

PUBLIC BUILDING COMMISSION OF CHICAGO

ADDENDUM NO.1 TO CONTRACT NO. 1516

For  
Haas Park Fieldhouse  
For  
New Construction

DATE: Tuesday, August 17, 2010

NOTICE OF CHANGES IN CONTRACT DOCUMENTS

The following changes are hereby made in the Contract Documents.

Changes to Book 1 PROJECT INFORMATION, INSTRUCTIONS TO BIDDERS, AND EXECUTION DOCUMENTS:

None

Changes to Book 2 STANDARD TERMS AND CONDITIONS FOR CONSTRUCTION CONTRACTS:

None

Changes to Book 3: TECHNICAL SPECIFICATIONS:

Change 1: Add the following listed Spec Sections to the Table of Contents: 15790 – Air Coils and 15830 – Radiant Heating Panels

Change 2: Delete Table of Contents, Section 02231 – Tree Protection and Trimming 10 pages  
Add Table of Contents, Section 02231 – Tree Protection and Trimming 9 pages

Change 3: Delete Spec Section 01352, part 1.2 (A), “minimum LEED Silver”  
Add Spec Section 01352, part 1.2 (A), “minimum LEED Gold”

Change 4: Add Spec Section 01352, part 1.1 “Related Documents”

- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

Change 5: Replace Spec Section 02231 dated 08/02/2010 with Spec Section 02231 dated 08/12/10.

Change 6: Delete Spec Sections 03300, 05120, 05210, 05310, part 1.1 (A) “and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.”  
Add part 1.1 “Related Documents”

- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

Change 7: Delete Spec Section 15110, part 1.1 (A), “and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.”

Mayor Richard M. Daley, Chairman

Erin Lavin Cabonargi, Executive Director

## PUBLIC BUILDING COMMISSION OF CHICAGO

Add part 1.1 "Related Documents"

- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

Change 8: Added the following to Divisions 2 thru 12, 15 and 16, part 1.1 "Related Documents"

- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

Change 9: Add Spec Section 15790 – Air Coils

Change 10: Add Spec Section 15830 – Radiant Heating Panels

Change 11: Add Spec Section 15990, part 2.5 (E), "Adjust the maximum outside air damper setting for each heat pump system to keep the ratio of outside air to total airflow below 26.6%."

Change 12: Add Spec Section 15958, part 2.1 (K.5), "HP-4 thermostat shall provide 2-stages of heat. The first stage shall enable the heat pump heating mode; the second stage shall activate the electric heating coil EDH-2."

Change 13: Delete Spec Section 15400, part 1.1 (A) "Work under this Section is subject to the requirements of the Contract Documents, including the Drawings, General and Supplementary Conditions, and Division 1 of the Project Specifications."

Add Spec Section 15400, part 1.1 "Related Documents"

- A. Drawings
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual"

Change 14: Delete Spec Section 15400, part 1.3 (L) "Mechanical"  
Add Spec Section 15400, part 1.3 (L) "Plumbing"

Change 15: Delete Spec Section 15400, part 1.3 (M) "Vibration Isolation"

Change 16: Delete Spec Section 15400, part 1.3 (Q) "15485"  
Add Spec Section 15400, part 1.3 (Q) "15495"

Change 17: Delete Spec Section 15190, part 1.1 (A) "and general provisions of the Contract, including, but not limited to General and Supplementary Conditions and Division 01 and Division 9 Specification Sections, apply to this Section."

Add Spec Section 15190, part 1.1 "Related Documents"

- A. Drawings
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual"

## PUBLIC BUILDING COMMISSION OF CHICAGO

Change 18: Replace Spec Section 15414, part 3.2 (D, E, and F) dated 08/02/10 with Spec Section 15414, part 3.2 (E, F, and G) dated 08/12/10

Change 19: Add Spec Section 15141, part 3.2 (D)

D. Under-Ground, Non-Potable Water: Do not use flanges or valves underground. Use the following:

1. NPS 2 and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints. Note: Pipe shall be painted yellow and identified 'NON-POTABLE' 10 feet on center.

### QUESTIONS & ANSWERS:

None

### CHANGES TO DRAWINGS (All Drawings dated 08/12/10)

#### GENERAL INFORMATION DRAWINGS – ARCHITECTURAL:

Change 1: Ref. G002

Added note #26 "Powerwash the interior of block before applying vapor air barrier."

#### LANDSCAPE DRAWINGS:

Change 2: Ref. L100

Reduced the area of concrete on the west side of the building and filled in area with planting.

Change 3: Ref. L300

Additional plants were added in six different species.

Change 4: Ref. L402

Added trash enclosure details to match the architectural drawings.

#### STRUCTURAL DRAWINGS:

Change 5: Ref. S100

Dimension width of footings along Column Lines 2 and 7 has been revised.

#### ARCHITECTURAL DRAWINGS:

Change 6: Ref. AS101

Detail 4 – Added descriptive note "3" Rounded corner ends, typ. @ all outside corners of bent plate"

Change 7: Detail 5 – Added descriptive note "3" Rounded corner ends, typ.

Change 8: Added Detail 7, Plan – Trash Enclosure Masonry Wall

Change 9: Ref. A101

Added a saddle to slope 1/4":12" on the west side of the low roof.

Change 10: The precast concrete splash block for the downspouts are revised to be 7'-6" in depth in lieu of 5'-0" in depth

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- Change 11: Ref. A210  
Added an access panel in the ceiling of the Men Toilet Room.
- Change 12: Ref. A301  
Detail 3 – Revised enlarged elevation of metal conductor and downspout to show termination at low roof.
- Change 13: Ref. A410  
Plan 1 – Revised the opening width of the cased opening in the North Hall.
- Change 14: Ref. A420  
Elevation 2 – Revised the opening width of the cased opening in the North Hall.
- Change 15: Ref. A424  
Added detail for signage for ADA height.
- Change 16: Ref. A451  
Wall Section 3 – Added exterior sheathing board in the vestibule ceiling.
- Change 17: Ref. A452  
Wall Section 1 – Added exterior sheathing board in the vestibule ceiling.
- Change 18: Ref. A453  
Wall Section 1 – Added treated wood blocking at low roof area.
- Change 19: Wall Section 2 – Revised detail at overhead fire rated coiling door and curtain wall at the gym/multipurpose room.
- Change 20: Ref. A501  
Plan Detail 9 – Revised the opening width of the cased opening in the North Hall.
- Change 21: Ref. A503  
Detail 2A – Revised downspout detail to show termination of downspout at low roof.
- Change 22: Section Detail 4 – Added treated wood blocking at low roof area.
- Change 23: Section Detail 6 – Revised detail at overhead fire rated coiling door and curtain wall at the gym/multipurpose room and added new descriptive notes to detail.
- Change 24: Ref. A504  
Section Detail 10 – Added width dimension to concrete curb.
- Change 25: Ref. A510  
Interior Detail 1 – Added exterior sheathing board in the vestibule ceiling.
- MECHANICAL DRAWINGS:
- Change 26: Ref. M100  
Revised duct size at connection to Lobby linear diffusers.
- Change 27: Added electric duct heater EDH-2.

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- Change 28: Ref. M700  
Revised Heat Pump schedule.
- Change 29: Revised Ventilation, Heating Schedule and Building Pressurization Table.
- Change 30: Corrected light and vent schedule.
- Change 31: Ref. M701  
Revised Pump Schedule.
- Change 32: Revised Electric Duct Heater Schedule to add electric duct heater EDH-2.
- Change 33: Ref. M800  
Added required ventilation note.
- Change 34: Ref. M801  
Revised glycol fill tank piping connection.

### ELECTRICAL DRAWINGS:

- Change 35: Ref. E003  
Moved the meter socket and CT enclosure from the exterior wall to the interior wall of the electrical room on Detail 1.
- Change 36: Added re-circuited loads EF-1, EF-02, EF-3, and UH-1 to panel board 1-RP-2.
- Change 37: Added new electrical load EDH-2 to panel board 1-QLP-1.
- Change 38: Ref. E004  
Revised panel board designation for loads EF-1, EF-2, EF-3, and UH-1 to 1-RP-2 on the electrical equipment schedule.
- Change 39: Added panel board designation, 1-QLP-1, for New electrical load EDH-2.
- Change 40: Ref. E005  
Revised ordering number for light fixture type 'L' in the Light Fixture Schedule.
- Change 41: Ref. E201  
Detail 2 – Moved the meter socket and CT enclosure from the exterior wall to the interior wall of the electrical room.
- Change 42: Details 1 and 3 – Revised panel board designation for loads EF-1, EF-2, EF-3, and UH-1 to 1-RP-2.
- Change 43: Detail 1 – Added new electrical load EDH-2.
- Change 44: Ref. E202  
Added weatherproof designation 'WP' to electrical junction boxes for EF-4, EF-5, and EF-6.

### PLUMBING DRAWINGS:

- Change 45: Ref. P000  
Added non-potable underground pipe to Material List.

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## PUBLIC BUILDING COMMISSION OF CHICAGO

Change 46: Ref. P200  
Added chlorinator to Rainwater Tank Detail.

Change 47: Added filter medium note to Rainwater Piping Diagram.

### List of Attachments:

#### Drawings Dated 08/12/10

Sheet G002	Sheet A420	Sheet M701
Sheet L100	Sheet A424	Sheet M800
Sheet L300	Sheet A451	Sheet M801
Sheet L402	Sheet A452	Sheet E003
Sheet S100	Sheet A453	Sheet E004
Sheet AS101	Sheet A501	Sheet E005
Sheet A101	Sheet A503	Sheet E201
Sheet A210	Sheet A504	Sheet E202
Sheet A301	Sheet A510	Sheet P000
Sheet A410	Sheet M100	Sheet P200
Sheet A420	Sheet M700	

#### Specifications Dated 08/12/10

Table of Contents	Section 15110
Section 01352	Section 15141
Section 02231	Section 15190
Section 03300	Section 15400
Section 05120	Section 15830
Section 05210	Section 15958
Section 05310	Section 15990

END OF ADDENDUM NO.1

THE CHICAGO PARK DISTRICT

HAAS PARK FIELDHOUSE

FOR

CHICAGO PARK DISTRICT

The Following Listed Documents Comprise The Project Manual for The Project Listed Above. Where Numerical Sequence of Sections Is Interrupted, Such Interruptions Are Intentional.

The Complete Project Manual for This Project Consists of This Entire Volume, Which Must Not Be Separated for Any Reason. The Architect and Owner Disclaim Any Responsibility for Any Assumptions Made By A Contractor Or Subcontractor Who Does Not Receive A Complete Project Manual, Including All Sections Listed In The Table of Contents.

Table of Contents

Section No. Section Title Pages

---

**BIDDING REQUIREMENTS – BOOK I**

By Public Building Commission

**CONDITIONS OF CONTRACT – BOOK II**

By Public Building Commission

**CONDITIONS PROCEDURE MANUAL OF CONTRACT – BOOK II A**

By Public Building Commission

**TECHNICAL SPECIFICATIONS – BOOK III (1 of 2)**

Division 1 - General Requirements

By Public Building Commission

01810 .....	General Commissioning Requirements.....	16
01352 .....	LEED Requirements.....	10
01352a.....	LEED Appendix “B”.....	6
01524 .....	Construction Waste Management.....	8

Division 2 - Site Construction

02010 .....	Summary of Existing Site Conditions.....	3
02110 .....	Site Clearing.....	2
02210 .....	Trenching and Backfilling.....	5
02215 .....	Topsoil.....	3
<b>02231 .....</b>	<b>Tree Protection and Trimming .....</b>	<b>9</b>
02300 .....	Earthwork.....	9
02316 .....	Soil Fill Backfill, CU Structural Soil & Construction and Demolition Debris .....	14
02318 .....	Acceptance of Backfill, Top Soil, and CU Structural Soil.....	7

02511	Hot Mix Asphalt Paving	4
02520	Portland Cement Concrete Paving	6
02700	Site Underground Utilities	11
02780	Interlocking Concrete Pavers	4
02833	Prefabricated Ornamental Metal Fencing System	15
02836	Handrails	6
02870	Site Furnishings	3
02900	Landscaping	19
02903	Permeable Root Mix	3
02920	Sod	7
Division 3 - Concrete		
03300	Cast-in-Place Concrete	24
Division 4 – Masonry		
04200	Unit Masonry	20
Division 5 - Metals		
05120	Structural Steel Framing	12
05210	Steel Joists Framing	6
05310	Steel Decking	6
05400	Cold Formed Metal Framing	8
05500	Metal Fabrications	10
05513	Alternating Tread Steel Stairs	6
Division 6 – Woods and Plastics		
06105	Miscellaneous Carpentry	6
06160	Sheathing	4
06202	Interior Finish Carpentry	4
06402	Interior Architectural Woodwork	8
06416	Paper Composite Countertops	6
Division 7 – Thermal and Moisture Protection		
07125	Extensive Modular Green Roof System	7
07210	Building Insulation	6
07272	Fluid Applied Membrane Air Barriers	6
07542	Polyvinyl Chloride Roofing	10
07620	Sheet Metal Flashing and Trim	6
07710	Green Roof Components	6
07720	Roof Hatch	4
07811	Sprayed Fire Resistive Materials	8
07841	Through Penetration Firestop Systems	8
07842	Fire Resistive Joint Systems	6
07920	Joint Sealants	12



Division 8 – Doors and Windows

08110 ..... Standard Hollow Metal Doors and Frames ..... 10  
08311 ..... Access Doors and Frames ..... 6  
08331 ..... Overhead Coiling Fire Door ..... 6  
08411 ..... Aluminum Framed Entrance Doors ..... 10  
08423 ..... Stainless Steel Clad Entrance Doors ..... 6  
08442 ..... Structural Sealant Glazed Curtain Walls ..... 12  
08520 ..... Aluminum Windows ..... 12  
08710 ..... Door Hardware ..... 24  
08716 ..... Automatic Door Operators ..... 8  
08800 ..... Glazing ..... 12  
08830 ..... Mirrors ..... 4  
08900 ..... Louvers and Vents ..... 6

Division 9 - Finishes

09111 ..... Non-Load Bearing Steel Framing ..... 8  
09250 ..... Gypsum Board ..... 8  
09300 ..... Ceramic Tile ..... 12  
09511 ..... Acoustical Panel Ceilings ..... 8  
09642 ..... Wood Sports Floor Assembly ..... 8  
09652 ..... Rubber Sheet Flooring ..... 6  
09653 ..... Resilient Base and Accessories ..... 6  
09681 ..... Carpet Tile ..... 6  
09751 ..... Interior Stone Facing ..... 10  
09772 ..... Special Composite Wall Surfaces ..... 6  
09912 ..... Painting ..... 12  
09970 ..... High Performance Coatings for Steel ..... 6

Division 10 – Specialties

10120 ..... Display Cases and Markerboards ..... 6  
10155 ..... Toilet and Shower Compartments ..... 6  
10520 ..... Plastic Lockers ..... 4  
10522 ..... Fire Extinguisher Cabinets ..... 6  
10523 ..... Fire Extinguishers ..... 4  
10800 ..... Toilet and Bath Accessories ..... 10

Division 11 – Equipment

11491 ..... Gymnasium Equipment ..... 8

Division 12 – Furnishings

12485 ..... Foot Grilles ..... 4  
12660 ..... Telescoping Bleachers ..... 6

Division 13 – Special Construction

13700 ..... Security and CCTV Surveillance ..... 64

Division 14 – Conveying Systems

(Not Applicable)

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**TECHNICAL SPECIFICATIONS – BOOK III (2 of 2)**

Table of Contents

Section No.	Section Title	Pages
Division 15 – Mechanical		
15010	General Provisions for Mechanical Work	8
15020	Shop Drawings Product Data and Samples	5
15050	Basic Mechanical Materials and Methods	13
15051	Miscellaneous Equipment and Work	4
15055	Motors	6
15060	Hangers and Supports	6
15074	Vibration Controls for HVAC Piping Equip	10
15077	Identification for HVAC Piping and Equip	7
15080	Mechanical Insulation	8
15082	Plumbing Insulation	18
15110	HVAC Valves	9
15124	Exp Fittings and Loops HVAC Piping	5
15127	Meters Gauges for HVAC Piping	6
15141	Domestic Water Piping	9
15145	Domestic Water Piping Specialties	10
15150	Sanitary Waste and Vent Piping	10
15155	Drainage Piping Specialties	12
15160	Storm Drainage Piping	9
15181	Hydronic Piping	17
15185	Hydronic Pumps	6
15189	HVAC Water Treatment	8
15195	Natural Gas Piping	15
15400	Plumbing	18
15410	Plumbing Fixtures	15
15420	Plumbing Valves	6
15441	Domestic Water Pumps	5
15450	Rainwater Harvesting System	5
15486	Fuel-Fired Water Heaters	8
15513	Condensing Boilers	9
15550	Breeching Chimneys Stacks	4
15745	Water Source Heat Pumps	12
15747	Ground Heat Exchanger (GHEX)	12
15748	Formation Thermal Conductivity	4
15766	Cabinet Unit Heaters	6
<b>15790</b>	<b>Air Coils</b>	<b>3</b>
15815	Metal Ducts CPD	7

15820	..... Duct Accessories .....	8
<b>15830</b>	<b>..... Radiant Heating Panel .....</b>	<b>3</b>
15838	..... Power Ventilators .....	7
15855	..... Diffusers Registers Grilles .....	5
15856	..... Intake and Relief Ventilators .....	5
15940	..... Building Automation System .....	32
15950	..... HVAC Controls Instrumentation.....	11
15958	..... Sequence of Operations.....	7
15965	..... Variable Frequency Controller Drives .....	10
15990	..... Testing, Adjusting, and Balancing .....	18
15995	..... Mechanical Systems Commissioning.....	10

Division 16 – Electrical

16010	..... General Electrical Provisions .....	11
16015	..... Electrical Power System Studies .....	8
16110	..... Conduit.....	9
16118	..... Duct Bank.....	3
16123	..... Building Wire and Cable .....	5
16130	..... Boxes.....	6
16140	..... Wiring Devices.....	6
16145	..... Lighting Control Devices .....	10
16160	..... Cabinets and Enclosures.....	4
16170	..... Grounding and Bonding .....	4
16180	..... Equipment Wiring Systems.....	5
16190	..... Supporting Devices .....	5
16195	..... Electrical Identification .....	5
16421	..... Utility Service Entrance .....	4
16441	..... Enclosed Switches.....	4
16470	..... Panelboards .....	6
16477	..... Fuses.....	4
16481	..... Enclosed Motor Controllers .....	6
16510	..... Interior Luminaires.....	5
16530	..... Site Lighting .....	8
16675	..... Transient Voltage Surge Suppression Systems .....	6
16722	..... Fire Alarm Systems – Addressable with Horn-Strobe .....	12
16950	..... Testing.....	4
16995	..... Electrical Systems Commissioning.....	5

END OF TOC

## SECTION 01352 - LEED REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings
- B. **Book 1: Project Information, Instructions to Bidders, and Execution Documents**
- C. **Book 2: Standard Terms and Conditions for Construction Contracts**
- D. **Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain **minimum LEED Gold** certification based on LEED-NC version 2009.
  - 1. Other LEED prerequisites and credits needed to obtain LEED certification depend on material selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.
  - 2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.
  - 3. A copy of the LEED Project checklist is attached at the end of this Section for information only.

#### 1.3 DEFINITIONS

- A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by a FSC-accredited certification body.
- B. Chain-of-Custody Certification: Certification is awarded to companies that produce, sell, promote, or trade forest products after audits verifying proper accounting of material flows and proper use of the Forest Stewardship Council name and logo. The COC certificate number is listed on invoices for nonlabeled products to document that an entity has followed FSC guidelines for product accounting
- C. LEED: Leadership in Energy & Environmental Design.
- D. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If only a fraction of a product or material is

extracted, harvested or recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

- E. Recycled Content: Is the ratio, by weight, of preconsumer and postconsumer recycled material in a product.
  - 1. **Postconsumer Material** is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
  - 2. **Preconsumer material** is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

#### 1.4 SUBMITTALS

- A. General: Submit additional LEED submittals required by other Specification Sections.
- B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.
- C. Submit a completed MATERIALS CREDITS DOCUMENTATION SHEET. A sample form (See Appendix "B") is included at the end of this Section. Information to be supplied for this form includes, but is not limited to, the following:
  - 1. Cost breakdowns for the materials included in the contractor's or subcontractor's work. Cost breakdowns shall include total cost plus labor, equipment, and material costs.
  - 2. The solar reflectance values of products used to reduce heat island effect.
  - 3. The amount of salvaged, refurbished or reused materials and products.
  - 4. The amount of recycled content in the supplied products, with percentages broken down to indicate post-consumer and pre-consumer percentages.
  - 5. The location (source) of the raw materials extracted, harvested, or recovered and then used to manufacture the supplied product(s).
  - 6. The manufacturing location for the supplied products.
  - 7. The amount of rapidly renewable materials used.
  - 8. The amount of "FSC Certified" wood products used.
  - 9. The amount of VOC content in products used.
  - 10. The amount of urea-formaldehyde resins in products used.
- D. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
  - 1. Wood-based construction materials.
- E. LEED Action Plans: Provide preliminary submittals within seven days of date established for the Notice of Award indicating how the following requirements will be met:
  - 1. Credit MR 2: Waste management plan that identifies materials that are being diverted from disposal and whether these materials will be sorted on-site or comingled.

2. Credit MR 4: Recycled Content. Use materials with recycled content such that sum of postconsumer recycled content plus  $\frac{1}{2}$  of the preconsumer content constitutes at least 20%, based on cost, of the total value of the materials in the project.
  3. Credit MR 5: Regional Materials. List of proposed regional materials. Identify each regional material, including its source and cost of certified wood products.
  4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
  5. Credit IEQ 3.1: Construction indoor-air-quality management plan.
- F. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:
1. Credit MR 2: Construction Waste Management
  2. Credit MR 4: Recycled content.
  3. Credit MR 5: Regional materials.
  4. Credit MR 7: Certified wood products.
- G. LEED Documentation Submittals:
1. Credit EA 5: Product data and wiring diagrams for sensors and data collection system used to provide continuous metering of building energy-consumption performance over time.
  2. Credit MR 2: Develop and implement a construction waste management plan that will recycle or salvage 95% of construction and demolition debris. Maintain a log of all construction waste, by type, that was diverted from landfills and incineration facilities. Record the total percentage of waste diverted from landfill disposal. Construction waste management plan should identify diversion goals, record all materials to be diverted, list implementation protocols and identify responsible parties for implementing plan.
  3. Credit MR 4: Document manufacturers' names, product names, costs, percentage of postconsumer content and percentage of preconsumer content. Document the total sustainable criteria value and the total materials cost. For assembly components, determine the recycled content value by calculating the percentage by weight, of the postconsumer recycled content and the preconsumer recycled content. Provide 20% of total cutsheets or manufacture letters for recycled content to show credit compliance. Record total CSI divisions 3-10, 31.60.00, 32.10.00, 32.30.00 and 32.90.00 materials cost.
  4. Credit MR 5: Materials or products that have been regionally harvested, extracted and manufactured within 500 miles of the project site will comprise at least 30%, based on cost, of the total materials value. List the percentage of the item that contains regional material by weight. Record name of product, manufacturer and the location information source. Document product cost, manufacture's names and the distances between the project and manufacturer. Record distance between the project and extraction and the distance between the project and the harvesting site. Document the total sustainable criteria value and the total materials cost. Provide cutsheets for at least 20% of the materials (by cost) to support regional material claims. Record total CSI divisions 3-10, 31.60.00, 32.10.00, 32.30.00 and 32.90.00 materials cost.
  5. Credit MR 7: Track certified wood purchases and collect all COC documentation. Retain copies of vendor invoices for each certified wood product. Compile a record that identifies the percentage of certified wood in each purchase. Use a minimum of 50%

based on cost, of wood-based materials and products in accordance with the Forest Stewardship Council's criteria for wood building components.

6. Credit IEQ 3.1:
  - a. Construction indoor-air-quality management plan.
  - b. Product data for temporary filtration media.
  - c. Product data for filtration media used during occupancy.
  - d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.
  
7. Credit IEQ 3.2:
  - a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
  - b. Product data for filtration media used during occupancy.
  - c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.
  
8. Credit IEQ 4.1: Only adhesives and sealants that comply with specified VOC limits can be used on this project. Record every indoor aerosol adhesive products, sealants and sealant primers that were used on the project. Include the product type, product manufacturer and the product name or model. Provide the specific product VOC content in g/L (or % for aerosol adhesives) along with the referenced standard and specific VOC limit (g/L) for all products used on the project. Record the source of the VOC data for each product including allowable VOC from the referenced standard. Provide cutsheets for at least 20% of all adhesives and sealants used on the project.
  
9. Credit IEQ 4.2: Only paints and coatings that comply with specified VOC limits can be used on this project. Generate a list of all indoor aerosol adhesive products, sealants and sealant primers that were used on the project. Include the manufacturer's name, product name, and specific VOC limit (g/L) for all paints and coatings used on the project. Record the source of the VOC data for each product including allowable VOC from the referenced standard. Provide cutsheets for at least 20% of all paints and coatings used on the project.
  
10. Credit IEQ 4.3: All flooring systems installed in the building interior have to meet VOC limits or referenced standards requirements. Record product type, product manufacturer and product name or model. For flooring and carpeting materials, list the appropriate referenced standard along with providing the source of the compliance statement or certification program. Document VOC content for each adhesive and finish. Maintain a list of each hard surface flooring product, tile setting adhesive, finishes, and grout installed in the building interior. Document the VOC content for each tile setting adhesive and grout. Provide VOC limit and the source of the VOC data used. Document the source of the VOC data used. Provide cutsheets for at least 20% of all flooring system items used on the project.
  
11. Credit IEQ 4.4: Document that all products containing composite wood or agrifiber products or wood glues do not contain urea-formaldehyde resin. List product manufacturer along with product name or model. Collect all information regarding the source of Urea-Formaldehyde Data. Provide cutsheets from the manufacturer showing

that the product contains no added urea-formaldehyde for at least 20% of the products listed.

## 1.5 QUALITY ASSURANCE

- A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator. This consultant will be vital in making sure that all LEED requirements are being followed, and that LEED goals set out for this project will be met.

## PART 2 - PRODUCTS

### 2.1 RECYCLED CONTENT OF MATERIALS

- A. Credit MR 4.: Provide building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 20% of cost of materials used for Project.
  - 1. Cost of post-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
  - 2. Cost of pre-consumer recycled content of an item shall be determined by dividing weight of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.
  - 3. Do not include plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

### 2.2 REGIONAL MATERIALS

- A. Credit MR 5: At least 30 percent of the building materials (by cost) will have been extracted, harvested, recovered and manufactured within 500 miles of the project site.

### 2.3 CERTIFIED WOOD

- A. Credit MR 7: Provide a minimum of 50 percent (by cost) of wood-based materials and products that have been certified in agreement with the Forest Stewardship Council's principles and criteria for wood building components.
  - 1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
    - a. Rough carpentry.
    - b. Miscellaneous carpentry.
    - c. Finish carpentry.
    - d. Architectural woodwork.
    - e. Wood flooring.
    - f. Wood cabinets.



## 2.4 LOW-EMITTING MATERIALS

A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, use adhesives and sealants that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D:

1. Indoor carpet adhesives: 50 g/L.
2. Carpet pad adhesives: 50 g/L.
3. Carpet adhesives: 50g/L
4. Wood flooring adhesives: 100 g/L.
5. Subfloor Adhesives: 50 g/L.
6. Rubber Floor Adhesives: 60 g/L.
7. Ceramic Tile Adhesives: 65 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Drywall and Panel Adhesives: 50 g/L.
11. Multipurpose Construction Adhesives: 70 g/L.
12. Fiberglass Adhesives: 80 g/L.
13. Contact Adhesive: 80 g/L.
14. Wood Glues: 30 g/L.
15. Metal to Metal Adhesives: 30 g/L.
16. Adhesives for Porous Materials (Except Wood): 50 g/L.
17. Carpet Adhesives: 50 g/L.
18. Gypsum Board and Panel Adhesives: 50 g/L.
19. Structural Glazing Adhesives: 100 g/L.
20. Wood Flooring Adhesive: 100 g/L.
21. Structural Wood Member Adhesive: 140 g/L.
22. Special Purpose Contact Adhesive (contact adhesive that is used to bond melamine covered board, metal, unsupported vinyl, Teflon, ultra-high molecular weight polyethylene, rubber or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
23. Top and Trim Adhesive: 250 g/L.
24. Metal to Metal: 30g/L.
25. Porous Material (except wood): 50 g/L.
26. Wood: 30 g/L.
27. Fiberglass: 80 g/L.
28. Plastic Foam Adhesive: 50 g/L
29. Plastic Cement Welding Compounds: 250 g/L.
30. ABS Welding Compounds: 325 g/L.
31. CPVC Welding Compounds: 490 g/L.
32. PVC Welding Compounds: 510 g/L.
33. Adhesive Primer for Plastic: 550 g/L.
34. Sheet Applied Rubber Lining Adhesive: 850 g/L.
35. Aerosol Adhesive, General Purpose Mist Spray: 65 percent by weight.
36. General Purpose Web Spray: 55% VOCs by weight.
37. Special Purpose Aerosol Adhesive (All Types): 70 percent by weight.
38. Other Adhesives: 250 g/L.
39. Architectural Sealants: 250 g/L.
40. Nonmembrane Roof Sealants: 300 g/L.
41. Roadway: 250 g/L.
42. Single-Ply Roof Membrane Sealants: 450 g/L.

43. Other Sealants: 420 g/L.
44. Sealant Primers for Nonporous Substrates: 250 g/L.
45. Sealant Primers for Porous Substrates: 775 g/L.
46. Modified Bituminous Sealant Primers: 500 g/L.
47. Other Sealant Primers: 750 g/L.

B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, use paints and coatings that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D and the following chemical restrictions:

1. Flat Paints, Coatings, and Primers: VOC not more than 50 g/L.
2. Nonflat Paints, Coatings, and Primers: VOC not more than 150 g/L.
3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Clear Wood Finishes, Varnishes, Sanding: VOC not more than 350 g/L.
5. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
6. Floor Coatings: VOC not more than 420 g/L.
7. Shellacs, Clear: VOC not more than 730 g/L.
8. Shellacs, Pigmented: VOC not more than 550 g/L.
9. Stains: VOC not more than 250 g/L.
10. Bond Breakers: VOC not more than 350 g/L.
11. Clear Brushing Lacquer: not more than 680 g/L.
12. Concrete-curing Compounds: not more than 350 g/L.
13. Dry-fog Coatings: not more than 400 g/L.
14. Fireproofing exterior coatings: not more than 450 g/L.
15. Fire-retardant Coatings, Clear: 650 g/L.
16. Fire-retardant Coatings, Pigmented: 350 g/L.
17. Flats: not more than 250 g/L.
18. Graphic Arts (sign) Coatings: not more than 500 g/L.
19. Industrial Maintenance Coatings High temperature Industrial Maintenance coatings and Zinc-rich Industrial Maintenance Primers: not more than 420 g/L.
20. Japans/faux Finishing Coatings: not more than 700 g/L
21. Magnesite Cement Coatings: not more than 600 g/L
22. Mastic Coatings: not more than 300 g/L
23. Metallic Pigmented Coatings: not more than 300 g/L
24. Multicolor coatings: not more than 250 g/L
25. Nonflat High Gloss: not more than 250 g/L
26. Pigmented Lacquer: not more than 550 g/L
27. Pretreatment Wash Primers: not more than 780 g/L
28. Primers, sealers, undercoaters: not more than 350 g/L
29. Quick-dry Enamels: not more than 400 g/L
30. Quick-dry primers, sealers, undercoaters: not more than 350 g/L
31. Recycled Coatings: not more than 250 g/L.
32. Roof Coatings: not more than 300 g/L.
33. Aluminum Roof Coatings: not more than 500 g/L.
34. Roof Primers, Bituminous: not more than 500 g/L.
35. Rust Preventive Coatings: not more than 420 g/L.
36. Specialty Primers: not more than 350 g/L.
37. Swimming Pool Coatings: not more than 340 g/L.
38. Traffic Coatings: not more than 250g/L.

39. Waterproofing Sealers: not more than 400 g/L.
40. Waterproofing Concrete, Masonry Sealers: not more than 400 g/L.
41. Wood preservatives-Below ground: not more than 350 g/L.
42. Other: not more than 350 g/L.
43. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
44. Restricted Components: Paints and coatings shall not contain any of the following:
  - a. Acrolein.
  - b. Acrylonitrile.
  - c. Antimony.
  - d. Benzene.
  - e. Butyl benzyl phthalate.
  - f. Cadmium.
  - g. Di (2-ethylhexyl) phthalate.
  - h. Di-n-butyl phthalate.
  - i. Di-n-octyl phthalate.
  - j. 1,2-dichlorobenzene.
  - k. Diethyl phthalate.
  - l. Dimethyl phthalate.
  - m. Ethylbenzene.
  - n. Formaldehyde.
  - o. Hexavalent chromium.
  - p. Isophorone.
  - q. Lead.
  - r. Mercury.
  - s. Methyl ethyl ketone.
  - t. Methyl isobutyl ketone.
  - u. Methylene chloride.
  - v. Naphthalene.
  - w. Toluene (methylbenzene).
  - x. 1,1,1-trichloroethane.
  - y. Vinyl chloride.

- C. Credit IEQ 4.3: All flooring systems must meet the following requirements depending on the project scope.
  1. Carpet installed in the building interior must meet the requirements as stated in the Carpet and Rug Institute's Green Label Plus program.
  2. All carpet cushion installed in the building interior shall meet the requirements of the Carpet and Rug Institute Green Label program.
  3. All carpet adhesive shall meet the requirements of IEQ Credit 4.1: VOC limit of 50 g/L.
  4. All hard surface flooring must be certified as compliant with FloorScore standard by an independent third party. Products include vinyl, linoleum, laminate flooring, wood flooring, ceramic flooring, rubber flooring and wall base.
  5. 100% of the non-carpet finished flooring must be FloorScore certified and has to constitute at least 25% of the finished floor area. Examples of unfinished flooring are mechanical rooms, electrical rooms and elevator service rooms.

6. Concrete, wood, bamboo and cork floor finishes such as a sealer, stain and finish must meet the requirements of South Coast Air Quality Management District Rule 1113, Architectural Coatings.
7. Tile setting adhesives and grout have to meet South Coast Air Quality Management District Rule 1168.

D. Credit IEQ 4.4: All composite wood or agrifiber products used within the interior of the building must not contain any urea-formaldehyde resins. Composite wood and agrifiber products are: particleboard, MDF, strawboard, wheatboard, plywood, panel substrates and door cores. All materials that are included in FF&E are not part of this credit.

### PART 3 - EXECUTION

#### 3.1 CONSTRUCTION WASTE MANAGEMENT

A. Credit MR 2: Comply with Division 1 Section "Construction Waste Management."

#### 3.2 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Credit IEQ 3.2: Comply with the following requirements:

##### 1. Air-Quality Testing:

- a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "LEED Reference for Green Building Design and Construction, 2009 Edition."
- b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
  - 1) Formaldehyde: 27 ppb.
  - 2) Particulates (PM10): 50 micrograms/cu. m.
  - 3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
  - 4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
  - 5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
- c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.
- d. Air-sample testing shall be conducted as follows:

- 1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
- 2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Non fixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
- 3) Number of sampling locations will vary depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
- 4) Air samples shall be collected between 3 and 6 feet from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

END OF SECTION 01352

## SECTION 02231 – TREE PROTECTION & TRIMMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SUMMARY

- A. This section specifies trimming and protection of trees that are indicated to remain but interfere with or are close to new construction, as herein specified. Trees which are to remain and must be protected are indicated on the Drawings.
- B. The Contractor is responsible for ensuring the ongoing protection of all landscaped areas within the scope of work, including adjacent areas that may be impacted including access and egress routes. Existing landscaping including trees, shrubs, lawns, planting beds, etc. shall be adequately protected by the Contractor so as to avoid destruction and/or damage as a result of operations by the Contractor.
- C. Before beginning work, the contractor will be required to meet with the Architect at the site to review all work procedures, access routes, storage areas, and tree and landscape protection measures.
- D. Any proposed changes to agreed-upon work procedures, access routes, storage areas, and/or tree and landscape protection measures must be reviewed and approved by the Architect prior to implementation of any proposed changes.

#### 1.3 REFERENCES

- A. IDOT Standard Specifications: IDOT Standard Specifications for Road and Bridge Construction, latest edition.
- B. International Society of Arboriculture.
- C. CDOT Standards and Specifications for Openings in the Public Way.

#### 1.4 SUBMITTALS

- A. Certification: Submit written certification by a Certified Arborist that trees indicated to remain have been protected during the course of construction in accordance with recognized standards and that where damage did occur, trees were promptly and properly treated. Indicate which damaged trees are incapable of retaining full growth potential and are recommended to be replaced.

## 1.5 QUALITY ASSURANCE

- A. Arborist Qualifications: Contractor shall engage and pay for a Certified Arborist who has successfully completed tree protection and trimming, to perform the following work:
  - 1. Remove branches from trees that are to remain.
  - 2. Recommend procedures to compensate for loss of roots and perform initial pruning of branches and stimulation of root growth where removed to accommodate new construction.
  - 3. Recommend procedures for excavation and grading work juxtaposed to established plants.
  - 4. Perform tree repair work for damage incurred by new construction.
- B. Arborist shall be certified by International Society of Arboriculture

## 1.6 PROJECT CONDITIONS

- A. Protect root systems: Do not store construction materials, debris, or excavated material within drip line of trees to remain. Do not permit vehicles within drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems within drip line.
- B. Leave all protection in place and maintain until construction work has been completed and all danger of damage has passed. Protection shall be removed only after approval is given by Architect.
- C. Water Trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.

## PART 2 - PRODUCTS

### 2.1 TREE AND LANDSCAPE PROTECTION FENCING

- A. See Drawing “Tree Preservation Details” for layout and installation.
- B. Materials
  - 1. Fabric: To be 4 ft. high orange plastic construction fencing, securely fastened to posts with durable ties.
  - 2. Posts: 6 ft. long steel post, to be installed on maximum 8 ft. spacing, driven 2 feet into the ground; final orientation to be straight and plumb.

- C. Fencing is to completely enclose all protected zones.
- D. Fencing is to be maintained intact at all times. Fencing will not be considered intact if fabric is missing, torn, or no longer attached to posts, posts are bent, broken, missing or otherwise non-functional, or if any other circumstances are present which compromise the integrity of the protection zone.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All trees designated to be preserved by Architect shall be protected in accordance with the Standard Specifications for Road and Bridge Construction and with the requirements of the drawings and specifications.
- B. Protect tree root systems from damage due to noxious materials caused by run-off or spillage during mixing, placement, or storage of construction materials. Protect root systems from flooding, eroding, or excessive wetting resulting from dewatering operations.
- C. Do not allow fires under or adjacent to trees or other plants that are to remain.
- D. Remove branches from trees that are to remain.
  - 1. Extend pruning operation to all trees to remain on site and to restore natural shape of entire tree. Verify operations with Arborist.
  - 2. Cut branches and roots as required, with sharp pruning instruments; do not break or chop.
  - 3. All pruning and cutting of branches and roots shall be performed by Certified Arborist using state of the art equipment.
- E. The location, limits and extent of tree and/or landscape protection zones are to be determined in the field by the Architect prior to any work being performed.
- F. See Drawing "Tree Preservation Details" for required limits of protection and construction and installation details.
- G. Driving, parking, dumping, stockpiling and/or storage of vehicles, equipment, supplies, materials, debris, spoils, waste or washout water within tree and/or landscape protection zones is strictly prohibited.
- H. All underground utilities, drain and/or irrigation lines are to be routed OUTSIDE the landscape protection zone. When underground lines must traverse the protection area, they shall be tunneled or bored below the root zones.
- I. All tree and landscape protection zones must be identified and all fencing or other approved measures in place prior to any project-related activity being performed on site, including delivery of materials or supplies, vehicular traffic, installation of security fencing, etc., and must be maintained intact throughout the duration of the work.



### 3.2 TREE AND LANDSCAPE PROTECTION FENCING

- A. Tree and/or landscape protection zones are to be enclosed by 4 ft. high orange plastic construction fencing secured to steel posts on max. 8 ft. spacing (see Drawing “Tree Preservation Details”).
- B. All tree and landscape protection fencing must be in place prior to any work being performed on site, including delivery of materials or supplies, vehicular traffic, installation of security fencing, etc.
- C. Tree and landscape protection fencing is to be maintained intact, by the Contractor, throughout the duration of the work and until all site work has been completed. Removal or relocation of protection fencing must be approved by the Architect. Fences may NOT be relocated or removed without the written permission of the Architect.

### 3.3 TEMPORARY ACCESS OVER ROOT ZONES

- A. Where temporary haul or access routes must pass over the root area of trees to be retained, a 6-inch thick “access route” of an approved cushioning material shall be put in place to protect the root zones.
- B. The location and route of them temporary “access route” must be approved by the Architect prior to any work being performed.
- C. The “access route” material shall be replenished as necessary to maintain a uniform 6-inch depth. Failure to maintain the depth of cushioning material will be considered a violation of the contract and may result in the assessment of fines and/or damages.
- D. Vehicular traffic must be confined to the defined “access route;” failure to confine vehicular access to the defined “access route” will be considered a violation of the contract and may result in the assessment of fines and/or damages.
- E. Approved temporary haul or access routes are to be constructed of a 6-inch thick layer of an approved cushioning material, such as shredded mulch or non-limestone gravel in accordance with section 02318.
- F. The material, location and route of the temporary “access route” must be approved by the Architect prior to any work being performed.
- G. Delivery of the cushioning material to the “access route” location and installation of the cushioning material must be done either by hand or with small bobcat-type machines to prevent compaction of the root zones.
- H. The cushioning material shall be replenished as necessary to maintain a uniform 6-inch depth.
- I. Removal of the cushioning material must be done either by hand or with small bobcat-type machines. All of the material must be completely removed. Where small machinery is used to remove the bulk of the material, removal of material in contact with the soil surface must be done by hand, and in such a way as to minimize disturbance of the soil surface and prevent damage to surface or feeder roots.

3.4 TREE AND LANDSCAPE PROTECTION DURING DEMOLITION AND/OR CONSTRUCTION ACTIVITIES

A. General

1. The Contractor is required to meet with the Architect at the site prior to beginning work to review all work procedures, access and haul routes, and tree and landscape protection measures.
2. The Architect shall be on site during all operations within protection zones. 24-hour notice must be given to Architect, requesting his presence for work scheduled within the tree protection zone.
3. Work determined to have occurred within protection zones without the presence and approval of the Architect will be considered a violation of the Contract.
4. Any damage to trees due to the Contractor's activities shall be reported to the Architect within 6 hours so that proper remedial action can be taken.

B. Staging and Work Activities

1. No grade changes, including cutting (soil removal) or filling (deposition of soil) will be allowed within tree protection zones or on the root zones of trees.
2. Demolition, removal, repair, construction or other work on structures or underground features within protection zones shall be accomplished using the smallest equipment possible, operated from outside the protection zone.
3. Temporary vehicle clearance:
  - a. Where temporary clearance is needed for access, tree branches shall be tied back to hold them clear of the clearance zone. Tie backs shall be done in such a manner as to prevent any cracking or breakage of branches or skinning of bark.
  - b. All tree pruning required for clearance during construction must be approved by the Architect. All pruning is to be performed by a Certified Arborist.
4. Chemical treatments
  - a. All herbicides, insecticides, pesticides or other chemicals proposed for use on the project site must be safe for use around trees, not easily transported by water, labeled for the use intended and approved for use by the Architect.
  - b. All chemicals used on the project site must be used and disposed of according to the labeled directions. Landscape damage resulting from improper use or disposal will be considered a violation of the Contract.
5. Spoil from trenches, basements, or other excavations shall not be placed within tree protection zones, either temporarily or permanently.
6. No burn piles or debris pits shall be placed within tree protection zones. No ashes, debris, or garbage may be dumped or buried within the tree protection zone.

C. Tree Removals

1. All trees to be removed from within the project area shall be removed by a Certified Arborist.

2. Trees shall be cut near ground level and the stump ground out to a clear depth of eighteen inches below grade, or as otherwise specified.
3. Trees to be removed from project areas not within tree protection zones must be felled and removed in such a way as to avoid damage to trees(s) and understory to remain.
  - a. Tree(s) to be removed which have branches extending into the canopy of tree(s) to remain must be removed in a manner that causes no damage to the branches, limbs, trunk or bark of trees(s) and understory to remain.
  - b. Trees to be removed shall be felled so as to fall away from tree protection zones and to avoid pulling and breaking of roots of trees to remain. If roots are entwined, the Architect may require first severing the major woody root mass before extracting the trees. This may be accomplished by cutting through the roots by hand, with a vibrating knife, rock saw, narrow trencher with sharp blades, or other root-pruning equipment as approved by the Architect.
  - c. Extraction of downed trees within protection areas shall occur by lifting the material out either by hand or with equipment staged outside the tree protection zone. Dragging or skidding across the ground will not be permitted.

#### D. Pruning

1. All pruning shall be performed by a Certified Arborist.
2. Standards
  - a. All pruning shall be in accordance with the Tree Pruning Guidelines (International Society of Arboriculture) and/or the ANSI A300 Pruning Standard (American National Standard for Tree Care Operations) and adhere to the most recent edition of ANSI Z133.1
  - b. Guidelines:
    - 1) Interior branches shall not be stripped out.
    - 2) Pruning cuts larger than 4 inches in diameter, except to remove dead wood, shall be avoided.
    - 3) Pruning cuts that expose heartwood shall be avoided whenever possible.
    - 4) No more than 20 percent of the foliage shall be removed within any single tree.
3. Root Pruning
  - a. Any grading, construction, demolition, or other below-ground work which may reasonably be expected to encounter tree roots must be monitored by the Architect.
  - b. All root pruning is to be performed by a Certified Arborist.
  - c. Before grading, excavation or trenching for project work adjacent to tree protection zones, trees shall be root pruned to a depth of 24 inches as follows:
    - 1) A 24" deep trench shall be manually dug one (1) foot outside the tree protection zone perimeter.

- 2) As roots are exposed, they shall be cleanly cut with a hand saw, vibrating knife, rock saw, narrow trencher with sharp blades, or other root-pruning equipment approved by the Architect.
  - d. Any roots damaged during grading or construction shall be exposed to sound tissue and cut cleanly with a saw.
- E. Brush Removal
1. Any brush clearing required within the tree protection zone shall be accomplished with hand-operated equipment.
  2. Removal of all downed brush within protection areas shall occur by lifting the material out either by hand or with equipment staged outside the tree protection zone. Dragging or skidding across the ground will not be permitted.
  3. Where approved by the Architect, brush removed from the project site may be chipped and chips spread underneath trees within the tree protection zone to a maximum depth of 6 inches, leaving the trunks clear of mulch.

### 3.5 EXCAVATION AROUND TREES

- A. Excavate within proximity of trees only where indicated. Do not machine excavate within drip-line or limit of tree protection.
- B. Where excavating for new construction is required within drip line of trees, hand excavate to minimize damage to root systems. Provide sheeting at excavations as required. Use narrow-tine spading forks and comb soil to expose roots. Engage a Certified Arborist to survey root radius and locate large lateral support roots prior to work.
  1. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots as directed by the Arborist to avoid new construction.
- C. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.
- D. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots; cut only smaller roots that interfere with installation of new work. Cut roots with sharp pruning instruments; do not break or chop.
- E. Prune branches to balance loss to root system caused by damage or cutting of root system.
- F. Tree and/or landscape protection fencing must be in place prior to any work being performed on site, including delivery of materials or supplies, vehicular traffic, installation of security fencing, etc.

### 3.6 GRADING AND FILLING AROUND TREES

- A. Maintain existing grade within drip-line or limit of protection of trees.

### 3.7 REPAIR AND REPLACEMENT OF TREES

- A. Repair trees damaged by construction operations. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
- B. Remove and replace dead and damaged trees that Arborist determines to be incapable of restoration to normal growth pattern.
  - 1. Provide new trees of same size and species as those being replaced. Plant and maintain as specified by Architect of Record.
  - 2. If trees over 6 inches in caliper measurement (taken 12 inches above grade) are required to be replaced, provide new trees of 6 inch caliper size and of species selected by the Architect.
- C. Specimen Trees: Where trees indicated to remain are determined to be essential to the project prior to any construction activities, the Owner may impose monetary penalties related to damage and subsequent death of these trees in addition to the above requirements.

### 3.8 CLEANUP & DISPOSAL

- A. Burning on Owner's property of removed trees and branches is not permitted on site.
- B. Removal from Owner's Property: Remove excess excavation, displaced trees, and trimmings and dispose of off Owner's property in accordance with section 02316.
- C. Upon completion of work, the Contractor is responsible for ensuring that all landscaped areas within the scope of work, including adjacent areas that may have been impacted, are clean and free of trash or debris.
- D. All landscaped areas are to be restored to their previous condition, to the satisfaction of the Architect.
- E. All excess material, debris and/or waste generated by the Contractor's operations is to be disposed of in accordance with Section 02316.

### 3.9 TREE AND LANDSCAPE DAMAGE

- A. General
  - 1. Trees, shrubs, lawns and/or other landscaping destroyed or damaged by the actions of the Contractor or any of the Contractor's subcontractors or agents shall be replaced or restored to its previous condition, including repair of ruts, new topsoil and regrading, at the sole expense of the Contractor, to the standards of work set forth in these

specifications and to the satisfaction of the Architect. All repaired lawn areas are to be sodded.

- a. Damage or injury to trees includes, but is not be limited to: breakage, gouging, stripping, skinning, inappropriate pruning or cutting to bark, limbs, branches, trunks and/or roots, and/or compaction, dumping or flooding of roots or root zones.
2. Failure to comply with any of the provisions set forth in this specification by the Contractor or any of the Contractor's subcontractors or agents, whether resulting in obvious landscape damage or not, will be considered a violation of the Contract.
3. Examples of landscape violations include, but are not limited to:
  - a. Failure to erect and/or maintain landscape protection fencing.
  - b. Storage or dumping of materials, equipment or debris within landscape protection zones.
  - c. Driving and/or parking on non-paved surfaces, particularly under trees and/or on lawn areas.
  - d. Damage to trees, shrubs, lawns, planting beds and other landscape elements caused by the action, or consequence of an action, by the Contractor or any of the Contractor's subcontractors or agents.
  - e. Pruning of trees, branches, limbs or other woody material by any personnel other than a Certified Arborist.

END OF SECTION 02122

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents**
- C. Book 2: Standard Terms and Conditions for Construction Contracts**
- D. Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Footings.
  - 2. Foundation walls.
  - 3. Slabs-on-grade.
  - 4. Insulation cast into concrete foundation wall.
- B. Related Sections:
  - 1. Section "Architectural Concrete" for general building applications of specially finished formed concrete.
  - 2. Section "Earth Moving" for drainage fill under slabs-on-grade.
  - 3. Section "Concrete Paving" for concrete pavement and walks.
  - 4. Section 07210 "Building Insulation" for foundation wall insulation.
- C. The materials in this Section are part of the overall USGBC "Leadership in Energy and Environmental Design" LEED prerequisites and credits needed for Project to obtain a minimum LEED "Silver" Certification based on LEED-NC, Version 2.2 requirements. See Section 01352 LEED Requirements and this section for more information.

#### 1.3 DEFINITIONS

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

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

- B. Complete the LEED MATERIALS CREDITS DOCUMENTATION SHEET for products in this section.
- C. LEED Submittal:
  - 1. Product Data as required to show compliance with the following credits:
    - a. Product Data for Credit MR 4.1 and Credit MR 4.2: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content.
      - 1) Include statement indicating costs for each product having recycled content.
    - b. Product Certificates for Credit MR 5.1 and Credit MR 5.2: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material.
      - 1) Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
  - 2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements, and for equivalent concrete mixtures that do not contain portland cement replacements.
- D. 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.
- E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include 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.
- F. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
  - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- G. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - 1. Location of construction joints is subject to approval of the Architect.
- H. Samples: For waterstops and vapor retarder.
- I. Qualification Data: For Installer, manufacturer, testing agency.
- J. Welding certificates.



## SECTION 03300 - CAST-IN-PLACE CONCRETE

- K. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
  2. Admixtures.
  3. Form materials and form-release agents.
  4. Steel reinforcement and accessories.
  5. Fiber reinforcement.
  6. Curing compounds.
  7. Floor and slab treatments.
  8. Bonding agents.
  9. Adhesives.
  10. Vapor retarders.
  11. Semirigid joint filler.
  12. Joint-filler strips.
  13. Repair materials.
- L. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- M. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- N. Field quality-control reports.
- O. Minutes of preinstallation conference.

### 1.5 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. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
  2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency

## SECTION 03300 - CAST-IN-PLACE CONCRETE

laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

- D. 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.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5. and Sections 1 through 5 and Section 7, "Lightweight Concrete."
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. 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:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
    - e. Special concrete finish subcontractor.
  - 2. 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, vapor-retarder installation, anchor rod and anchorage device installation tolerances steel reinforcement installation, concrete repair procedures, and concrete protection.

### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### 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.
  - 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:
    - a. High-density overlay, Class 1 or better.
    - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    - c. Structural 1, B-B or better; mill oiled and edge sealed.
    - d. 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. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
- G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- H. Form-Release Agent: Commercially formulated form-release agent 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.
- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic 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 inch (25 mm) to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

### 2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 60 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.
- C. 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 epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
  3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

### 2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  1. Portland Cement: ASTM C 150, Type I or Type III, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class C.
    - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
  2. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag.
- B. Silica Fume: ASTM C 1240, amorphous silica.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

- C. Normal-Weight Aggregates: ASTM C 33, Class 3S or Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch (19 mm) nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C 330, 3/4-inch (19-mm) [1/2-inch (13-mm) nominal maximum aggregate size.
- E. Water: ASTM C 94/C 94M and potable.

### 2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. 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.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

### 2.6 FIBER REINFORCEMENT

- A. Carbon-Steel Fiber: ASTM A 820/A 820M, deformed, minimum of 2 inches (50 mm) long, and aspect ratio of 35 to 40
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Fiber: Type 1, Cold-Drawn Wire:
      - 1) Bekaert; Dramix.
      - 2) Fibercon International, Inc.; Fibercon Drawn Wire.
      - 3) Nycon, Inc.; Nycon SF Type I.
      - 4) Propex Concrete Systems Corp.; Novocon 1050.
      - 5) Sika Corporation; Sika Fiber SH.
- B. 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, [1/2 to 1-1/2 inches (13 to 38 mm)] [1 to 2-1/4 inches (25 to 57 mm)] <Insert dimensions> long.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. Monofilament Micro-Fibers:
    - 1) Axim Italcementi Group, Inc.; Fibrasol II P.
    - 2) FORTA Corporation; FORTA Econo-Mono.
    - 3) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.
    - 4) Metalcrete Industries; Polystrand 1000.
    - 5) Nycon, Inc.; ProConM.
    - 6) Propex Concrete Systems Corp.; Fibermesh 150.
    - 7) Sika Corporation; Sika Fiber PPM.
  - b. Fibrillated Micro-Fibers:
    - 1) Axim Italcementi Group, Inc.; Fibrasol F.
    - 2) Euclid Chemical Company (The), an RPM company; Fiberstrand F.
    - 3) Grace Construction Products, W. R. Grace & Co.; Grace Fibers.
    - 4) Nycon, Inc.; ProConF.
    - 5) Propex Concrete Systems Corp.; Fibermesh 300.
    - 6) Sika Corporation; Sika Fiber PPF.

### 2.7 VAPOR RETARDERS

- A. 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
    - a. Raven Industries Inc.; Vapor Block 10.
    - b. Reef Industries, Inc.; Griffolyn 10 mil Green.
    - c. Stego Industries, LLC; Stego Wrap 10 mil Class A.
- B. 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 (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- C. 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 (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

### 2.8 FLOOR AND SLAB TREATMENTS

- A. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.
  1. Products: Subject to compliance with requirements, provide one of the following:

## SECTION 03300 - CAST-IN-PLACE CONCRETE

- a. BASF Construction Chemicals - Building Systems; Maximent.
- b. ChemMasters; ConColor.
- c. Conspec by Dayton Superior; Conshake 500.
- d. Dayton Superior Corporation; Quartz Tuff.
- e. Edoco by Dayton Superior; Burke Non Metallic Floor Hardener 250.
- f. Euclid Chemical Company (The), an RPM company; Surfex.
- g. Kaufman Products, Inc.; Tycron.
- h. Lambert Corporation; Colorhard.
- i. L&M Construction Chemicals, Inc.; Quartzplate FF.
- j. Metalcrete Industries; Floor Quartz.
- k. Scofield, L. M. Company; Lithochrome Color Hardener.
- l. Symons by Dayton Superior; Hard Top.

### 2.9 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ChemMasters; Chemisil Plus.
    - b. ChemTec Int'l; ChemTec One.
    - c. Conspec by Dayton Superior; Intraseal.
    - d. Curecrete Distribution Inc.; Ashford Formula.
    - e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
    - f. Edoco by Dayton Superior; Titan Hard.
    - g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
    - h. Kaufman Products, Inc.; SureHard.
    - i. L&M Construction Chemicals, Inc.; Seal Hard.
    - j. Meadows, W. R., Inc.; LIQUI-HARD.
    - k. Metalcrete Industries; Floorsaver.
    - l. Nox-Crete Products Group; Duro-Nox.
    - m. Symons by Dayton Superior; Buff Hard.
    - n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
    - o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.

### 2.10 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
    - b. BASF Construction Chemicals - Building Systems; Confilm.
    - c. ChemMasters; SprayFilm.

SECTION 03300 - CAST-IN-PLACE CONCRETE

- d. Conspec by Dayton Superior; Aquafilm.
  - e. Dayton Superior Corporation; Sure Film (J-74).
  - f. Edoco by Dayton Superior; BurkeFilm.
  - g. Euclid Chemical Company (The), an RPM company; Eucobar.
  - h. Kaufman Products, Inc.; Vapor-Aid.
  - i. Lambert Corporation; LAMBCO Skin.
  - j. L&M Construction Chemicals, Inc.; E-CON.
  - k. Meadows, W. R., Inc.; EVAPRE.
  - l. Metalcrete Industries; Waterhold.
  - m. Nox-Crete Products Group; MONOFILM.
  - n. Sika Corporation; SikaFilm.
  - o. SpecChem, LLC; Spec Film.
  - p. Symons by Dayton Superior; Finishing Aid.
  - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
  - r. Unitex; PRO-FILM.
  - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
    - b. BASF Construction Chemicals - Building Systems; Kure 200.
    - c. ChemMasters; Safe-Cure Clear.
    - d. Conspec by Dayton Superior; W.B. Resin Cure.
    - e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
    - f. Edoco by Dayton Superior; Res X Cure WB.
    - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
    - h. Kaufman Products, Inc.; Thinfilm 420.
    - i. Lambert Corporation; AQUA KURE - CLEAR.
    - j. L&M Construction Chemicals, Inc.; L&M Cure R.
    - k. Meadows, W. R., Inc.; 1100-CLEAR.
    - l. Nox-Crete Products Group; Resin Cure E.
    - m. Right Pointe; Clear Water Resin.
    - n. SpecChem, LLC; Spec Rez Clear.
    - o. Symons by Dayton Superior; Resi-Chem Clear.
    - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
    - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
    - r. Vexcon Chemicals, Inc.; Starseal 309.



## SECTION 03300 - CAST-IN-PLACE CONCRETE

### 2.11 CAST-IN FOUNDATION WALL INSUALTION

- A. Insulation: Provide Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board, Type I, Class 1 or 2 as indicated on drawings.
  - 1. Basis of Design: Subject to compliance with requirements, provide ISOCAST-R Insulation as manufactured by Dow Building Soultions or comparable product.
    - a. Meets manufacture's applicable standards.
    - b. Thickness: As indicated on drawings.
    - c. Polyisocyanurate foam core with a trilaminate aluminum/poly/kraft facer on both sides.
    - d. Use: In cast-in-place concrete foundation walls, where it is sandwiched between two layers of concrete with connectors holding together the finished panel.

### 2.12 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- D. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

### 2.13 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) 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 (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi (29 MPa) 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 (6.4 mm) 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.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

### 2.14 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. 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.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

### 2.15 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings and Foundation Walls: Proportion normal-weight concrete mixture as follows:
  1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
  2. Maximum Water-Cementitious Materials Ratio: 0.45.
  3. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture plus or minus 1 inch (25 mm).
  4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
- B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

## SECTION 03300 - CAST-IN-PLACE CONCRETE

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m)
3. Slump Limit: 4 inches (100 mm) plus or minus 1 inch (25 mm).
4. Air Content (for Exterior slabs on grade only): 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch (19-mm) nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

### 2.16 FABRICATING REINFORCEMENT

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

### 2.17 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
  1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
  1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
  2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK

- 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 (3.2 mm), for surfaces predominantantly exposed to public view.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

2. Class B, 1/4 inch (6 mm), for coarse-textured concrete formed surfaces intended to receive plaster, stucco or wainscoting.
  3. Class C, 1/2 inch (13 mm) for all other surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- 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 for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, reglets, recesses, and the like, for easy removal.
  2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED 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.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) 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 75 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 Architect.

### 3.4 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.
- C. Granular Course: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).

### 3.5 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 bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

### 3.6 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 Architect.
  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. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  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 at 60 feet on center, maximum, unless indicated otherwise. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- 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.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
  2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
  3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

### 3.7 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. 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.
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 according to ACI 301.
  3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) 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. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  2. Maintain reinforcement in position on chairs during concrete placement.
  3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  4. Slope surfaces uniformly to drains where required.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

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 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.8 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.9 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.



## SECTION 03300 - CAST-IN-PLACE CONCRETE

- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings, to receive mortar setting beds for bonded cementitious floor finishes
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces exposed to view
  2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
  3. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm)

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. 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 at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

### 3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 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 (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound

## SECTION 03300 - CAST-IN-PLACE CONCRETE

manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

### 3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect'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 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

## SECTION 03300 - CAST-IN-PLACE CONCRETE

- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) 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 (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.14 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. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:

## SECTION 03300 - CAST-IN-PLACE CONCRETE

1. Steel reinforcement placement.
  2. Headed bolts and studs.
  3. Verification of use of required design mixture.
  4. Concrete placement, including conveying and depositing.
  5. Curing procedures and maintenance of curing temperature.
  6. Verification of concrete strength before removal of shores and forms from beams and slabs.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
  2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
  6. 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.
  7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

## SECTION 03300 - CAST-IN-PLACE CONCRETE

10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. 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.
12. 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 Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03300

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents**
- C. Book 2: Standard Terms and Conditions for Construction Contracts**
- D. Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Structural steel.
  - 2. Grout.
- B. Related Sections:
  - 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
  - 2. Division 05 Section "Steel Decking" for field installation of shear connectors through deck.
  - 3. Division 05 Section "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.
  - 4. Division 09 painting Sections and Division 09 Section "High-Performance Coatings" for surface-preparation and priming requirements.

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified structural engineer, licensed in the State of Illinois, to withstand loads indicated and comply with other information and restrictions indicated.
  - 1. Select and complete connections using schematic details indicated and AISC 360
  - 2. Use LRFD; data are given at factored-load level

## SECTION 05120 - STRUCTURAL STEEL FRAMING

- B. Moment Connections: Type FR, fully restrained.
- C. Construction: Shear wall system.

### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. LEED Submittal:
  - 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
- C. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
  - 5. For structural-steel connections indicated to comply with design loads, include structural design data signed and sealed by the qualified structural engineer responsible for their preparation, to be submitted concurrently with connection details.
- D. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
  - 1. Power source (constant current or constant voltage).
  - 2. Electrode manufacturer and trade name, for demand critical welds.
- E. Qualification Data: For qualified Installer, fabricator, professional engineer, testing agency.
- F. Welding certificates.
- G. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- H. Mill test reports for structural steel, including chemical and physical properties.
- I. Product Test Reports: For the following:
  - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 2. Direct-tension indicators.
  - 3. Tension-control, high-strength bolt-nut-washer assemblies.
  - 4. Shear stud connectors.



## SECTION 05120 - STRUCTURAL STEEL FRAMING

5. Shop primers.
6. Nonshrink grout.

J. Source quality-control reports.

### 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, P2 or SSPC-Q P 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- E. Comply with applicable provisions of the following specifications and documents:
  1. AISC 303.
  2. AISC 341 and AISC 341s1.
  3. AISC 360.
  4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- F. Preinstallation Conference: Conduct conference at Project site.

### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

3. 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. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
  1. W-Shapes: 60 percent.
  2. Channels, Angles: 60 percent.
  3. Plate and Bar: 25 percent.
  4. Cold-Formed Hollow Structural Sections: 25 percent.
  5. All Other Steel Materials: 25 percent.
- B. W-Shapes: ASTM A 992/A 992M
- C. Channels, Angles: ASTM A 36/A 36M
- D. Plate and Bar: ASTM A 36/A 36M
- E. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50 (345).
- F. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- G. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.
- H. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.
- I. Steel Forgings: ASTM A 668/A 668M.
- J. Welding Electrodes: Comply with AWS requirements.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490 (ASTM A 490M), Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends; ASTM A 563, Grade DH, (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers with plain finish.
  - 1. Direct-Tension Indicators: ASTM F 959, Type 490 (ASTM F 959M, Type 10.9), compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH (ASTM A 563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers.
  - 1. Finish: Hot-dip or mechanically deposited zinc coating.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
  - 1. Finish: Plain
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable straight.
  - 1. Nuts: ASTM A 563 (ASTM A 563M) hex carbon steel.
  - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
  - 3. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  - 4. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.
- G. Threaded Rods: A 572/A 572M, Grade 50 (345).
  - 1. Nuts: ASTM A 563 (ASTM A 563M) hex carbon steel.
  - 2. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  - 3. Finish: Mechanically deposited zinc coating, ASTM B 695, Class 50.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### 2.3 PRIMER

- A. Primer: Comply with Division 09 painting Sections.
- B. Primer: SSPC-Paint 25, Type I or Type II, zinc oxide, alkyd, linseed oil primer.
- C. Primer: SSPC-Paint 25 BCS, Type I or Type II, zinc oxide, alkyd, linseed oil primer.
- D. Primer: SSPC-Paint 23, latex primer.
- E. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- F. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20, ASTM A 780.

### 2.4 PREFABRICATED BUILDING COLUMNS

- A. General: Prefabricated building columns consisting of load-bearing structural-steel members encased in manufacturer's standard insulating material for fire protection and enclosed in an outer, non-load-bearing steel shell. The load-bearing pipe and tube column will be filled with concrete,
  - 1. Concrete Fill: Manufacturer's standard-mix structural concrete, with a minimum 28-day compressive strength of 5000 psi (34.5 MPa), machine mixed and mechanically vibrated during placement to produce concrete fill free of voids.
- B. Fire-Resistance Rating: Provide prefabricated building column listed and labeled by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing according to ASTM E 119.
  - 1. UL Fire-Resistance Rating: XI 06 (2-Hour) or as specified.
- C. Column Configuration: Provide columns of sizes and shapes indicated. Fabricate connections to comply with details shown or as required to suit type of structure indicated.
- D. Available Manufacturers: Subject to compliance with requirements, manufacturers offering prefabricated building columns that may be incorporated into the work include, but are not limited to, the following:
  - 1. Fire-Trol Division; Dean Lally L.P.

### 2.5 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- 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.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### 2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
  - 1. Camber structural-steel members where indicated.
  - 2. Fabricate beams with rolling camber up.
  - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
  - 4. Mark and match-mark materials for field assembly.
  - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. 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.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning, SSPC-SP 2, "Hand Tool Cleaning or SSPC-SP 3, "Power Tool Cleaning."
- 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 (250 mm) 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. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Baseplate Holes: Cut, 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.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### 2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install 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.
  - 1. Joint Type: Snug tightened or Pretensioned
- B. Welded 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. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 3. Verify that weld sizes, fabrication sequence, and equipment used for "exposed structural steel" will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces
    - a. Grind butt welds flush.
    - b. Grind or fill exposed fillet welds to smooth profile. Dress all exposed welds.

### 2.8 SHOP PRIMING

- A. Shop prime Fire-Trol Shell and exposed column surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
  - 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 7/NACE No. 4, "Brush-Off Blast Cleaning."
- 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 (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

### 2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
  2. Galvanize lintels, shelf angles, and welded door frames attached to structural-steel frame and located in exterior walls.

### 2.10 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. 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 Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. 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."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and 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.
- E. 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.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

### 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.
  - 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- 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. Weld plate washers to top of baseplate.
  - 3. Snug-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.
  - 4. 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."
- 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.



## SECTION 05120 - STRUCTURAL STEEL FRAMING

1. Level and plumb individual members of structure.
  2. 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. Do not use thermal cutting during erection
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. 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.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install 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.
1. Joint Type: Snug tightened
- B. 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. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  3. 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.
  4. Verify that weld sizes, fabrication sequence, and equipment used for "exposed structural steel" will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces
    - a. Grind butt welds flush.
    - b. Grind or fill exposed fillet welds to smooth profile. Dress all exposed welds.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds
- B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

## SECTION 05120 - STRUCTURAL STEEL FRAMING

1. In addition to visual inspection, 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.
- D. 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.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
- B. Touchup Painting: Immediately after erection, clean 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. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION 051200

## SECTION 05210 - STEEL JOIST FRAMING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents**
- C. Book 2: Standard Terms and Conditions for Construction Contracts**
- D. Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. K-series steel joists.
  - 2. KCS-type K-series steel joists.
  - 3. K-series steel joist substitutes.
  - 4. Joist accessories.
- B. Related Sections include the following:
  - 1. Division 03 Section "Cast-in-Place Concrete" for installing bearing plates in concrete.
  - 2. Division 04 Section "Unit Masonry" for installing bearing plates in unit masonry.

#### 1.3 DEFINITIONS

- A. SJI "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads indicated.
- B. Design special joists to withstand design loads with live load deflections no greater than the following:
  - 1. Roof Joists: Vertical deflection of 1/240 (total load) of the span.
  - 2. Roof Joists: Vertical deflection of 1/300 (live load) of the span.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of joist, accessory, and product indicated.
  - 1. Show load tables for spans of joists specified.

## SECTION 05210 - STEEL JOIST FRAMING

### B. LEED Submittal:

1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
  - a. Include statement indicating costs for each product having recycled content.

### C. Shop Drawings: Show layout, designation, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, joist accessories; splice and connection locations and details; and attachments to other construction.

1. Indicate locations and details of bearing plates to be embedded in other construction.

### D. Welding certificates.

### E. Manufacturer Certificates: Signed by manufacturers certifying that joists comply with requirements.

### F. Mill Certificates: Signed by bolt manufacturers certifying that bolts comply with requirements.

### G. Qualification Data: For manufacturer and professional engineer.

### H. Field quality-control test and inspection reports.

### I. Research/Evaluation Reports: For joists.

## 1.6 QUALITY ASSURANCE

### A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables of SJI "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

### B. SJI Specifications: Comply with standard specifications in SJI's "Specifications" that are applicable to types of joists indicated.

### C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## 1.7 DELIVERY, STORAGE, AND HANDLING

### A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

### B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

## SECTION 05210 - STEEL JOIST FRAMING

### 1.8 SEQUENCING

- A. Deliver steel bearing plates to be built into masonry construction.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Steel: Comply with SJI's "Specifications" for web and steel-angle chord members.
  - 1. Recycled Content: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 50 percent.
- B. Steel Bearing Plates: ASTM A 36/A 36M.
- C. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
  - 1. Finish: Plain, uncoated.
- D. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
  - 1. Finish: Plain.
- E. Welding Electrodes: Comply with AWS standards.

### 2.2 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.
  - 1. Joist Type: K-series steel joists and KCS-type K-series steel joists.
- B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.
- C. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- D. Provide holes in chord members for connecting and securing other construction to joists.
- E. Do not camber joists.
- F. Camber joists according to SJI's "Specifications."

## SECTION 05210 - STEEL JOIST FRAMING

- G. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches (1:48).

### 2.3 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- C. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- D. Fabricate steel bearing plates with integral anchorages of sizes and thicknesses indicated. Shop prime paint.
- E. Steel bearing plates with integral anchorages are specified in Division 05 Section "Metal Fabrications."
- F. Supply ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface, unless otherwise indicated.
- G. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

### 2.4 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.
- C. Apply 1 coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1 mil (0.025 mm) thick.
- D. Shop priming of joists and joist accessories is specified in Division 09 painting Sections.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

## SECTION 05210 - STEEL JOIST FRAMING

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

### 3.2 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
  1. Before installation, splice joists delivered to Project site in more than one piece.
  2. Space, adjust, and align joists accurately in location before permanently fastening.
  3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
  4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads have been applied.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.
- B. Field welds will be visually inspected according to AWS D1.1/D1.1M.
- C. In addition to visual inspection, field welds will be tested according to AWS D1.1/D1.1M and the following procedures, as applicable:
  1. Radiographic Testing: ASTM E 94.
  2. Magnetic Particle Inspection: ASTM E 709.
  3. Ultrasonic Testing: ASTM E 164.
  4. Liquid Penetrant Inspection: ASTM E 165.
- D. Bolted connections will be visually inspected.

## SECTION 05210 - STEEL JOIST FRAMING

- E. High-strength, field-bolted connections will be tested and verified according to procedures in RCSC's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts."
- F. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.
- G. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

### 3.4 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists, bearing plates, abutting structural steel, and accessories.
  - 1. Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
  - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.
- D. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION 052100



## SECTION 05310 - STEEL DECKING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instruction to Bidders, and Execution Documents**
- C. Book 2: Standard Terms and Conditions for Construction Contracts**
- D. Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Composite roof deck.
- B. Related Sections include the following:
  - 1. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.
  - 2. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
  - 3. Division 09 painting Sections for repair painting of primed deck.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. LEED Submittal:
  - 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - a. Include statement indicating costs for each product having recycled content.
- C. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.
- D. Product Certificates: For each type of steel deck, signed by product manufacturer.
- E. Welding certificates.
- F. Field quality-control test and inspection reports.

## SECTION 05310 - STEEL DECKING

- G. 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. Power-actuated mechanical fasteners.
- H. Research/Evaluation Reports: For steel deck.

### 1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.
- B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."
- C. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.
  - 1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
  - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- D. 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."
- E. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

### 1.5 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. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

### 1.6 COORDINATION

- A. Coordinate installation of sound-absorbing insulation strips in topside ribs of acoustical deck with roofing installation specified in Division 07 Section "07452 – PVC Roofing ensure protection of insulation strips against damage from effects of weather and other causes.

## SECTION 05310 - STEEL DECKING

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Steel Deck:
    - a. ASC Profiles, Inc.
    - b. Canam Steel Corp.;The Canam Manac Group.
    - c. Consolidated Systems, Inc.
    - d. DACS, Inc.
    - e. D-Mac Industries Inc.
    - f. Epic Metals Corporation.
    - g. Marlyn Steel Decks, Inc.
    - h. New Millennium Building Systems, LLC.
    - i. Nucor Corp.; Vulcraft Division.
    - j. Roof Deck, Inc.
    - k. United Steel Deck, Inc.
    - l. Valley Joist; Division of EBSCO Industries, Inc.
    - m. Verco Manufacturing Co.
    - n. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

#### 2.2 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

## SECTION 05310 - STEEL DECKING

- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.
- H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.
- I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and level or sloped recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.
- K. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.
- L. Galvanizing Repair Paint: ASTM A 780, SSPC-Paint 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.
- M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

### 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.

#### 3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, 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.
  - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- 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.

## SECTION 05310 - STEEL DECKING

- 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.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

### 3.3 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 (38 mm) long, and as follows:
  - 1. Weld Diameter: 5/8 inch (16 mm), nominal.
  - 2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds 12 inches (305 mm) apart in the field of roof and 6 inches (150 mm) apart in roof corners and perimeter, based on roof-area definitions in FMG Loss Prevention Data Sheet 1-28.
  - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches (910 mm), and as follows:
  - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
  - 2. Mechanically clinch or button punch.
  - 3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
  - 1. End Joints: Lapped 2 inches (51 mm) minimum
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches (305 mm) apart with at least one weld or fastener at each corner.
  - 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
  - 1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

## SECTION 05310 - STEEL DECKING

- 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.
- G. Install piercing hanger tabs at 14 inches (355 mm) apart in both directions, within 9 inches (228 mm) of walls at ends, and not more than 12 inches (305 mm) from walls at sides, unless otherwise indicated.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field welds will be subject to inspection.
- C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.
- D. Remove and replace work that does not comply with specified requirements.
- E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

### 3.5 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 and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
  - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
  - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 09 painting Sections for repair painting of primed deck.
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 09 painting Sections for repair painting of primed deck.
- D. 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 15141 - DOMESTIC WATER PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings
- B. Book 1: Project Information, Instructions to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SUMMARY

- A. This Section includes domestic water piping inside the building.

#### 1.3 DEFINITIONS – NOT APPLICABLE

#### 1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

#### 1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

- C. Protect flanges, fittings, and piping specialties from moisture and dirt..

## 1.7 WARRANTY

- A. Provide manufacturer's standard 1-year warranty for materials and labor, commencing on date of substantial completion.

## 1.8 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing domestic water piping systems with 125 psig (860 kPa), unless otherwise indicated.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

- A. Refer to Part 3 "Pipe and Fitting Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A, Schedule 40, galvanized. Include ends matching joining method.
  - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
  - 2. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body, with ball-and-socket, metal-to-metal, bronze seating surface and female threaded ends.
  - 3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
  - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
  - 5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.
  - 6. Steel-Piping, Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

### 2.3 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Types K and L (ASTM B 88M, Types A and B), water tube, annealed temper.



1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Hard Copper Tube: ASTM B 88, Types K and L (ASTM B 88M,), water tube, drawn temper.
1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
  2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
  3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- C. Ductile-Iron Pipe: AWWA C151, 250-psig minimum pressure rating with mechanical-joint bell, plain spigot end, and AWWA C104 cement-mortar lining.
1. Include AWWA C111 ductile-iron gland, rubber gasket, and steel bolts with mechanical-joint pipe.
  2. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections, 1 or more gasketed sleeve sections, 250-psig minimum working-pressure rating, and AWWA C550 epoxy interior coating. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

## 2.4 VALVES

- A. Bronze and cast-iron, general-duty valves are specified in Division 15 Section "Valves."
- B. Balancing and drain valves are specified in Division 15 Section "Plumbing Specialties."

## PART 3 - EXECUTION

### 3.1 EXCAVATION

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

### 3.2 PIPE AND FITTING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
- B. Flanges may be used on aboveground piping, unless otherwise indicated.

- C. Under-Ground, Water-Service Piping on Service Side of Water Meter: Underground, Service Entrance Piping: Do not use flanges or valves underground. Use the following:
1. NPS 2 and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints.
  2. 3- to 8-Inch NPS: Ductile-iron pipe and fittings, and mechanical joints.
- D. **Under-Ground, Non-Potable Water: Do not use flanges or valves underground. Use the following:**
1. **NPS 2 and Smaller: Soft copper tube, Type K (Type A); copper pressure fittings; and soldered joints. Note: Pipe shall be painted yellow and identified 'NON-POTABLE' 10 feet on center.**
- E. Water Piping on Service Side of Water Meter inside the Building: Use the following piping materials for each size range:
1. NPS 4 and smaller: Hard copper tube, Type K; copper pressure fittings; and soldered joints.
  2. NPS 4 and larger: Steel pipe; gray-iron, threaded fittings; and threaded joints.
- F. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
1. NPS 3 and smaller: Hard copper tube, Type L, copper pressure fittings; and soldered joints.
  2. NPS 4 to NPS 6: Steel pipe; gray-iron, threaded fittings; and threaded joints.
- G. Non-Potable-Water Piping: Use the following piping materials for each size range:
1. NPS 3 and smaller: Steel pipe; gray-iron, threaded fittings; and threaded joints.

### 3.3 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use bronze ball valves for piping NPS 2-1/2 (DN 65) and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 3 (DN 75) and larger.
  2. Throttling Duty: Use bronze ball or globe valves for piping NPS 2 (DN 50) and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
  3. Hot-Water-Piping, Balancing Duty: Calibrated balancing valves.
  4. Drain Duty: Hose-end drain valves.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2-1/2 (DN 65) and smaller. Use butterfly or gate valves for piping NPS 3 (DN 75) and larger.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch, size shall be based on flow, not line size to ensure readability of flow at valve in the hot water return main where branches join together and on discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Calibrated balancing valves are specified in Division 15 Section "Plumbing Specialties."

### 3.4 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Install under-building-slab copper tubing according to CDA's "Copper Tube Handbook."
- C. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 15 Section "Meters and Gages," and drain valves and strainers are specified in Division 15 Section "Plumbing Specialties."
- E. Install domestic water piping level without pitch and plumb.
- F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

### 3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 15 Section "Basic Mechanical Materials and Methods."
- B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- C. Grooved Joints: Assemble joints with grooved-end-pipe or grooved-end-tube coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

### 3.6 WATER METER INSTALLATION

- A. Rough-in water piping for water meter installation according to City of Chicago Department of Water requirements. Water meters shall be purchased from Department of Water Management.

### 3.7 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 15 Section "Hangers and Supports." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs: According to the following:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet : MSS Type 49, spring cushion rolls, if indicated.
  3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 15 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch
- E. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
  2. NPS 1-1/2: 108 inches with 3/8-inch rod.
  3. NPS 2: 10 feet with 3/8-inch rod.
  4. NPS 2-1/2: 11 feet with 1/2-inch rod.
  5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
  6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
  7. NPS 6: 12 feet with 3/4-inch rod.
  8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- F. Install supports for vertical steel piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  4. NPS 2-1/2: 108 inches with 1/2-inch rod.
  5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
  6. NPS 6: 10 feet with 5/8-inch rod.
  7. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.

### 3.8 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve, and extend and connect to the following:
  - 1. Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 15 Section "Plumbing Fixtures."
  - 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.9 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
  - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  - 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
  - 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
  - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
  - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

### 3.10 CLEANING AND ADJUSTING

#### A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

#### B. Prepare and submit reports of purging and disinfecting activities.

#### C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

#### D. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
  - b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.11 CONTRACTOR STARTUP AND REPORTING

- A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
- B. Perform the following steps before putting into operation:
  1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Open throttling valves to proper setting.
  4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
  5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
  6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use
- C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- D. Check plumbing specialties and verify proper settings, adjustments, and operation.
- E. Energize pumps and verify proper operation.

### 3.12 DEMONSTRATION AND COMMISSIONING – NOT APPLICABLE.

END OF SECTION 15140

## SECTION 15190 - PLUMBING IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. **Drawings**
- B. **Book 1: Project Information, Instructions to Bidders, and Execution Documents**
- C. **Book 2: Standard Terms and Conditions for Construction Contracts**
- D. **Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### 1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.



## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

#### A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032 inches (0.8-mm.) Minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

#### B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### 2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black (high hazard) White (low hazard) Yellow.

- C. Background Color: Yellow (high hazard) Green (low hazard).
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

## 2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material: Fiberboard.
  - 2. Stencil Paint: Exterior, gloss, black unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.032-inch (0.8-mm).
  - 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of painting, identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.

- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
1. Identification Paint: Use for contrasting background.
  2. Stencil Paint: Use for pipe marking.
- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe Label Color Schedule:
1. Non-Potable Water:
    - a. Paint piping yellow.
    - b. Background Color: Blue.
    - c. Letter Color: White.
  2. Domestic Water Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.

### 3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
    - a. Cold Water: 1-1/2 inches (38 mm) round.
    - b. Hot Water: 1-1/2 inches (38 mm) round.
    - c. Non-Potable Water: 1-1/2 inches (38 mm) round.

2. Valve-Tag Color:
  - a. Cold Water: Brass.
  - b. Hot Water: Brass.
  - c. Non-Potable Water: Brass.
  
3. Letter Color:
  - a. Cold Water: White.
  - b. Hot Water: White.
  - c. Non-Potable Water: Yellow.

### 3.5 PAINTING

- A. Prime and paint all above ground and underground non-potable water piping yellow in accordance to Illinois Plumbing Code requirements.
- B. Prime and paint pipe materials and insulation in accordance to paint manufacturer instructions.

### 3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 15190

## SECTION 15400 - PLUMBING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. **Drawings**
- B. **Book 1: Project Information, Instructions to Bidders, and Execution Documents**
- C. **Book 2: Standard Terms and Conditions for Construction Contracts**
- D. **Book 2A: Standard Terms and Conditions Procedures Manual**

#### 1.2 SECTION INCLUDES

- A. This section includes general Scope of Work for plumbing.

#### 1.3 RELATED SECTIONS

- A. Section 15010 - General Provisions for Mechanical Work.
- B. Section 15082 – Plumbing Insulation.
- C. Section 15121 - Pipe Expansion Compensation.
- D. Section 15135 - Meters and Gauges.
- E. Section 15140 - Hangers and Supports.
- F. Section 15141 – Domestic Water Piping.
- G. Section 15145 – Domestic Water Piping Specialties.
- H. Section 15150 – Sanitary Waste and Vent Piping.
- I. Section 15155 – Drainage Piping Specialties.
- J. Section 15160 – Storm Drainage Piping.
- K. Section 15170 - Motors.
- L. Section 15190 –~~Plumbing-Mechanical~~ Identification.
- M. ~~Section 15245 – Vibration Isolation.~~
- N. Section 15420 - Plumbing Valves.

- O. Section 15441 – Domestic Water Pumps.
- P. Section 15450 – Rainwater Harvesting System.
- Q. Section ~~15195~~15485 - Natural Gas Piping.
- R. Section 15486 – Fuel Fired Water Heaters.

#### 1.4 DESCRIPTION

- A. These Specifications and accompanying drawings are to cover the furnishing of all labor, materials, equipment, apparatus, services, permanent and temporary facilities, as necessary to do the plumbing work involved in the furnishing, installing, testing, adjusting, readjustment as required and directed and placing into approved satisfactory operation the complete respective system as shown on the drawings, called for in the specifications, and as required by the job conditions. The Contractor shall pay all fees required for tests, permits, inspections and street openings.

#### 1.5 SCOPE OF WORK

- A. The scope of work for the plumbing is outlined within the contents of the contract documents. In general, the plumbing work to be furnished includes, but is not limited to, the following:
- B. Furnish and install a complete and operable system of domestic water including:
  1. Extension of water service from outside the building to inside of the building as indicated on drawings. Obtain approved water meter from municipality and provide required shut-off valves for domestic water service entrance. Site contractor installs exterior valve vault, valve and installs blind flange for receipt of building service line. Building plumber makes this connection and chlorinates to this point.
  2. New water service entrance with water meter and valves.
  3. Extension of hot, cold and recirculating water to each and every plumbing fixture, appliance and outlet and final connections thereto including: heaters, fill systems, hose bibbs, fixture stops, backflow preventers and all required or necessary miscellaneous related items.
  4. Fittings, valves, air chambers, di-electric unions, vacuum breakers, backflow preventers, hangers and supporting steel, expansion loops and miscellaneous related items
  5. Provide and install stop valves at each fixture.
  6. Provide and install drain valves at the base of each riser.
  7. Domestic hot water heaters with ASME/ANSI relief valves and controls. Extension of relief valve discharge piping to nearest floor or hub drain. Provide all start up services.
  8. Thermostatic mixing valves.
  9. Domestic hot water building recirculation system.
  10. Provide insulation for all water systems.
  11. Extend water piping to areas as indicated on the drawings for the use of all equipment furnished by other sections requiring water. Terminate line with shut off valve and a code approved back flow anti-siphon device. Contractors under other sections shall extend piping to their equipment as required.
  12. The domestic water system shall be designed to maintain maximum velocity of 5 feet per second in copper piping branches and 7 feet per second in copper piping mains, 6 feet per

second in galvanized steel piping branches and 8 feet per second in galvanized steel piping mains. Friction loss shall not exceed 3 psi per 100 feet of pipe.

13. The domestic water system shall be designed to maintain a minimum constant water pressure at each fixture of at least thirty psi, or the minimum pressure recommended by the fixture manufacturer, whichever is greater.
  14. The maximum length of ½ inch diameter pipe is 5'-0". The maximum length of ¾ inch diameter pipe is 30'-0", excluding hose bibbs and wall hydrants.
  15. Excavation and back fill for underground water service and distribution.
- C. Furnish and install a complete and operable system of sanitary, waste, vent, and storm water drainage including:
1. Floor drains, hub drains, area drains, roof drains and open site drains.
  2. Flashing of all roof penetrations including roof drains and vent pipes through roof.
  3. Extension of sanitary and storm drainage piping from building wall to a point or structure as indicated on the drawings for extension to site mains by the site work contractor, or as otherwise indicated.
  4. Sanitary, waste and vent connection to each and every plumbing fixture, drain, appliance and outlet and final connections thereto.
  5. Grease traps at kitchen sinks.
  6. Solids interceptors at multipurpose sinks.
  7. All floor drains, including floor drains below grade, shall be individually vented.
  8. Trap primers and related piping.
  9. Elevator pit pumps and related appurtenances.
  10. Excavation and backfill for all work.
- D. Furnish and install a complete and operable rainwater harvesting system complete with all required pumps, receiver tanks, pressure tanks, domestic water make-up break tank, chlorinators, filters, and non-potable distribution. Non-potable distribution shall be in strict conformance to code and piped to supply building water closets and urinals for flushing purposes only. Insulate, paint and identify non-potable water systems in accordance to City and State Plumbing Codes.
- E. Furnish and install all plumbing fixtures complete and operable with traps, waste fittings, supplies with stops, hangers, carriers, backflow devices, vacuum breakers and miscellaneous related items. Provide rough in and final connection to all fixtures in accordance to manufacturer's instructions.
- F. All cutting, coring and patching for installation of all pipes and equipment.
- G. Provide access panels for all valves and plumbing devices concealed within walls or concealed above inaccessible ceilings to allow proper access. Coordinate final acceptable locations with Architect. Refer to architectural sections for acceptable types of access panels.
- H. All piping and equipment insulation.
- I. Concrete housekeeping pads for plumbing equipment including, but not limited to, water heaters, pumps, tanks and large devices.
- J. All exterior and interior penetrations and openings through walls, partitions, floors and ceilings shall have the annular space around pipes properly caulked to prevent the entrance of rodents, insects, smoke, sound, odors, etc. Rated assemblies shall have penetrations and openings sealed with UL Listed systems equal to the assembly rating. Exterior penetrations and openings shall be made watertight.



- K. Testing of all piping systems.
- L. Sleeves for all pipes.
- M. Plumbing system identification.
- N. Factory authorized equipment start-up.
- O. Balancing of all water circulating systems.
- P. Cleaning and disinfection of all piping systems.
- Q. Miscellaneous wiring as herein specified.
- R. Close out documentation, including as-built drawings and Operation & Maintenance manuals.

1.6 RELATED REQUIREMENT SPECIFIED UNDER OTHER SECTIONS

- A. Insulation and pipe covering.
- B. Fire Protection.
- C. Finished Painting.
- D. Electrical
- E. Heating and Cooling
- F. Ventilation
- G. Concrete equipment bases (housekeeping pads).
- H. Patching of streets and sidewalks.
- I. Gas mains and service.
- J. Breechings and stacks.
- K. Motor starters.
- L. Excavating, backfilling and compaction of soils.
- M. Painting.

1.7 SUBMITTALS

- A. General: Submit all items according to the conditions of the contract and Division 1 and Division 15 specification sections.

- B. Shop Drawings for all fixtures and trims, equipments, materials, etc., shall be submitted. Submit piping drawings for all systems. Refer to Division 1 and Section 15010 for requirements.

1.8 QUALITY ASSURANCE

- A. Cooperate and consult with other trades in the proper location of piping and equipment before the final preparation and installation of same.
- B. Study project drawings and specifications in connection with the work of other trades and inform the Architect and Engineer of anticipated conflicts.
- C. Install all equipments and devices requiring access for servicing, testing, replacement, etc., in such a manner to properly execute for such in future. Coordinate with other trades the required clearances and access to be maintained for the proper installation of their said work.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Exercise care in transporting and handling to avoid damage to materials, including but not limited to, equipment, piping, fixtures, trim, valves, etc.
- B. Store materials on the site so as to prevent damage and theft.
- C. Keep materials clean, dry and free from deleterious conditions.

1.10 STANDARDS, REGULATIONS AND CODES

- A. The work under this section shall comply with the latest edition of the applicable standards and codes of the following:
  1. City of Chicago Municipal Plumbing Code (2009) (COCPC)
  2. State of Illinois Plumbing Code (2004) (ISPC)
  3. Department of Water Management Standards (DOWM)
  4. Mayor's of for People with Disabilities (MOPD)
  5. Illinois Accessibility Code (IAC)
  6. American Society of Plumbing Engineers (ASPE)
  7. American Society of Heating, Refrigeration  
And Air Conditioning Engineers (ASHRAE)
  8. American Society of Sanitary Engineers (ASSE)
  9. American Standard Testing Materials (ASTM)
  10. American National Standard Institute (ANSI)
  11. Americans with Disabilities ACT (ADA)
  12. Underwriters' Laboratories, Inc. (UL)
  13. Factory Mutual Standard (FM)
  14. Cast Iron Soil Pipe Institute (CISPI)
  15. Plumbing and Drainage Institute (PDI)
  16. National Sanitation Foundation (NSF)
  17. American Water Works Association (AWWA)

- 18. Air Conditioning and Refrigeration Institute (ARI)
- 19. National Fire Protection Association (NFPA)
- 20. American Gas Association (AGA)
- 21. National Electric Code (NEC)

- B. Include all items of labor and material required to comply with such standards and codes. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of the requirements of the standards and codes, the specifications and/or drawings shall govern.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Furnish and install as indicated within drawings and specifications.
- B. See schedules on drawings for specification of plumbing equipment, fixtures, trim and miscellaneous devices.

### 2.2 SEWER LINES, GRADE AND ELEVATIONS

- A. Sewers shall be laid out with a transit and level. After the trench is excavated these lines and grades shall be transferred to a level grade string at 50 ft. intervals along the trench. During the pipe laying, the line shall be determined by reference to the grade string. The invert of each length of pipe shall be set to the proper elevation as noted on the drawings or in the specifications.
- B. For excavating, trenching and backfilling, see Section 15010.

### 2.3 CONNECTIONS TO PLUMBING FIXTURES

- A. Supply connections to closet fixtures shall be galvanized steel pipe or copper pipe to the face of the wall. Provide chromium plated brass sleeves on exposed pipe from the wall to the valve.
- B. Supply connections to all plumbing fixtures shall be chrome plated brass pipe with heavy pattern chrome plated brass loose key stops with metal stems.
- C. Provide chrome plated brass escutcheons to match waste and supply pipe as it passes through floors, walls and ceilings.

### 2.4 DOMESTIC WATER RECIRCULATING PUMPS

- A. Bell & Gossett, Taco or Grundfoss in line type of capacities as indicated.
- B. Pumps shall be for vertical or horizontal installation and shall have adequate connections, all bronze construction, mechanical seal, built in motor overload protection, oil circulating lubrication system and direct connected motor.

- C. Recirculating pumps shall be controlled by an on-off switch in series with aquastat and timer.

## 2.5 PLUMBING FIXTURES

- A. General: Furnish, erect, connect-up and complete all plumbing fixtures and associated trimmings specified. All fixtures shall be perfect in finish and color, shall be set level and square with relation to interior finished, and located as indicated on the drawings. All vitreous, porcelain and cast iron enameled fixtures shall be acid resistant.
- B. Rough-Ins: Provide plumbing fixtures rough-ins and stub-outs utilizing manufactured pipe supports and brackets, as manufactured by Hubbard Enterprises 'HoldRite', or approved equal. Supports and brackets shall be attached to the building framing with proper attachments. Copper bonded brackets shall be used where copper piping is present.
- C. Trim: All exposed parts, faucet, supplies, stops, waste, traps, etc., shall be chrome plated brass.
- D. Support: Modify brackets, supports and/or plates as required to suit wall construction for proper support of fixtures. Provide oversized sleeves for all pipes through shear walls.
- E. Traps: Every waste pipe shall be provided with a trap in or near the fixture. Each trap shall be vented, unless otherwise specified. Traps shall be specified with all fixtures.
- F. Make and Model: Fixtures shall be to type and quality specified. Specifications, in referring to a particular catalog number and manufacturer's description, establish type and quality.
- G. Adjusting stops: After plumbing fixtures have been installed, adjust all fixture stops to obtain proper flow of water to each fixture without splashing or noise.
- H. All fixtures not included in this contract, shall be received, stored and installed by this contractor. This contractor shall make all final connections to these fixtures and shall furnish and install p-traps and supplies with stops for all fixtures.
- I. After work has been completed, all plumbing fixtures and trim shall be thoroughly cleaned. No metal scrapers or compounds shall be used.
- J. Plumbing fixtures shall be caulked at walls and floor with mold resistant sealants to match fixture colors. Stainless steel fixtures shall be caulked with clear sealant.
- K. Lavatory bowls and sinks to be installed under countertops shall be fastened to underside of countertop with angle clips.
- L. Lavatory bowls and sinks to be installed above countertops shall be installed by this Contractor, fastened and caulked.

## 2.6 CLEANOUTS

- A. Provide cleanouts in soil, waste and sewer lines as indicated on plans and herein specified.

- B. Cleanout extension to unfinished floors inside building shall terminate with countersunk cleanout plugs set below the finished floor and access covers set flush with the finished floor surface.
- C. Cleanout extensions to finished floors inside building shall terminate with countersunk cleanout plugs set below the finished floor and shall be provided with cast brass cleanout frame, and cast brass, serrated nickel bronze cover held in place with brass screws and set flush with finished floor covering.
- D. Cleanout extensions to grade in sewers outside of building walls shall consist of a cast iron Y branch of 1/8 bend in the sewer line and brass countersink plug set in an 18 x 18 x 10" thick concrete block set flush with the finished grade.
- E. Where cleanout extensions occur in wall surfaces they shall terminate with a countersunk tapped plug just behind the finished wall surface and be provided with a stainless steel or nickel bronze access cover.
- F. Cleanout covers shall be as follows:
  - 1. Floor cleanout in all finish floors, except as otherwise noted, shall be J.R. Smith Figure 4020 (Wade, Josam or Zurn) cast iron cleanout with round adjustable heavy duty Nickel Bronze top.
  - 2. Floor cleanout in all unfinished concrete floors shall be J.R. Smith Figure 4220 (Wade, Josam or Zurn) cast iron cleanout with round adjustable heavy duty cast iron top.
  - 3. Cleanouts extended to grade shall be J.R. Smith Figure 4250 (Wade, Josam or Zurn) cast iron cleanout with flanged cast cleanout housing set in an 18 inch square by 12 inch deep concrete pad, provided by this Contractor.
  - 4. Floor cleanouts in tile floor shall be J.R. Smith Figure 4145 (Wade, Josam or Zurn) cast iron cleanout with round adjustable recessed nickel bronze top.
  - 5. Cleanout in carpet areas shall be J.R. Smith Figure 4020-Y (Wade, Josam or Zurn) cast iron cleanout with round adjustable heavy duty Nickel Bronze top with carpet marker.
  - 6. Cleanout exposed to view or in ceiling space shall be J.R. Smith Figure 4420 (Wade, Josam or Zurn) cast iron ferrule and cast bronze plug.
  - 7. Cleanout at concealed risers shall be J.R. Smith Figure 4420 (Wade, Josam or Zurn) cast iron ferrule and cast bronze plug and Figure 4725 round flush with stainless steel or nickel bronze cover.
- G. Cleanouts shall be installed at base of each soil stack, each turn and angle bend greater than 45 degrees, and at each place within horizontal house drains and sewers, as hereinafter specified:
  - 1. In sewers 4 inch and smaller, maximum of 50 feet apart.
  - 2. In sewers 5 inch through 10 inch, a maximum of 100 feet apart.
  - 3. In sewer larger than 10 inch, manholes shall be provided and spaced a maximum of 150 feet apart.
  - 4. Underground drainage lines exceeding 10 inch in size, manholes instead of cleanout shall be provided.
  - 5. Size of cleanouts in sewers and wastes:
    - In pipe 6 inch and smaller, same size as pipe.
    - In pipe 6 inch and larger 6 inch.
- H. Cleanouts must not be placed in public corridors or lobbies where Granite, Terrazzo, or other special floor finishes occur. Cleanouts should be located so that sewers can be rod out at any time

without creating an unsightly mess which is visible to the public. In general, cleanouts must be located on walls, centered 12 inches above the floor, in one of the following locations:

1. On the wall underneath the lavatory counter in washrooms.
  2. On the walls inside sidewalls, service corridors or on walls inside other maintenance areas.
  3. See plans for details and location of typical cleanouts.
- I. Cleanouts should not be located inside rooms that are likely to become filled with clutter (i.e., janitor's closets, storage rooms, rubbish rooms, electrical rooms, etc.). Cleanouts should be readily accessible, but not located in areas away from ordinary public view.
- J. All cleanouts must be carefully coordinated with the architectural plans so the cleanouts are easily accessible. Care must be exercised to avoid placing wall or other installations too close to a cleanout. At least eighteen inches of clearance should be provided in all directions.

## 2.7 HOT WATER RELIEF VALVES

- A. Install at domestic water heaters a pressure and temperature relief valve of size, number and type required for the different pressures according to ANSI-221.22.
- B. Contractor shall extend pipe from relief valve down and extended to spill into open drain or floor drain near heaters. No threads on open end of discharge pipe.
- C. All relief valves shall be set and stamped for pressure setting by manufacturer.
- D. Relief valves shall be as manufactured by Cash Acme, or approved equal.

## 2.8 PIPE FREEDOM

- A. Wherever horizontal water pipe branches pass through partitions, this contractor shall check to make sure that none of the partitions material rests on the piping so that water branches can move freely as expansion and contraction occurs.
- B. Pipes within plumbing chases and walls shall not be permanently soldered or attached to other piping systems.

## 2.9 WATER HAMMER

- A. Adequate provisions shall be made to prevent water hammer from occurring within the plumbing system.
- B. Each fixture receiving hot and cold water shall have an air chamber not less than 12 inches long and same size as fixture supply pipe.
- C. Each riser pipe, hot and cold water, shall have separate air chambers not less than 24 inches long and same diameter as the riser pipe.

- D. Water supply connections to fixtures and equipments with quick closing valves, or solenoid operated valves, shall be provided with adequately sized water hammer arrestors on the supply side to prevent water hammer.
- E. Backflow devices serving equipment with quick closing valves, or solenoid operated valves, shall be provided with a soft seated check valve and a water hammer arrestor on the supply side to prevent water hammer and accidental release of the backflow relief valves.
- F. Water hammer arrestors shall be provided with adequate means for access and where concealed, shall be provided with an access panel.
- G. Water hammer arrestors shall be stainless steel factory pre-charged and permanently sealed similar to 'Hydrotrol' as manufactured by J.R. Smith Mfg., or approved equal.

#### 2.10 SLEEVES

- H. All penetrations through slabs, walls, and partitions shall be sleeved. Contractor shall be responsible for providing and setting all such sleeves at the appropriate times during construction.
- I. Sleeves shall be sized approximately two nominal pipe sizes larger than the conveying pipe diameter for uninsulated piping and one inch larger than outside insulation diameter for insulated piping.
- J. Sleeves through below grade foundation walls shall be made watertight by means of interlocking mechanical penetration seals, similar to 'Link-Seal' as manufactured by Thunderline, or approved equal.
- K. After pipes have been installed, this contractor shall pack all sleeves with proper sealants. All smoke and fire rated penetrations shall be sealed with approved UL Listed fire stopping systems. All non-rated penetrations shall be sealed with fiberglass and approved caulking packed sufficiently tight to close the annular opening and remain in place during the life of the building.

#### 2.11 FLASHING

- L. Flash all pipe extending through roof. Flashing shall be 6 lb sheet lead.
- M. Flash all roof, deck and floor drains above grade.
- N. Flashing on vent pipes through roof shall be carried up and over and turned down into pipe. Offset pipes away from walls where passing through roof to permit proper flashing.
- O. Flashing for roof penetrations, roof drains and deck drains shall be made with a minimum of 6 lb. sheet lead. Flashing for floor drains above grade shall be made with a minimum of 4 lb. sheet lead.
- P. Furnish and install a 4 lb. lead shower pan with a minimum thickness of 1/16 inch on all showers with tiled floors. Fold corners and turn up edges a minimum of 12 inches on all sides. Prior to installation, coordinate with all other trades for additional methods of water proofing.

## 2.12 PIPE GUIDES

- Q. Pipe guides shall be Metraflex spider type pipe alignment guides, or approved equal. Each guide shall have a two part four finger spider which bolts on to pipe inside guiding sleeve allowing complete insulation within spider housing.
- R. Each sleeve shall be capable of guiding the spider fingers for a minimum of 1-1/2 times the possible movement of the pipe at the point it is located within the piping system. Use minimum of 2 guides per expansion loop.

## PART 3 - EXECUTION

### 3.1 COORDINATION

- A. Contractor shall familiarize himself with the electrical, air conditioning, heating and ventilating, architectural, structural, site development and piping drawings and project specifications to plan the installation of the plumbing work, in coordination with other trades, so as to provide the best assembly of combined work.
- B. Although the locations of the equipment and fixtures may be shown on the drawings in certain positions, the Contractor shall be guided by the architectural details and conditions at the jobsite, correlating his work with that of others, and shall provide oversets in piping to produce a neat, workmanlike arrangement.
- C. Equipment shall be arranged so that all parts requiring maintenance and all operating and adjustment devices are accessible, and that all gauges and instruments are visible and readable from the floor or, in the case of concealed equipment, visible and readable from access openings.
- D. Equipment shall be installed in such a manner for convenient future replacement. Such equipments shall be plumbed in a manner to expedite this future replacement. Equipments shall not be plumbed whereas the demolition and replacement of the piping systems will be necessary for the replacement of in kind equipment.
- E. Apparatus and equipment dimensions indicated on the drawings have been taken from specific equipment of the class indicated. Contractor shall check the drawings and be responsible to see that the equipment he contemplates installing will fit the spaces provided.
- F. Piping and equipment shall avoid obstructions, preserve headroom, and keep openings and passageways clear. Changes in locations, equipment or piping which may be necessary to accomplish this shall be made only with the approval of the Engineer and Owner's representative.
- G. Piping shall be supported with hangers and supports attached to building structure. Piping shall not be supported from other piping systems or building system components.

### 3.2 PIPING INSTALLATION

- A. Ceiling and wall plates: Provide ceiling and wall escutcheons for all pipes passing through walls and ceilings in finished areas, and shall be unhinged chrome-plated brass.



- B. Drainage: All water piping shall be arranged to drain to low points and to provide for air elimination at high points. Provide drain valves at low points and base of each riser.
- C. Expansion: Mains, risers and branch connections to same shall be arranged to permit expansion and contraction without strain by means of elbow swings and/or expansion joints.
- D. Access: All valves i.e, backflow devices, check valves, reducing valves, water hammer arrestors, tempering valves, etc., shall be easily accessible for maintenance and/or removal. Screwed valves shall be installed with a nipple and union within 6 inches of valves.
- E. Pipe compound: All screwed joints shall be made with best quality approved pipe compound, carefully placed on male threads only and not on the fittings.
- F. Burrs: All cut and threaded pipe shall have the cutting burrs and sharp edges reamed out and the pipe end cleaned of all loose materials.
- G. Tools: In erecting pipe, friction wrenches and vises shall be used exclusively, and any pipe cut, dented or otherwise damaged shall be replaced.
- H. Copper Tubing: Cut square and remove all burrs outside and inside of the fittings. The outside of all tubing, at each connecting end, shall be well cleaned with steel wool before soldering to remove all traces of oxidation, regardless of how clean the surfaces of the pipe and fittings may appear.
- I. Backflow preventers: Provide approved backflow devices vacuum breakers, on each piece of equipment, fixture or appliance required by these documents and/or the Plumbing Code.
- J. Unions: Provide unions at connections to each piece of equipment for easy dismantling and at such other points to facilitate installation. Unions shall be of the same strength and manufacturer used in the respective piping systems.
- K. Drain valves: Provide and install all brass drain valves at riser heels and horizontal water distribution low points. Drain valves shall be 3/4 inch in size, of required pressure rating and shall have drain runoff piping arranged as indicated.
- L. Stub-Outs: Piping at fixture and equipment rough-ins and/or stub-outs shall be adequately supported by means of manufactured pipe supports and brackets, as manufactured by Hubbard Enterprises 'HoldRite', or approved equal. Supports and brackets shall be attached to building framing with proper attachments. Copper bonded brackets shall be used where copper piping is present.

### 3.3 INSTALLATION, UNDERGROUND WORK

- A. Fittings: Changes in line or grade shall be made with proper curved fittings and any junction shall be made with "Y" branches. Drainage piping shall be made with long turn drainage pattern fittings only.
- B. All fixture and equipment openings for piping connections shall be closed with screw plugs until used. All drains shall be kept clean of any earth or foreign matter that may get into drain lines.

- C. Connections between cast iron pipe and tile or concrete pipe shall be cast in a block of concrete at least 24 in. long and 6 in. all around the pipe. Concrete furnished and installed by this trade.
- D. Support: Cast iron pipe buried in ground shall have firm bearing along entire length on undisturbed earth. Pipe on fill or loose soil shall be supported every 5 ft. on brick or concrete piers, and then firmly embedded in sand. Bells shall be laid upstream.
- E. Slope: Piping shall be evenly pitched and graded as indicated on the drawings. Where slope is not indicated on the drawings, the piping shall be installed at a slope of not less than 1/8 in. per ft., or as approved.
- F. Sleeves: Unless specified otherwise, provide Thunderline 'Link-Seal' interlocking type watertight penetration seals and steel sleeve complete with waterstop, of length to suit, for all piping passing through foundation walls.
- G. Invert elevations of underground water piping shall be determined by instruments from established grades. Depth of bury shall not be less than 5'-0" from finished grade to top of pipe barrel.
- H. Flushing: All underground water piping shall be thoroughly flushed under line pressure before connections are made to each building system and the fire protection system.
- I. Pressure test all piping as specified in Sections 15010 and 15410 before backfilling.

### 3.4 WIRING BY PLUMBING CONTRACTOR

- A. Plumbing Contractor shall furnish and install all control wiring in conduit in accordance with the requirements of Division 16000 - ELECTRICAL.
  - 1. Domestic water heaters safety and operating controls.
  - 2. Strap on aquastat set at 115 degrees F to start each recirculating pump and stop pump at 120 degrees F.
  - 3. Rainwater harvesting system.

### 3.5 WATER PIPING

- B. Water service line: Connect to water main where shown on drawing and extend underground domestic water distribution main into building.
- C. Water meter and installation shall be approved and tested. All fees for services, materials or work furnished by City, etc., shall be paid for under this section. Provide pressure gauges at meter outlet.
- D. Arrangement of water piping shall be as direct as possible and as shown on the drawings. Lines shall run with gradual fall and shall have drains so located that entire system may be drained dry.
- E. Provide 12 in. high air chambers at all fixtures and 24 in. long at terminals of water supply branches and tops of risers to prevent water hammer. Air chambers shall be full size of pipe. Pipes in riser shafts shall have 6" separation.
- F. Shut-off isolation valves shall be provided on water piping systems as a minimum on main separations; branch extensions from mains; on water supply branchlines extending to each

individual room with plumbing; all branches to groups of 2 or more fixtures; and at each piece of equipment requiring a water supply connection.

- G. Installation of valves shall be made to provide a neat appearance and easy grouping with all parts easily accessible. Wherever vertical (up) valve stems are not possible, valve stems may be horizontal. Valve stems upside down are not permitted. Valves located in partitions or furred ceiling spaces shall be accessible by an access panel located to provide easy operation and maintenance of the valve. Install a union on downstream side of valve connecting to equipment. Provide shut-off valve as follows:
  - 1. Where indicated on the drawings.
  - 2. Where required for adequate control of the systems.
  - 3. For isolation of fixture groups or equipment. Groups are to be considered as two or more fixtures or items of equipment.
  - 4. Provide unions at connection of each piece or equipment.

### 3.6 DRAINAGE AND VENT SYSTEM - INSTALLATION, GENERAL

- A. Accessible cleanouts shall be provided at the foot of each new soil, waste and vent stack and at the foot of each new downspout. Accessible cleanouts shall be provided at each change in direction of horizontal drains, and at not more than 50 ft. intervals on straight runs of drain lines.
- B. Cleanout branches shall be brought to such point as to make them easily accessible, and where same are in floors, they must be flush, using adjustable cleanout sockets as hereinafter specified, and fitted with bronze or brass chrome-plated plugs. Cleanouts shall be same size as pipe up to and including 4 in. over 4 in. shall be size indicated on the drawings, but not less than 4 in.
- C. Change in line or grade shall be made with proper curved or long sweep fittings, and junction shall be made with "Y" fittings shall be used elsewhere. Special care shall be used in installing soil branches from water closets to provide easy sweeps in all changes in direction.
- D. Fixture and equipment openings for piping connections must be closed with screw on plugs until connection is made. Any foreign substance which may get into floor drains, roof drains or drain piping systems shall be completely removed by this contractor, to the satisfaction of the Owner's representative.
- E. Soil and waste pipes shall be laid with continuous even pitch as shown on the drawings. Where slope is not indicated the piping shall be installed at a slope of not less than 1/8" per ft., or as approved by owner's representative.
- F. Each plumbing fixture, open drain, floor drain shall be furnished and installed with water seal traps located as close to the fixture as possible. Traps shall be extra heavy cast iron for drains and as specified for fixtures.
- G. No unions shall be installed in waste lines, vent or revent piping. Long screws will not be allowed as tapping into piping.
- H. Pipe shall be run at right angles, or parallel to walls. Offsets shall be made by means of proper fittings.

### 3.7 PLUMBING VENTS

- A. Install complete, all required vents and re-vents from main soil waste pipes, as shown. Pitch all vent piping in a manner to keep the pipe drained at all times.
- B. Plumbing stacks and vent piping shall be carried 1 ft. or more above roof and shall be made watertight with Zurn Z-195-10C, roof vent flashing clamps device with 6 lb. lead flashing extending 18 in. outside of pipe surface and secured under clamping ring. Pipe extension shall be caulked into flashing clamp device. Plumbing and vent stacks through roof shall have cast iron increaser which shall be at least one pipe size larger than stack. No increaser shall be less than 4 in. diameter in size. If vent must be carried through finished roof after completion of roof, contractor under Section, "Roofing", shall cut and repair that portion of roof, but shall be reimbursed for above work by contractor under this section.
- C. Individual vents of water closets, urinals and service sinks shall be 2" and all other fixtures and floor drains shall be 1-1/2". All fixtures shall be individually vented and connected up to main vent riser above highest fixture as required by Plumbing Code.

### 3.8 VALVES, GENERAL

- A. Valves shall be provided on the plumbing system in accordance to code and as indicated within the project documents. Valves shall be installed to allow adequate measures for plumbing systems maintenance, isolation and complete shut down.
- B. Shut off valves shall be installed on domestic water piping systems as a minimum in the following locations: at all water main separations; at branch extensions from mains; at the base of each riser; on water supply piping outside each room with plumbing; and on the supply piping to each piece of equipment requiring water. Shut off valves within domestic water systems shall be of the full passage type.
- C. Shut off (stop) valves shall be provided at each plumbing fixture to isolate that plumbing fixture without affecting other plumbing fixtures. Fixtures unable to be provided with stops, such as shower and tub valve's, shall be factory furnished with integral stops to isolate that such valve. All stop valves shall be of brass construction with metallic stems.
- D. Shut off valves shall be provided on drainage piping systems in the following locations: on the discharge side of any sump or ejector pump. Shut off valves in drainage systems shall be gate valves of the full passage type.

### 3.9 STERILIZATION

- A. The domestic water piping shall be flushed, cleaned and disinfected per this section, all applicable codes, the Water Department, and all other authority's having jurisdiction.
- B. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet. Sterilize the entire water-distribution system thoroughly according to local and Illinois state plumbing codes with a solution containing not less than 50 parts per million of chlorine. The sterilizing solution to remain in the system for a period of 8 hours, during which time all valves and faucets shall be opened and closed several times until chlorine does not remain in

water coming from the system. After sterilization, flush the solution from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million, unless otherwise directed, or until approved by the State Health Department. Perform laboratory test approved by testing agency.

### 3.10 TRENCH SETTLEMENT

- A. The Contractor shall be responsible for any failure of pavement, curb, and gutter or sidewalk due to trench settlement, and the cost of repairing said failures shall be paid by the contractor.

### 3.11 WATERPROOFING

- A. Sleeves through foundation and exterior walls, slabs or grade, and where seepage may occur, waterproof thoroughly as follows:
  1. Remove all loose material and drive oakum and hot molten lead with one continuous pour around pipe to exterior and interior surfaces.
  2. Finish exterior surface with two layers of felt mopped on with hot asphalt cover 24 in. radius around penetration.
  3. Finish interior surface with cement coating.
  4. All waterproofing to be done before any backfilling.

### 3.12 PIPE COVERING SADDLES

- A. In general, all piping systems with insulation shall have insulation uninterrupted by hangers and supports. Insulated piping shall be provided with oversized hangers and supports and insulation saddles.
- B. Coordinate with documents for insulated piping systems before ordering hangers, supports, sleeves, etc., to determine the thickness of insulation which will be installed on the various piping systems.
- C. Saddles and blocking by this contractor.

### 3.13 WATER METERS, GAUGES, THERMOMETERS, FLOWMETERS.

- A. See Section 15135 - Meters and Gages.
- B. Pressure gages shall be provided within plumbing systems as a minimum in the following locations: Water service entrance, downstream of any backflow device; on the suction and discharge of any pumps or pumping equipment (exception of sewage ejectors and sump pumps); on the upstream and downstream side of any pressure regulating valves and devices; at the domestic water heater.
- C. Temperature gages shall be provided within the plumbing systems as a minimum in the following locations: On the inlet and outlet sides of water heaters; on the inlet and outlet sides of building re-circulating pumps; on the outlet side of any mixing valves; and on the inlet and outlet supply pipe to booster heaters.

- D. Domestic water meters shall be of the approved type for the local authority, including that of the local municipality and Water Department Standards. Exact meter types and standards shall be obtained from authority prior to purchase. Where applicable, meters shall be purchased direct from the authority. Meters shall be provided with readers as required by the local authority's standards and located in such a place coordinated with such authority.

### 3.14 TESTING

- A. See Section 15010 & 15410.
- B. Sewer lines shall be tested for displacement by reflecting a sunlight or flashlight beam with a mirror. If the illuminated interior of the pipeline shows poor alignment, displaced pipe or any other defects, the defects designated by the architect/engineer shall be remedied by the contractor at his expense.
- C. Sewer lines shall be hydrostatically tested for exfiltration by maintaining a 10 ft. water column in a minimum 4 in. standpipe, for a period of 4 hours. Allowable leakage shall not exceed 9 gallons of water per 100 ft. of pipeline during the test period.
- D. If requested by the Architect, sewer lines shall be tested for infiltration by maintaining a wet trench. Allowable shall not exceed 9 gallons of water per 100 ft. of pipe line during a 4 hour test period.
- E. Where sewer construction fails to meet these requirements, the work shall be removed and reconstructed. The contractor shall furnish all services and equipment necessary for tests. All tests shall be conducted in the presence of the Architect.

### 3.15 CLEANING

- A. After completion of all work, the entire sewer system shall be thoroughly cleaned out to remove all grit, or other foreign matter. Remove all rubbish, debris, etc., accumulated from the operation specified herein.

### 3.16 REPLACEMENT OF PAVEMENTS, WALKS AND LAWNS

- A. Pavements, walks, lawns, utilities which are damaged during construction of the new underground utilities shall be replaced and restored to original condition.

END OF SECTION 15400

## SECTION 15790 - AIR COILS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instructions to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SECTION INCLUDES

- A. This Section includes the following:
  - 1. Electric reheat coils.

#### 1.3 RELATED SECTIONS

- A. Section 15010 General Provisions for Mechanical Work.
- B. Section 15890 – Ductwork.
- C. Section 15940 – Building Automation System
- D. Section 15950 - HVAC Controls Instrumentation
- E. Section 15958 – Sequence of Operations.
- F. Division 16 – Electrical.

#### 1.4 SUBMITTALS

- A. General: Submit each item in this article according to the conditions of the contract and Division 1 Specification Section and Division 15, Section 15010.
- B. Product Data: Include rated capacities of selected models; pressure drop; shipping, installed, and operating weights; installation instructions; and startup instructions for each type of product indicated.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field

connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating coil location and ceiling-mounted access panels.
- E. Maintenance Data: For air coils to include in maintenance manuals specified in Division 1.

## 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with ARI 410, "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
  1. Certify coils to ARI 410, "Standard for Forced-Circulation Air-Cooling and Air-Heating Coils."

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Electric Coils:
    - a. Brasch Manufacturing Co., Inc.
    - b. Chromalox Wiegand Industrial Division; Emerson Electric Company.
    - c. INDEECO.
    - d. Markel
    - e. Trane Co. (The).

### 2.2 ELECTRIC COILS

- A. Electrical Heating Coils, Controls, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use and in accordance with the City of Chicago codes.
- B. Coil Assembly: Comply with UL 1096.



- C. Casing Assembly: Slip-in type with galvanized-steel frame.
- D. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
- E. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
  - 1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- F. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
  - 1. Magnetic or mercury contactor.
  - 2. Toggle switches; one per step.
  - 3. Step controller.
  - 4. Time-delay relay.
  - 5. Pilot lights; one per step.
  - 6. Airflow proving switch.
- G. Thermostats: Remote thermostat controls heat pump as first stage of heat and electric duct heater as second stage of heat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine ducts, plenums, and units to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

### 3.3 CONNECTIONS

- A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

#### 3.4 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Verify the proper operation of coil and all safety controls.

#### 3.5 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

END OF SECTION 15790

## SECTION 15830 - RADIANT HEATING PANELS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings.
- B. Book 1: Project Information, Instructions to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SECTION INCLUDES

- A. This Section includes hydronic radiant heating panels for space-heating applications.

#### 1.3 RELATED SECTIONS

- A. Section 15010 General Provisions for Mechanical work.
- B. Section 15110 – HVAC Valves
- C. Section 15181 – Hydronic Piping.
- D. Section 15940 – Building Automation System
- E. Section 15950 - HVAC Controls Instrumentation
- F. Section 15958 – Sequence of Operations.

#### 1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections and Division 15, Section 15010.
- B. Product Data for each panel and accessory specified.
- C. Shop Drawings showing fabrication and installation of radiant heating panels including plans, elevations, sections, details of components, and attachments to other units of Work. Detail connections.

- D. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
- E. Samples of painted panels with required finish for approval.
- F. Qualification data for firms and persons specified in the "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.
- G. Field test reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to compliance with performance requirements of radiant heaters.
- H. Maintenance data for radiant heating panels to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions for cleaning.

#### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing radiant heating panels similar to those indicated for this Project and that have a record of successful in-service performance.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hydronic Radiant Heating Panels:
    - a. Engineered Air.
    - b. Dunham-Bush, Inc.
    - c. Steel Ceilings, Inc.

#### 2.2 HYDRONIC HEATING PANELS

- A. Description: Lay-in radiant heating panel for installation in gypsum board ceiling.
- B. Fabrication: Perforated aluminum sheet with copper-serpentine water coil, mechanically bonded to faceplate.
- C. Finish: 2 coats, white-polyester finish with 70 to 80 percent light-reflection value.
- D. Insulation: 1/2-inch-thick, 3/4-pcf density, fiberglass pad.
- E. Panel Weight: No more than 1.5 lb/sq. ft. when filled with water.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces and supports to receive radiant heating panels for compliance with requirements for installation tolerances and other conditions affecting performance of radiant heating panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install radiant heating panels as indicated, to comply with manufacturer's written instructions.
- B. Connect ceiling panels to hydronic piping according to Division 15 Section 15510 "Hydronic Piping and Valves."

### 3.3 FIELD QUALITY CONTROL

- A. Testing: After installing radiant heating panels and after hydronic systems have been started, demonstrate product capability and compliance with requirements.
- B. Remove and replace malfunctioning units with new units, and retest.

END OF SECTION 15830

## SECTION 15958 - SEQUENCE OF OPERATIONS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings
- B. Book 1: Project Information, Instructions to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Written descriptions and diagrams of operational sequences.

### PART 2 - SEQUENCE of OPERATION

#### 2.1 Water source heat pump (typical of 7)

- A. Run Conditions - Scheduled:
  - 1. The unit shall run according to the Building Automation System (BAS) schedule in the following modes:
- B. Occupied mode: the unit shall maintain
  - 1. A 75°F (adj.) cooling setpoint
  - 2. A 72°F (adj.) heating setpoint
- C. Unoccupied mode (night setback): the unit shall maintain
  - 1. An 85°F (adj.) cooling setpoint.
  - 2. A 55°F (adj.) heating setpoint.
- D. Alarms shall be provided through the BAS as follows:
  - 1. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
  - 2. Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

- E. Zone Setpoint Adjust:
  - 1. The occupant shall be able to adjust the zone temperature heating and cooling setpoints. The BAS shall be able to override and adjust the zone temperature heating and cooling setpoints, enable/disable unit operation, monitor space temperature, entering/leaving condenser water temperatures, discharge air/return air temperatures, and unit power consumption.
- F. Zone Optimal Start:
  - 1. The BAS shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- G. Zone Unoccupied Override:
  - 1. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
- H. Heating and Cooling - 2 Compressor Stage:
  - 1. The controller shall receive a signal from the loop water source monitor indicating that there is water flow and that the water temperature is within acceptable limits.
  - 2. The controller shall measure the zone temperature and cycle the compressor to maintain its setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime. The compressor shall run subject to its own internal safeties and controls.
  - 3. The heating shall be enabled whenever:
    - a. Outside air temperature is less than 65°f (adj.) or
    - b. the thermostat is manually set in heating mode AND the reversing valve is in heating mode.
  - 4. The cooling shall be enabled whenever:
    - a. Outside air temperature is greater than 65°f (adj.) or
    - b. the thermostat is manually set to cooling mode AND the reversing valve is in cool mode.
- I. The compressor shall be disabled and remain off for 30 sec (adj.) after the reversing valve has changed position.
- J. Alarms shall be provided as follows:
  - 1. Compressor Runtime Exceeded: The compressor runtime exceeds a user definable limit (adj).
- K. Zone OA (Units HP-3 and HP-7):
  - 1. The BAS controls shall power open the 2-position duct mounted OA damper.
  - 2. The OA damper will be open during occupied time schedules.
  - 3. OA damper will be shut during the Unoccupied Mode or in the event of a low zone temperature or high zone temperature alarm.
  - 4. HP-7 thermostat shall provide 3-stages of heat. The first stage shall enable the heat pump heating mode; the second and third stages shall sequentially activate the 2 steps of the electric heating coil EDH-1.
  - 5. **HP-4 thermostat shall provide 2-stages of heat. The first stage shall enable the heat pump heating mode; the second stage shall activate the electric heating coil EDH-2.**
- L. Zone OA (HP-1, HP-2, HP-4, HP-5 and HP-6) :

1. The BAS controls shall power open the modulating duct-mounted OA damper to the minimum position during occupied time schedules.
2. The CO<sub>2</sub> sensor in each room shall open the OA damper as required to maintain the room 1,000 ppm (adj) CO<sub>2</sub> setpoint.
3. The maximum OA position shall be preset (adj) to limit the maximum OA quantity to the cfm quantity scheduled on the drawings.
4. The OA damper will shut during the Unoccupied Mode or in the event of a low zone temperature or high zone temperature alarm.

## 2.2 Boiler (B-1)

### A. Boiler System Run Conditions:

1. The boiler unitary controller shall be equipped with a BACnet interface communication card, to allow monitoring of all setpoints and safeties. The boiler system shall be enabled to run whenever:
  - a) Outside air temperature is less than 65°F (adj.).

### B. To prevent short cycling, the boiler system shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

### C. The boiler shall run subject to its own internal safeties and controls.

### D. The boiler manufacturer shall furnish OA reset controls with the boiler, to vary the water temperature based on OA temperature. The mechanical contractor is to furnish all factory supplied parts and boiler reset control components for installation by the BAS contractor.

### E. Boiler Safeties:

1. The following safeties shall be monitored:

- a) Boiler alarm.
- b) Low Water Level.

2. Alarms shall be provided as follows:

- a) Boiler alarm.
- b) Low Water Level.

### F. BCP-1 (Boiler Circulation Pump)

1. The circulation pump shall run anytime the boiler is called to run and shall have a user definable (adj) delay on stop.
2. Alarms shall be provided as follows:
  - a) Circulation Pump Failure: Commanded on, but the status is off.
  - b) Circulation Pump Running in Hand: Commanded off, but the status is on.
  - c) Circulation Pump Runtime Exceeded: Status runtime exceeds a user definable limit.

## 2.3 HOT WATER LOOP PUMPS (P-3 and P-4)

- A. The circulation pump shall be enabled anytime the outside air temperature is less than 65°F (adj.) and shall have a user definable (adj.) delay on stop.
- B. The pumps shall run for freeze protection anytime outside air temperature is less than 38°F (adj.).



- C. To prevent short cycling, the pump shall run for a minimum time and be off for a minimum time (both user adjustable).
- D. The two constant speed hot water pumps shall operate in a 100% / 100% stand-by fashion.
  - 1. One pump shall operate continuously.
  - 2. On failure of one pump, the second pump shall run and the lead pump shall turn off.
  - 3. The lead and lag pumps shall alternate on a weekly (adj) basis.
- E. Hot Water Differential Pressure Control:
  - 1. The BAS shall monitor hot water differential pressure controller and modulate the hot water system flow via the 2-way pressure bypass control valve located in the mechanical room to maintain its hot water differential pressure setpoint.
  - 2. The following setpoints are recommended values. All setpoints shall be adjustable by the BAS and adjusted during the commissioning period to meet the requirements of actual field conditions.
- F. Alarms shall be provided as follows:
  - 1. High Hot Water Differential Pressure: If 15% (adj.) greater than setpoint.
  - 2. Low Hot Water Differential Pressure: If 15% (adj.) less than setpoint.
  - 3. Hot Water Pump P-3
    - a. Failure: Commanded on, but the status is off.
    - b. Running in Hand: Commanded off, but the status is on.
    - c. Runtime Exceeded: Status runtime exceeds a user definable limit.
  - 4. Hot Water Pump P-4
    - a. Failure: Commanded on, but the status is off.
    - b. Running in Hand: Commanded off, but the status is on.
    - c. Runtime Exceeded: Status runtime exceeds a user definable limit.

#### 2.4 HEAT PUMP CONDENSER WATER LOOP PUMPS (P-1 and P-2)

- A. The loop pumps shall run whenever:
  - 1. Any Heat Pump is energized
  - 2. OR a definable number of unoccupied zones need heating or cooling.
- B. The following loop water conditions shall be monitored:
  - 1. Flow status and rate.
  - 2. Supply temperature.
  - 3. Return temperature.
- C. Alarms and a heat pump shutdown signal shall be generated upon any of the following loop water conditions:
  - 1. No Loop Flow.
  - 2. High Loop Water Supply Temp Shutdown: If the loop water supply temperature is greater than 95°F (adj.).

3. Low Loop Water Supply Temp Shutdown: If the loop water supply temperature is less than 25°F (adj.).
- D. Loop Water Pump Operation:
1. The two loop water pumps shall operate simultaneously, each operating at 50% total capacity.
  2. Both pumps will operate based on pressure differential.
  3. On failure of one pump, the other pump shall run at its highest capacity to attempt to maintain service to the heat pumps.
- E. Loop water Differential Pressure Control: (same for both pumps)
1. The BAS shall monitor geothermal (condenser water loop) differential pressure sensors and modulate the pump VFDs to maintain the loop water differential pressure set point.
  2. If the loop water differential pressure drops below a set point of 22 psi (adj), each pump shall speed up in unison.
  3. If the loop water differential pressure rises or falls 4 psi (adj) above or below set point, each pump shall reduce or increase speed in unison. To prevent short cycling, there shall be a minimum user definable (adj) time delay.
  4. Loop water differential pressure setpoint shall be adjustable by the BAS and adjusted during the commissioning period to meet the requirements of actual field conditions and the requirements of GHEX Contractor.
  5. A passive pressure relief valve shall maintain a maximum (adj) differential pressure across the geothermal field.
  6. Audible Alarms and alarms to the BAS shall be provided as follows:
    - a) High Loop Water Differential Pressure: If the loop water differential pressure is greater than 30 psi (adj.).
    - b) Low Loop Water Differential Pressure: If the loop water differential pressure is less than 20 psi (adj.).
    - c) Loop Water Pump P-1  
 Failure: Commanded on, but the status is off.  
 Running in Hand: Commanded off, but the status is on.  
 Runtime Exceeded: Status runtime exceeds a user definable limit.
    - d) Loop Water Pump P-2  
 Failure: Commanded on, but the status is off.  
 Running in Hand: Commanded off, but the status is on.  
 Runtime Exceeded: Status runtime exceeds a user definable limit.

## 2.5 CABINET HEATER

- A. The unit shall run according to a stand-alone, factory furnished and installed return air thermostat:

1. Occupied Mode: The unit shall maintain a heating set point of 70°F (adj.).
  2. Unoccupied Mode (night setback): The unit shall maintain a heating set point of 55°F (adj.).
- B. The fan shall run anytime the zone temperature is below heating set point, unless shutdown on safeties.
- C. The heating shall be enabled whenever:
1. Outside air temperature is less than 65°F (adj.),
  2. AND the zone temperature is below heating set point,
  3. AND the fan is on.

## 2.6 EXHAUST FANS

- A. EF-1 fan shall be enabled/disabled by the BAS to run whenever the occupied/unoccupied time schedule is energized unless it is shutdown on safeties.
- B. EF-2 fan shall be powered on/off by the room light switch.
- C. EF-3 fan shall be powered on/off by a dedicated wall switch with a pilot light.
- D. EF-4 and EF-5 shall be enabled/disabled by the BAS to run whenever the occupied/unoccupied time schedule is energized. They shall sequentially stage based on a building pressure sensor located in the entrance lobby set to maintain a positive pressure of 0.05 in. S.P.(adj) relative to the outdoors. To prevent short cycling, there shall be a minimum user definable (adj) time delay.
- E. EF-6 shall be enabled/disabled by the BAS to run continuously.
- F. KH-1 fan shall be powered on/off by a dedicated switch with a pilot light located on the kitchen hood.
- G. CH-1, 2, 3, and 4 ceiling fans shall be controlled locally by speed controllers located next to HP thermostats.

## 2.7 RADIANT HEATING PANEL

- A. Room Temperature:
1. Input Device: Room thermostat
  2. BAS Output Device: Electronic control-valve operator.
  3. Action: Modulate valve to maintain temperature.
  4. BAS shall monitor temperature of each room.
- B. Display:
1. Room temperature indication.
  2. Room temperature set point.

## 2.8 UNIT HEATER

- A. Room Temperature:
1. Input Device: Room thermostat.

2. Output Device: Room thermostat.
3. Action: Cycle fan to maintain temperature.
4. Sound audible alarm and send alarm signal to BAS when room temperature falls below 45 deg F (adj).

B. Low-Temperature Safety:

1. Input Device: Line-voltage, on-off thermostat, pipe mounted.
2. Output Device: Hard wired.
3. Action: Stop fan when return heating-water temperature falls below 35 deg F (2 deg C).

C. Display:

1. Room temperature indication.
2. Room temperature set point

END OF SECTION 15958

## SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings
- B. Book 1: Project Information, Instructions to Bidders, and Execution Documents
- C. Book 2: Standard Terms and Conditions for Construction Contracts
- D. Book 2A: Standard Terms and Conditions Procedures Manual

#### 1.2 SUMMARY

- A. This Section includes TAB to produce design objectives for the following:
  - 1. Air Systems:
    - a. Constant-volume air systems.
  - 2. Hydronic Piping Systems:
    - a. Constant flow and variable flow systems.
    - b. Primary-secondary systems.
  - 3. HVAC equipment quantitative-performance settings.
  - 4. Verifying that automatic control devices are functioning properly.
  - 5. Reporting results of activities and procedures specified in this Section.

#### 1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

- E. NC: Noise criteria.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. RC: Room criteria.
- H. Report Forms: Test data sheets for recording test data in logical order.
- I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- M. TAB: Testing, adjusting, and balancing.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

#### 1.4 SUBMITTALS

- A. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 2 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.
- B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- C. TAB Contractor: The duties of the TAB contractor, during construction and acceptance phases to support commissioning are:
  1. A running log of events and issues shall be kept by the TAB field technicians. Submit handwritten reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and CM at least twice a week.
  2. Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

3. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.
4. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
5. Provide a final TAB report for the CxA with details, as in the draft.

D. Sample Report Forms: Submit two sets of sample TAB report forms.

E. Submit two copies of special warranty specified in the "Warranty" Article of this Section.

## 1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by NEBB.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

- a. Submittal distribution requirements.
- b. The Contract Documents examination report.
- c. TAB plan.
- d. Work schedule and Project-site access requirements.
- e. Coordination and cooperation of trades and subcontractors.
- f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

## 1.6 DELIVERY, STORAGE AND HANDLING – NOT APPLICABLE

## 1.7 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.8 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## 1.9 WARRANTY

- A. Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
  1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
  2. Systems are balanced to optimum performance capabilities within design and installation limits.

## PART 2 - EXECUTION

### 2.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
  1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
  2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required



by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

- B. Examine approved submittal data of HVAC systems and equipment.
- C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."
- D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- G. Examine system and equipment test reports.
- H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- L. Examine strainers for clean screens and proper perforations.
- M. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- O. Examine system pumps to ensure absence of entrained air in the suction piping.

- P. Examine equipment for installation and for properly operating safety interlocks and controls.
- Q. Examine automatic temperature system components to verify the following:
  - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
  - 2. Dampers and valves are in the position indicated by the controller.
  - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
  - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
  - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
  - 6. Sensors are located to sense only the intended conditions.
  - 7. Sequence of operation for control modes is according to the Contract Documents.
  - 8. Controller set points are set at indicated values.
  - 9. Interlocked systems are operating.
  - 10. Changeover from heating to cooling mode occurs according to indicated values.
- R. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 2.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system readiness checks and prepare system readiness reports. Verify the following:
  - 1. Permanent electrical power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance, smoke, and fire dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

## 2.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and

balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

- C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

#### 2.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

#### 2.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure fan static pressures to determine actual static pressure as follows:
    - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

- d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
  3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
  4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
  5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
  6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure terminal outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

- E. **Adjust the maximum outside air damper setting for each heat pump system to keep the ratio of outside air to total airflow below 26.6%.**

## 2.6 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
  - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
  - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
  - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  - 1. Determine the balancing station with the highest percentage over indicated flow.
  - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.
- H. Re-adjust differential-pressure control valve settings as necessary to obtain desired system flow and capacity through the geothermal field .

## 2.7 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

- A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

## 2.8 PROCEDURES FOR HEAT EXCHANGERS AND GEOTHERMAL FIELD

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Check the setting and operation of safety and relief valves. Record settings.

## 2.9 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer, model, and serial numbers.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.

## 2.10 PROCEDURES FOR BOILERS

- A. If hydronic, measure entering- and leaving-water temperatures and water flow.
- B. If steam, measure entering-water temperature and flow and leaving steam pressure, temperature, and flow.

## 2.11 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Water Coils: Measure the following data for each coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
  - 7. Air pressure drop.

## 2.12 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.
- C. Measure outside-air, wet- and dry-bulb temperatures.

## 2.13 TEMPERATURE-CONTROL VERIFICATION

- A. Verify that controllers are calibrated and commissioned.
- B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
- C. Record controller settings and note variances between set points and actual measurements.
- D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- E. Check free travel and proper operation of control devices such as damper and valve operators.
- F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- G. Check the interaction of electrically operated switch transducers.
- H. Check the interaction of interlock and lockout systems.
- I. Check main control supply-air pressure and observe compressor and dryer operations.
- J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- K. Note operation of electric actuators using spring return for proper fail-safe operations.

## 2.14 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
  - 2. Air Outlets and Inlets: 0 to minus 10 percent.
  - 3. Heating-Water Flow Rate: 0 to minus 10 percent.
  - 4. Cooling-Water Flow Rate: 0 to minus 5 percent.

## 2.15 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

## 2.16 FINAL REPORT

- A. General: Word processor printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
  - 1. Include a list of instruments used for procedures, along with proof of calibration.
- C. Final Report Contents: In addition to certified field report data, include the following:
  - 1. Pump curves.
  - 2. Fan curves.
  - 3. Manufacturers' test data.
  - 4. Field test reports prepared by system and equipment installers.
  - 5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
  - 1. Title page.
  - 2. Name and address of TAB firm.
  - 3. Project name.
  - 4. Project location.
  - 5. Architect's name and address.
  - 6. Engineer's name and address.
  - 7. Contractor's name and address.
  - 8. Report date.
  - 9. Signature of TAB firm who certifies the report.
  - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  - 11. Summary of contents including the following:
    - a. Indicated versus final performance.



- b. Notable characteristics of systems.
  - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer, type size, and fittings.
  14. Notes to explain why certain final data in the body of reports varies from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outside-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Heat Pumps and Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- F. Heat Pump Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - j. Number of belts, make, and size.
    - k. Number of filters, type, and size.
  2. Motor Data:
    - a. Make and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.

- e. Sheave make, size in inches, and bore.
  - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg .
  - e. Filter static-pressure differential in inches wg.
  - f. Preheat coil static-pressure differential in inches wg .
  - g. Cooling coil static-pressure differential in inches wg.
  - h. Heating coil static-pressure differential in inches wg.
  - i. Outside airflow in cfm.
  - j. Return airflow in cfm.
  - k. Outside-air damper position.
  - l. Return-air damper position.
  - m. Vortex damper position.
- G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
- a. System identification.
  - b. Location.
  - c. Make and type.
  - d. Model number and unit size.
  - e. Manufacturer's serial number.
  - f. Fuel type in input data.
  - g. Output capacity in **Btuh**.
  - h. Ignition type.
  - i. Burner-control types.
  - j. Motor horsepower and rpm.
  - k. Motor volts, phase, and hertz.
  - l. Motor full-load amperage and service factor.
  - m. Sheave make, size in inches, and bore.
  - n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
  - b. Entering-air temperature in deg F.
  - c. Leaving-air temperature in deg F.
  - d. Air temperature differential in deg F.
  - e. Entering-air static pressure in inches wg.
  - f. Leaving-air static pressure in inches wg.
  - g. Air static-pressure differential in inches wg.
  - h. Low-fire fuel input in Btuh.
  - i. High-fire fuel input in Btuh.
  - j. Manifold pressure in psig.
  - k. High-temperature-limit setting in deg F.

- l. Operating set point in Btuh.
  - m. Motor voltage at each connection.
  - n. Motor amperage for each phase.
  - o. Heating value of fuel in Btuh.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in inches, and bore.
    - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
  - 2. Motor Data:
    - a. Make and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    - g. Number of belts, make, and size.
  - 3. Test Data (Indicated and Actual Values):
    - a. Total airflow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
    - a. System and air-handling unit number.
    - b. Location and zone.
    - c. Traverse air temperature in deg F.
    - d. Duct static pressure in inches wg.
    - e. Duct size in inches.
    - f. Duct area in sq. ft.
    - g. Indicated airflow rate in cfm.
    - h. Indicated velocity in fpm.
    - i. Actual airflow rate in cfm.
    - j. Actual average velocity in fpm.
    - k. Barometric pressure in psig.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
  - a. System and air-handling unit identification.
  - b. Location and zone.
  - c. Room or riser served.
  - d. Coil make and size.
  - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
  - a. Airflow rate in cfm.
  - b. Entering-water temperature in deg F.
  - c. Leaving-water temperature in deg F.
  - d. Water pressure drop in feet of head or psig.
  - e. Entering-air temperature in deg F.
  - f. Leaving-air temperature in deg F.

K. Geothermal Field Test Reports: Include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Service.
  - d. Designer and type.
  - e. Model and serial numbers.
  - f. Ratings.
2. Primary Water Test Data (Indicated and Actual Values for both Heating and Cooling Operation):
  - a. Entering-water temperature in deg F.
  - b. Leaving-water temperature in deg F.
  - c. Entering-water pressure in feet of head or psig.
  - d. Water pressure differential in feet of head or psig.
  - e. Water flow rate in gpm.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
  - a. Unit identification.
  - b. Location.
  - c. Service.
  - d. Make and size.
  - e. Model and serial numbers.
  - f. Water flow rate in gpm.
  - g. Water pressure differential in feet of head or psig.
  - h. Required net positive suction head in feet of head or psig.
  - i. Pump rpm.

- j. Impeller diameter in inches.
  - k. Motor make and frame size.
  - l. Motor horsepower and rpm.
  - m. Voltage at each connection.
  - n. Amperage for each phase.
  - o. Full-load amperage and service factor.
  - p. Seal type.
2. Test Data (Indicated and Actual Values):
- a. Static head in feet of head or psig.
  - b. Pump shutoff pressure in feet of head or psig.
  - c. Actual impeller size in inches.
  - d. Full-open flow rate in gpm.
  - e. Full-open pressure in feet of head or psig.
  - f. Final discharge pressure in feet of head or psig.
  - g. Final suction pressure in feet of head or psig.
  - h. Final total pressure in feet of head or psig.
  - i. Final water flow rate in gpm.
  - j. Voltage at each connection.
  - k. Amperage for each phase.

M. Boiler Test Reports:

1. Unit Data:
- a. Unit identification.
  - b. Location.
  - c. Service.
  - d. Make and type.
  - e. Model and serial numbers.
  - f. Fuel type and input in Btuh.
  - g. Number of passes.
  - h. Ignition type.
  - i. Burner-control types.
  - j. Voltage at each connection.
  - k. Amperage for each phase.
2. Test Data (Indicated and Actual Values):
- a. Operating pressure in psig.
  - b. Operating temperature in deg F.
  - c. Entering-water temperature in deg F.
  - d. Leaving-water temperature in deg F.
  - e. Number of safety valves and sizes in NPS.
  - f. Safety valve settings in psig.
  - g. High-limit setting in psig.
  - h. Operating-control setting.
  - i. High-fire set point.
  - j. Low-fire set point.
  - k. Voltage at each connection.
  - l. Amperage for each phase.

- m. Draft fan voltage at each connection.
- n. Draft fan amperage for each phase.
- o. Manifold pressure in psig.

N. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

2.17 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

2.18 DEMONSTRATION AND COMMISSIONING

- A. The contractor will demonstrate up to 10% of measurements to confirm if more than 10% of those readings vary by more than 10% from the reported reading the report will be corrected. With the corrected report the contractor will demonstrate a 10% sample of points chosen by the commissioning agent. This process will continue until the criteria are satisfied.
- B. This Section specifies systems and equipment which shall be commissioned as part of the construction process. Demonstrate proper operation of equipment to the Commissioning Authority (CxA) or designated owner personnel. The scope of the demonstration will include functional performance requirements under both local and building automation control as well as any commissioning requirements in Division 1 and 15. The contractor will be required to provide documentation and testing of these systems and shall work in cooperation with the CxA to ensure compliance.

END OF SECTION 15990

**PUBLIC BUILDING COMMISSION OF CHICAGO**

**CONTRACT NO. 1516  
HAAS PARK FIELD HOUSE  
REQUEST FOR INFORMATION LOG (RFI)  
\*FOR PROJECT TEAM REVIEW AND RESPONSE\*  
\*DO NOT DISTRIBUTE\***

Bid Opening: Wednesday, September 1, 2010

	<u>QUESTIONS</u>	<u>Requester</u>	<u>Person(s) Responsible</u>	<u>CSI Division (AOR/PM to provide)</u>	<u>Include in Addendum Yes or No (AOR to advise)</u>
Question 1	<p>8-2-10: Could you please tell me if there is going to be any athletic flooring going into this project. If so can you tell me what kind of flooring it is going to be. As my company only does Resilient Athletic surfacing.</p> <p><b>ANSWER: Yes, there is going to be an athletic sports flooring assembly in this project. The basis-of-design is a fixed resilient floor.</b></p>	Dynamic Sports Construction	AOR	09642	No
Question 2	<p>8-11-10: Is Divison 16 responsible for the furnishing and installation of the security system devices or just the backboxes and raceways? I have looked through the specs but only see specs for Fire Alarm. There is no spec for Tele/Data either. Are we required to perform this work as well?</p> <p><b>ANSWER: The following are part of the base building contract:</b></p> <ul style="list-style-type: none"> <li>• Security system conduit</li> <li>• Security back-box and pull-boxes</li> <li>• Security cabling</li> <li>• Security devices</li> <li>• Extension of 120VAC power to security cabinets/equipment (120VAC ckts. Are to be provided under Division 16)</li> <li>• Security programming</li> <li>• Testing</li> </ul>	F.H. Paschen, S.N. Nielsen & Assoc., LLC	AOR	13700	No
Question 3					
Question 4					
Question 5					
Question 6					
Question 7					
Question 8					
Question 9					