roots covered so as to leave no air spaces. Balled and burlapped plants shall have their earth balls covered by earth, wood chips, cloth, straw or other suitable material which shall be kept moist.

3. Layout: Plant material locations and bed outlines will be staked on the project site by the Engineer-Designer or his designee in the presence of the Contractor, or his representative, before any plant pits or beds are excavated. Request by the Contractor for the staking of the plant layout shall be at least 48 hours, excluding weekends and holidays, prior to the date he wishes to have the layout staked. Labor, equipment and new, smooth stakes of approved quality are to be furnished by the Contractor for this purpose.

4. Excavation: Excavation for planting beds and pits shall conform to the approved staked locations and outlines. The latter shall be neatly formed by means of spades or other approved tools. All sod, weeds, roots and other objectionable material excavated from the plant beds or pit sites which are unsuitable for backfill shall be removed from the site immediately and disposed of by the Contractor in a manner satisfactory to the Engineer.

The Contractor at his option may apply, prior to excavating plant pits in designated planting bed locations, at no expense to the State, a post-emergent aqueous spray treatment of Glyphosate (isopropylamine salt of glyphosate) 41% acid equivalent (ae) to the existing bed vegetation in accordance with the manufacturer's recommendations for perennial vegetation control, instead of excavating the planting bed.

A minimum of fourteen (14) days post application, or when the perennial species shows the visible effects of the treatment, the Contractor shall mow, at no expense to the State, all treated bed areas to a maximum height of 4 inches (100 millimeters).

Plant pits may then be excavated, and the excavated soil and vegetative debris shall then be immediately removed from the project site.

In planting bed areas following the excavation of the pits, but before the installation of plant material, the remaining turf grasses and unwanted vegetation shall be sprayed, unless otherwise directed by the Engineer, with Glyphosate at the manufacturer's recommended rate.

5. Pits: The pit diameters shall be twice the diameter of the root-spread or container diameters, and shall be 2- inches (50 millimeters) less than the height of the rootball measured from the bottom of the ball to the root collar. (i. e. A 12-inch (300 millimeters) measurement between the root collar and the bottom of the rootball will require a 10-inch (250 millimeters) deep pit). Any excavation in excess of that required shall be replaced with planting soil and compacted to the satisfaction of the Engineer.

6. Obstructions Below Ground: Any rock or underground obstruction shall be removed to the depth necessary for planting as specified, unless other locations for the planting are approved by the Engineer. If removal of obstructions results in a deeper hole than needed for planting, backfill material shall be added and compacted to the satisfaction of the Engineer.

7. Backfill: Backfill shall conform to M.13.01-1 Planting Soil.

8. Setting Plants: All plants shall be plumb and at a level that is 2-inches (50 millimeters) higher than the surrounding ground. Backfill material for all plants shall be thoroughly and properly settled by firming or tamping. Thorough watering shall accompany backfilling. Saucers capable of holding water shall be formed at individual plants (exclusive of plant beds) by placing ridges of planting soil around each, or as directed by the Engineer.

a. Balled and Burlapped plants: Plants shall be handled in such manner so that the soil will not be loosened from the roots inside of the ball. Carefully place the plant into the prepared pits and backfill with planting soil to one - half the depth of the pit, thoroughly tamp to the satisfaction of the Engineer around the ball. Fill the remaining area of the pit with water. Once water has completely drained, loosen the bur-

lap and peel down the top one third. If wire baskets are used, cut and bend down the top third of the basket.

Roots that have been wrapped around the ball within the burlap shall be straightened and the remainder of the pit filled with planting soil tamped to ensure that no air pockets remain.

b. Container Grown Plants: Carefully remove the plant from the container over the prepared pits. Gently loosen the soil and straighten all roots as naturally as possible. Place into the bottom of the pit. Backfill with planting soil to one - half the depth of the pit. Thoroughly tamp to the satisfaction of the Engineer.

Fill remaining area of the pit with water. Once water has completely drained fill the remainder of the pit with planting soil tamped to ensure that no air pockets remain.

c. Bare-roots Plants: Carefully spread roots as naturally as possible and place into the bottom of the pit. All broken or frayed roots shall be cleanly cut off. Backfill with planting soil to one - half the depth of the pit. Thoroughly tamp to the satisfaction of the Engineer. Fill remaining area of the pit with water. Once water has completely drained fill the remainder of the pit with planting soil tamped to ensure that no air pockets remain.

9. Fertilizing: Shrub beds shall be fertilized at the rate of 3 pounds per 100 square feet (1.3 kilograms per 9 square meters) of surface area (broadcast). The fertilizer shall be uniformly applied to the surface of the beds and worked into the upper 2 inches (50 millimeters) of soil. Individual trees shall be fertilized at the rate of 2 pounds per inch (1 kilogram per 25 millimeters) of trunk diameter, and the fertilizer shall be mixed into the upper 2 inches (50 millimeters) of soil.

A second application of fertilizer shall be applied to all plants at the same specified rates over the woodchip mulch at the end of the period of establishment.

10. Watering: All plants shall be watered upon setting and as many times thereafter as conditions warrant.

The following is a guide for minimum requirements:

Trees:

2 ½” Caliper and less – Fifteen (15) gallons each.
3” to 5” Caliper – Twenty (20) gallon each.
5 ½” Caliper and above – Twenty-five (25) gallon each.

Shrubs:

24” and less – Six (6) gallon each.
More than 24”- Ten (10) gallon each.
Vines, Perennials, and Ornamental Grasses – Three (3) gallons each.

Groundcovers and Bulbs – Two (2) gallons per square foot.

Water shall be applied at a controlled rate and in such a manner to ensure that the water reaches the root zone (saucer) of the plant or plant bed and does not run off to adjacent areas. Watering shall be applied in a manner that does not dislodge plants, erode soil or mulch, or cause damage to saucer.

The Contractor may use slow-release, drip irrigation bags for watering in accordance with manufacturer's instructions. The use of these portable/temporary irrigation bags will require the approval of the Engineer. Overhead hydro-seeder spray nozzles shall not be used as watering devices.

11. Guying and Staking: Immediately after planting, trees shall be guyed or staked as shown on the planting detail sheet of the plans, or as directed by the Engineer. Guy wires, hose and tree support stakes shall be removed after the initial establishment period.

12. Wrapping: Wrapping shall be placed around all trunks of deciduous trees 2 inches (50 millimeters)

or more in caliper or as directed by the Engineer. The wrapping shall start at the base of trees, shall cover the entire trunk surfaces, and shall terminate at the first branches. The wrapping shall be tied at top, bottom, and at intervals of not more than 2 feet (600 millimeters). Wrapping shall be done at the time of planting but not before inspection of the plant.

13. Pruning: As directed by the Engineer, plants shall be pruned at the project site before or immediately after planting in accordance with the best horticultural practice. No leader shall be cut unless directed by the Engineer. Broken, or badly bruised branches, sucker growth, etc., shall be removed with clean cuts.

14. Spraying: Spraying with antidesiccant shall be at the Contractor's discretion and as approved by the Engineer at no additional cost to the State.

15. Mulching: Following the plant material installations woodchip mulch (or gravel mulch when specifically called for on the plans) shall be hand placed and spread to a depth of 4 inches (100 millimeters) and raked to an even surface over all saucer areas for individual trees and shrubs and over the entire area of shrub beds and elsewhere as directed.

16. Repair: Repair of existing grass areas damaged by the Contractor in the progress of his work shall be the responsibility of the Contractor, who shall restore the disturbed areas to their original condition at no additional expense to the State.

17. Establishment Period: All plant material shall be subject to a One-Year Establishment Period.

During this time, the Contractor shall use currently accepted horticultural practices to keep all plant material installed in a healthy, vigorous growing condition at the date of final acceptance. The date of final acceptance shall be one full calendar year following the satisfactory completion of the planting activities as confirmed by the Engineer.

An inspection will be held one year from the date of installation with the Contractor, Engineer, and Landscape Designer to determine the acceptability of the plant establishment. An inventory of losses and rejected materials will be made and corrective and necessary clean up measures will be determined at the plant inspection.

SECTION 9.4911 - PROTECTIVE FENCING

9.4911.01 – Description:

The work shall consist of protecting and maintaining the existing trees and shrubs located within the limits indicated on the plans. Protection and maintenance work shall include furnishing and installing Protective Fencing.

9.4911.02 – Materials:

Protective fencing shall consist of a 5 feet high, orange safety delineator fence with 7 to 8 feet long posts of high carbon steel, drive type, with spade anchors.

9.4911.03 - Construction Methods:

1. General: All tree protection and maintenance work shall be performed in compliance with the National Arborist Association and the American National Standards Institute (ANSI) Publication: ANSI Z 133.1 "Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees, and for Cutting Brush."

The Contractor, the Department's representative, the Engineer, and the Landscape designer shall meet on the site to discuss all aspects of tree protection and maintenance prior to the commencement of any work, including clearing and grubbing operations. This meeting will include the field inspection of the staked limit of grading to review the existing vegetation and to identify any field modifications to the work.

No excavated material or construction materials are to be stockpiled within the drip line of any tree. Tree root systems shall be protected from smothering, flooding, erosion, and excessive wetting resulting from dewatering operations; and from run-off, spillage, and drainage of solutions containing materials which would be deleterious to tree roots. Parking and vehicular traffic will not be permitted within the tree's drip lines. Foot traffic over tree roots shall be restricted to prevent excessive compaction of soil over root systems.

2. Protective fencing: The Contractor shall install protective fencing along the edge of the drip line by driving posts 8 to 10 feet on centers into the ground to support the fence material firmly. The installations shall be maintained or replaced until they are no longer necessary for the purpose intended or as ordered by the Engineer. In areas where construction falls within the drip line of trees, fencing shall be removed and replaced as work near the trees is completed, to prevent excessive soil compaction.

SECTION 9.4943 - ROOT PRUNING

9.4943.01 – Description:

This item shall consist of protecting and maintaining the existing trees and shrubs located within the limits indicated on the plans. Protection and maintenance work shall include Root Pruning.

9.4943.02 - Construction Methods:

1. General: All tree protection and maintenance work shall be performed in compliance with the National Arborist Association and the American National Standards Institute (ANSI) Publication: ANSI Z 133.1 "Safety Requirements for Pruning, Trimming, Repairing, Maintaining and Removing Trees, and for Cutting Brush."

The Contractor, the Department's representative, the Engineer, and the Landscape Designer shall meet on the site to discuss all aspects of tree protection and maintenance prior to the commencement of any work, including clearing and grubbing operations. This meeting will include the field inspection of the staked limit of grading to review the existing vegetation and to identify any field modifications to the work.

No excavated material or construction materials are to be stockpiled within the drip line of any tree. Tree root systems shall be protected from smothering, flooding, erosion, and excessive wetting resulting from dewatering operations; and from run-off, spillage, and drainage of solutions containing materials which would be deleterious to tree roots. Parking and vehicular traffic will not be permitted within the tree's drip lines. Foot traffic over tree roots shall be restricted to prevent excessive compaction of soil over root systems.

2. Root Pruning: The Contractor shall operate a trenching machine, vibratory knife, or rock saw along the outside limits of grading prior to clearing and grubbing operations. The activity involves clean cutting tree roots to minimize the construction activity shock to the affected trees. Unless otherwise instructed by the Engineer, root pruning shall be performed to a depth of 2.5 feet only in the vicinity of existing trees. When a trenching machine is used, the trench shall be immediately backfilled with soil removed or organic soil. This root pruning operation shall occur prior to protective fencing and clearing and grubbing

SECTION 9.50 TURF ESTABLISHMENT

9.50.01—Description:

The work included in this item shall consist of providing an accepted stand of grass by furnishing and placing seed as shown on the plans or as directed by the Engineer.

9.50.02—Materials:

The materials for this work shall conform to the requirements of Section M.13. The following turf seed mix shall be used:

1. Turf Seed Mix:

In order to preserve and enhance the diversity, the source for seed mixtures shall be locally obtained within the Northeast USA including New England, New York, Pennsylvania, New Jersey, Delaware, or Maryland. One approved seed mixture is detailed below. Other proposed mixtures must be approved by the Conn DOT Landscape Design office.

Proportion (Percent)	Species Common name	Scientific name
20	Abbey Kentucky Bluegrass	Poa pratensis
10	Envicta Kentucky Bluegrass	Poa pratensis
25	Pennlawn Red Fescue	Festuca rubra
15	Ambrose Chewing Fescue	Festuca rubra
30	Manhattan Ryegrass	Lolium perenne

9.50.03—Construction Methods:

Construction Methods shall be those established as agronomically acceptable and feasible and that are approved by the Engineer. Rate of application shall be field determined in Pure Live Seed (PLS) based on the minimum purity and minimum germination of the seed obtained. Calculate the PLS for each seed species in the mix. Adjust the seeding rate for the above composite mix, based on 250 lbs. (274 kg.) per acre (hectare).

1. Preparation of the Seedbed:

(a) Level areas and lawns: These areas shall be made friable and receptive for seeding by disking or by other approved methods to the satisfaction of the Engineer. In all cases the final prepared and seeded soil surface shall meet the lines and grades for such surface as shown in the plans, or as directed by the Engineer.

(b) Slope and Embankment Areas: These areas shall be made friable and receptive to seeding by approved methods which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.

(c) All areas to be seeded shall be reasonably free from weeds taller than 3 inches (75 millimeters).

Removal of weed growth from the slope areas shall be by approved methods, including hand-mowing, which do not rut or scar the slope surface, or cause excessive disruption of the slope line or grade. Seeding on level areas shall not be permitted until substantially all weed growth is removed. Seeding on slope

areas shall not be permitted without removal or cutting of weed growth except by written permission of the Engineer.

2. Seeding Season: The calendar dates for seeding shall be:

Spring—March 15 to June 15

Fall—August 15 to October 15

All disturbed soil areas shall be treated during the seeding seasons as follows:

(a) Areas at final grade: Seeding will be accomplished.

(b) "Out-of-season" seedings shall be performed in the same manner as "in-season" seedings. Since acceptable turf establishment is less likely, the Contractor shall be responsible for "in-season" reseeding until the turf stand conforms to Article 300000-9.50.03-5.

(c) During "out-of-season" periods unseeded areas shall be treated in accordance with Section 300000-2.10, Water Pollution Control.

3. Seeding Methods: The grass seed mixture conforming to Article M.13.04 shall be applied by any agronomically acceptable procedure. The rate of application shall be no less than 175 pounds per acre (195 kg/hectare).

Fertilizer conforming to M.13.03 shall be initially applied at a rate of 320 pounds per acre (360 kilograms/hectare) during or preceding seeding. When wood fiber mulch is used, it shall be applied in a water slurry at a rate of 2,000 pounds per acre (2250 kilograms/hectare) with or immediately after the application of seed, fertilizer and limestone. When the grass seeding growth has attained a height of 6 inches (150 millimeters), the specified areas designated herein shall be mowed to a height of 3 inches (75 millimeters). Following mowing, all seeding grass areas (mowed and un-mowed) shall receive a uniform application of fertilizer hydraulically placed at the rate of 320 pounds per acre (360 kilograms/hectare).

4. Compaction: The Contractor shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the Contractor shall rework the soil to make a suitable seedbed; then re-seed and mulch such areas with the full amounts of the specified materials, at no extra expense to the State.

5. Stand of Perennial Turf Grasses: The Contractor shall provide and maintain a uniform stand of established turf grass species having attained a height of 6 inches (150 millimeters) consisting of no less than 100 plants per square foot (1100 plants per square meter) throughout the seeded areas until the entire project has been accepted.

6. Establishment: The Contractor shall keep all seeded areas free from weeds and debris, such as stones, cables, baling wire, and he shall mow at his own expense, on a one-time-only basis, all slopes 4:1 or less (flatter) and level turf established (seeded) areas to a height of 3 inches (75 millimeters) when the grass growth attains a height of 6 inches (150 millimeters).

Clean-up shall include, but not be limited to, the removal of all debris from the turf establishment operations on the shoulders, pavement, and/or elsewhere on adjacent properties publicly and privately owned.

7. Erosion Control Matting: Erosion control matting shall be installed following seeding where called for on the plans or as directed by the Engineer. Staples shall be installed as per Manufacturer's recommendations. Where two lengths of matting are joined, the end of the up-grade strip shall overlap the down-grade strip.

The Contractor shall maintain and protect the areas with erosion control matting until such time as the turf grass is established. The Contractor shall replace or repair at his own expense any and all erosion control matting areas damaged by fire, water or other causes including the operation of construction equipment.

No mowing will be required in the locations where erosion control matting is installed.

SECTION 9.52 CONTROL AND REMOVAL OF INVASIVE VEGETATION

9.52.01 – Description:

This work shall include all materials, labor and equipment necessary for the identification, eradication, removal, and disposal of unwanted vegetation in locations either indicated on the plan sheets or as directed by an Environmental Scientist from the Connecticut Department of Transportation's Office of Environmental Planning (OEP). While any and all invasive species, including those listed on the website for the Connecticut Invasive Plant Working Group's (CIPWG) Invasive Plants Council (http://www.hort.uconn.edu/cipwg/IPC.html), may be subject to eradication at the direction of the Environmental Scientist, the following species must always be eradicated: tree-of-heaven (*Ailanthus altissima*), Russian and autumn olive (*Elaeagnus angustifolia and E. umbellata*), smooth buckthorn *(Rhamnus cathartica)* and glossy buckthorn (*Frangula alnus*), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), winged euonymus (*Euonymus alata*), shrub honeysuckles (*Lonicera maackii, L. morrowii, L. tartarica,L. X bella, L. xylosteum*), privet (*Ligustrum obtusifolium, L. ovalifolium, L. sinense, L. vulgare*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese knotweed (*Polygonum cuspidatum*), common reed *(Phragmites australis)*, and reed canary grass (*Phalaris arundinacea*). If project-specific invasive species additional to those listed above need to be removed, the Environmental Scientist will give appropriate direction.

All vegetation designated for removal shall be eradicated in its entirety in accordance with the methods submitted by the Contractor and approved by the Environmental Scientist. Some work will be completed within areas where desirable species are present and will remain. The Contractor will be responsible for protection of desirable species that are to remain.

9.52.02 – Materials:

Mechanical removal shall consist of either manual labor, utilizing a weed wrench or other approved machine, or some other approved method that will enable removal of all root pieces and other parts of the target species while minimizing soil disturbance and avoiding any spread of invasive plant material. Where large infestations of invasive/unwanted vegetation are present and identified on the plans, removal via over-excavation of such vegetation and the underlying soils may be required

All herbicides shall be registered for the species being treated and shall be formulated as applicable for target-species foliar treatment, cut surface, or injection applications. Where work in or immediately adjacent to wetlands is necessary, the product label(s) for any chemical/adjuvant formulation applied must indicate that the formulation is approved for aquatic environments.

9.52.03 – Construction Methods:

The Contractor shall have sole responsibility for identifying all invasive species present within the invasive removal areas called out in the contract documents prior to the Pre-Construction Meeting. The Contractor shall submit the required invasive removal plan at the Pre-Construction Meeting for the review and approval of the Environmental Scientist. This plan shall include a list of all invasive species present on site, along with a schedule of operations and an outline of construction methodologies for the required control and removal of invasive vegetation specific to each species listed.

While the Environmental Scientist will review the Contractor's delineation and removal plan, the Contractor must be competent to identify invasive vegetation at all times of the year and to prepare a plan for its eradication without assistance.

During the Pre-Construction Meeting, a field review shall be scheduled so that the Contractor and the Environmental Scientist can review the areas of invasive species removal, the specific species required to be removed, and the Contractor's submitted invasive species control plan. At this time, the Environmental Scientist may designate areas for removal that are additional to those shown on the plans. If changes are required to the originally submitted plan, these changes must be submitted to the Environmental Scientist at least 10 days prior to beginning work.

Upon receiving a Notice to Proceed, the Contractor will delineate all areas designated for invasive species removal. The Contractor will be responsible for maintaining this delineation throughout the life of the contract.

The Contractor will not be allowed to begin construction activities in the designated removal areas until all schedules, outlines, and methodologies are approved in writing by the Environmental Scientist. This schedule must take into consideration the time period required between herbicide application and the physical removal of the target species wherever such removal is to occur. No removal work can occur for a minimum of two weeks after herbicide application. In all cases, the submitted schedule shall consider mechanical methods for removal before proposing herbicide application.

The schedule and outline shall include:

1) The type(s) of invasive species identified in the designated area(s);

2) Species specific treatment methods describing a full course of treatment for each species to achieve eradication. These methods must show:

    a. Removal methods planned (e.g. pulling, cutting, spraying, etc);
    b. Types and concentrations of any herbicides to be used, including any adjuvants; and
    c. Schedules showing dates and types of initial, intermediate and final treatments;

3) Any construction activities planned in designated removal area(s) during the eradication period;

4) Disposal methods, including:

    a. Onsite methods and locations; and
    b. Requests for off-site disposal locations;

5) Proof of DEP licensure for herbicide application;

6) A description of safety equipment required; and

7) Procedures for handling chemical spills.

The Contractor shall also:

a. Maintain the labels for herbicides being used in his/her possession;
b. Provide OEP with a 10 day work notice prior to proceeding so that the Environmental Scientist can schedule to be present when appropriate;
c. Conduct all herbicide formulations and applications, including the addition of appropriate surfactants and other adjuvants, in strict conformance with the manufacturer's recommendation and per requirements of regulatory agencies; and

d. Maintain a written record of herbicide application, including the formulation, concentration, area treated, and date for each application, to be provided by the commercial applicator and submitted to the Environmental Scientist following each treatment.

A "treatment period" for each designated area will be derived from the schedule submitted by the Contractor and determined by the following:

1) The first treatment date of the earliest treatable vegetation; and

2) The last treatment date of the latest treatable vegetation

It is anticipated that many species will require more than one season to obtain complete eradication. The treatment period must take into consideration those species that will require follow up treatments and more than one season for complete eradication. Upon completion of the treatment period, the Contractor shall notify the Environmental Scientist in writing of the status of eradication. If the eradication has not been successful, the Contractor shall also submit additional treatment plans. If the Contractor believes that eradication has been achieved, the Contractor shall request a site inspection by the Environmental Scientist for concurrence. If the Environmental Scientist concurs that eradication has been achieved, the area will be subject to a one (1) year warranty starting on the first day following the inspection by the Environmental Scientist. During this period the Contractor will be responsible for any further occurrences of the invasive species inside the delineated area.

The Contractor will be responsible for removal and eradication of all plant material deemed as invasive or unwanted within the delineated area(s) for the duration of the project or until relieved of responsibility of the removal item, and the delineation shall remain in place until this time.

Flush cut brush and trees shall not be more than 2 inches (50mm) above the ground line. Flush cutting shall be performed in a controlled manner that will prevent the spread of parts or seeds of invasive species. Brush hogging or any other clearing method that may promote the spread of invasive plant material is also not permissible.

Broadcast or uncontrolled spray application will not be permitted, and care must be taken to avoid contacting non-target species and/or deterring the recolonization of native species following application.

Remove all twining vines in treetops to the greatest extent possible without damaging the branches of the supporting desired vegetation. Cut and remove vines overtopping tree canopies. Climbing spikes will not be permitted for aerial work.

Prune out any branches on non-treatment plants that are damaged during removal of vegetation. All corrective pruning shall conform to the ANSI A300 Tree Pruning Standards.

The site must be monitored by the Contractor and any new or regrowth treated prior to beginning installation of any landscape plantings.

Processing and disposal of unwanted vegetation shall be done in a controlled manner so as not to spread invasive seed or plant parts within the surrounding areas. All cut invasive vegetation shall be separated from clearing and grubbing operations and all other cleared material. Invasive plant materials may be buried on site within the Department ROW provided that they are under a minimum of 10 feet (3.0 m) of cover on all sides for Japanese knotweed and phragmites and 3 feet (1 m) of cover on all sides for all other species and/or removed from the site and disposed of at the approved location(s) identified in the Contractor's submitted schedule and outline of construction methodologies.

No equipment or vehicles other than that required to complete the work will be permitted in the areas designated for invasive vegetation removal. Any equipment used to process invasive materials, such as chippers and transport vehicles, must be cleaned prior to further use. Processing equipment must also be cleaned prior to further transport.

Wherever removal operations result in exposed soils, disturbed areas must be vegetatively stabilized with the appropriate seed mix and protected with hay, cellulous fiber mulch, or erosion control matting. The application rate for hay mulch and fiber mulch shall be 3500 lbs per acre (3920 kg/hectare).

SECTION 9.54 – CONSERVATION SEEDING FOR SLOPES

9.54.01 - Description:

The work included in this item shall consist of providing an accepted stand of established conservation grasses by furnishing and placing seed as shown on the environmental permit plates, construction plans, or as directed by an Environmental Scientist from the Connecticut Department of Transportation's Office of Environmental Planning (OEP) within the wetland creation areas, habitat enhancement areas, and/or designated environmentally sensitive areas. Seeding shall be applied to all constructed slopes associated with the created wetlands, and/or specific areas designated by OEP.

9.54.02 - Materials:

All approved seed mixtures shall be obtained in sufficient quantities to meet the pure live seed (PLS) application rates as required by the seed analysis of the mixture.

The Contractor shall submit the Form for Affidavit-Seed (Official Stationery of Supplier) for the proposed seed mix to the Engineer a minimum of 10-days prior to the seeding date for the area(s) in order to verify that the seed mix is compliant with the specification. The seed mixture shall be delivered to the project in sealed containers/bags and inspected by the Engineer prior to seeding the specified site. Application of fertilizer, where necessary, will be directed by the Environmental Scientist based on a soil analysis of the area to be seeded. The following mix shall be used for this item.

Conservation Mix (for slopes):

In order to preserve and enhance the diversity of native species, it is necessary that the source for seed mixtures used in created wetlands and/or designated environmentally sensitive areas be locally obtained within the Northeast USA including New England, New York, Pennsylvania, New Jersey, Delaware, or Maryland. One approved seed mixture is detailed. Other proposed mixtures must be submitted to OEP and approved by the Environmental Scientist prior to use. The materials certification for any proposed mixture that is different from that described below must be submitted a minimum of ten (10) days prior to delivery on site. This certification must match both the previously approved substitute mixture and the seed tags on the bags that are to be removed upon delivery. No seeding shall occur if all three items do not match.

Pounds (lbs) of PLS per acre	**Scientific Name**	**Common Name**
30	*Festuca rubra*	Creeping red fescue
20	*Lolium multiflorum*	Annual rye-grass
15	*Panicum clandestinum*	Deer tongue
10	*Chamaecrista fasciculata*	Partridge pea
15	*Schizachyrium scoparium*	Little bluestem
10	*Tridens flavus* var. *flavus*	Purple top

9.54.03 – Construction Methods:

Construction Methods shall be those established as agronomically acceptable and feasible as determined by the OEP. Rate of application shall be 100 lbs PLS per acre. Where seed is not obtained based on PLS quantities, the actual application rate of approved and delivered seed mixture will be determined by calculating the amount of PLS from the information provided on the seed tags at delivery. The PLS formula will be used to determine the desired application rate to obtain a stand of even seed growth for

each seed type to be applied within the seeded area(s). The rate of application will be increased based on the actual percentage of PLS for each species delivered to the site so that each species is seeded at 100 % PLS. The PLS formula is as follows:

(Germination Percentage X Purity Percentage) / 100 = Percentage PLS

The Engineer shall determine and verify the actual application rate based on the PLS formula for the areas to be seeded with conservation mix.

The seed shall be temporarily stabilized with hay or cellulous fiber mulch. The application rate for hay mulch and fiber mulch shall be 3500 lbs per acre. Unless directed by OEP, absolutely no mowing shall be conducted within the areas that are seeded with conservation mix.

All areas to receive conservation seed mix shall be seeded during the spring, fall, or as directed by the OEP. Spring seeding must be performed between March 15th and June 15th. Fall seeding must be performed between August 15th and October 15th. At the direction of the Environmental Scientist, partial seeding of a site may be required in order to stabilize slopes that are finished prior to completion of the entire creation site.

SECTION 12.09 PAINTED PAVEMENT MARKINGS

12.09.01—Description:

Work shall consist of furnishing and installing painted pavement markings, hot applied painted pavement markings and painted legend, arrows and markings, of the type and color specified at the locations indicated on the plans and in conformity with the plans, these specifications, and as directed by the Engineer.

Painted legend, arrows, and markings includes paint installed with a hand striping machine such as: stop bars, crosswalks, parking stalls, lane arrows, legends, markings within gore areas, and painting of paved islands or medians.

Painted pavement markings and hot applied painted pavement markings include paint installed with a truck-mounted painting machine such as center lines, lane lines and shoulder lines.

The exact location for passing zones will be determined by the Engineer prior to the application of the pavement markings. The Engineer shall be notified a minimum of two weeks before the anticipated date of painting, to allow time for the determination of the passing zone locations.

12.09.02—Materials:

Materials for this work shall conform to the requirements of Article M.07.20 for waterborne pavement marking paint, Article M.07.21 for hot-applied waterborne pavement marking paint and Article M.07.30 for glass beads.

12.09.03—Construction Methods:

Pavement areas to be painted shall be dry and sufficiently cleaned of sand and road debris so as to provide an acceptable bond between the paint and the pavement.

Paint shall be applied at a rate of 100 to 115 square feet per gallon (2.5 to 2.8 square meters per liter), with glass beads applied at a rate of 6 pounds per gallon (0.72 kilograms per liter) of paint for painted pavement markings and painted legend, arrows, and markings, and 8 pounds per gallon (0.96 kilograms per liter) of paint for hot-applied painted pavement markings.

Hot-applied paint shall be applied at a temperature of 130°F to 145°F (54°C to 63°C) at the spray gun.

All painting shall be performed in a neat and workmanlike manner. The lines shall be sharp and clear with no feathered edging or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied parallel to the centerline or as shown on the plans with no unsightly deviations.

After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

END OF SECTION 300000