



Addendum #1

Project: Indiana University;
BL411 Central Chilled Water Plant – Chiller 3 & 4 Replacement
Bloomington, IN; IU Project Number: 20240165

Date: June 04, 2026

This Addendum, issued prior to bidding, alters, amends, corrects, or clarifies the Construction Bid Documents to the extent stated herein and does thereby become a part of the Construction Bid Documents, and will become part of the Contract Documents of the successful bidder. Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

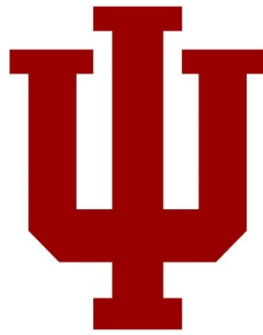
ITEMS INCLUDED IN THIS ADDENDUM

Information provided is a clarification of pre-bid meeting and additional commercial project specifications.

Item 1 – Pre-bid Meeting Time and Location: **The Pre-bid meeting is clarified in the Notice to Bidders as 10:00 AM in the Davis Conference Room in the Service Bldg.**

Item 2 – Project Manual / Specifications: Initial Specifications packet issued missing IU front end. **IU front end specifications reissued with IU Front End specifications included.**

END OF ADDENDUM



Construction Specifications

Indiana University
BL411 – Chiller 3 & 4 Replacement
Bloomington, IN

IU Project 20240165

ISSUED FOR BID
REV. 1

JUNE 4, 2026

BMcD Project 182536



**INDIANA UNIVERSITY
BL411 – CHILLER 3 & 4 REPLACEMENT**

**IU PROJECT # 20240165
Burns & McDonnell Project No. 182536**

TECHNICAL SPECIFICATIONS

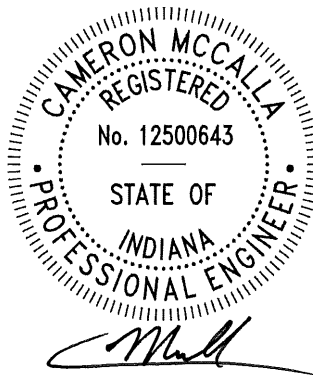
ENGINEER SEALS

DIVISION 3 – CONCRETE

DIVISION 4 – MASONRY

DIVISION 5 – METALS

DIVISION 31 - EARTHWORK



05/12/2026

DIVISION 00 – INTRODUCTORY INFORMATION

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 2 – EXISTING CONDITIONS

DIVISION 9 – FINISHES

DIVISION 23 – MECHANICAL



Nicholas W. Meeker

05/12/2026

DIVISION 26 – ELECTRICAL



DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

DIVISION 40 – PROCESS INTEGRATION



Nicholas W. Meeker

05/12/2026

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OTHER CONTRACT DOCUMENTS:

REFER TO DRAWING SET FOR ADDITIONAL INFORMATION REGARDING CAPACITIES, PERFORMANCE, EQUIPMENT SPATIAL ALLOCATIONS, MATERIALS, AND OTHER DETAILS.

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Appendix B – General Conditions of the Contract for
Construction

Appendix C – Insurance Requirements

VPCPF Support Resources - Construction Procurement
2901 East Discovery Parkway
Bloomington, IN 47408
812-855-5294
bidtab@iu.edu

NOTICE TO BIDDERS

Notice is hereby given that electronic bids will be received:

By: The Trustees of Indiana University
Bloomington, Indiana

For: BL411 Central Chilled Water Plant – Chiller 3 & 4 Replacement
Indiana University Bloomington
IU 20240165

At: Office of the Vice President for Capital Planning and Facilities

In accordance with Indiana Code 4-13-18 Drug Testing of Employees of Public Works
Contractors and IC 5-16 Public Works

Via electronic bid submission on www.iuplanroom.com. Bidders must be registered on the plan room, and signed into the plan room, in order to submit a bid.

Bids will be electronically opened via Zoom: <https://iu.zoom.us/j/82623978895>
Meeting ID: 826 2397 8895
Join By Telephone: 312-626-6799

Until: 2:00 P.M. Eastern Time, on June 26th, 2026.

Bids received after that time will not be accepted. Bid results will be published on www.iuplanroom.com.

A Unified Bid is requested for all work in this project, including General, Mechanical, and Electrical Construction work.

See project specifications for electronic bid submission instructions.

All bid proposals shall be in full accord with the Bidding Documents, which are on file with the Owner and may be examined by prospective Bidders:

VPCPF Support Resources – Construction Procurement
Indiana University
bidtab@iu.edu
812-855-5294

Bidding documents will be available June 1st, 2026. Please contact the Eastern Engineering Distribution Department, 9901 Allisonville Road, Fishers, Indiana 46038, Ph. 317-598-0661, www.iuplanroom.com for deposit and purchase information.

Each bid must be accompanied by:

- a completed Minority, Women's and Veteran's Business Enterprise Participation Plan, detailing the good faith efforts of the contractor to include minority, women and veteran-

- owned enterprises as subcontractors or material suppliers on the Project;
- a bid security for 5% of the total bid; and
- the contractor's written drug testing program, which must be in full compliance with IC 4-13-18.

The Owner reserves the right to accept or reject any bid and to waive any irregularities in bidding. The Owner may consider a bid to be incomplete if it does not provide the required documentation as described in this Notice, including but not limited to the Minority, Women's and Veteran's Business Enterprise Participation Plan. The Base Bid may be held for a period not to exceed sixty days before awarding Contracts. All Alternate Bids may be held for a period not to exceed ninety days before award and incorporation into the contract by proper Change Directive.

Should a successful Bidder withdraw his bid or fail to execute a satisfactory Contract within 10 days after notice of acceptance of bid, the Owner may declare the Bid Security forfeited as liquidated damages, not as penalty.

A Pre-bid meeting is scheduled for June 9th 2026 at 10:00 AM in the Davis Conference Room in the Service Bldg. All interested parties should assemble at 2901 East Discovery Pkwy at the Service Building.

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Indiana University Bloomington
IU 20240165

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00 00 00 Procurement and Contracting Requirements

00 20 00 Instructions for Procurement

00 21 13 Instructions to Bidders – Appendix A

- 1.1 Instructions to Bidders
- 1.2 Mandatory Electronic Bid Submittal Instructions

00 40 00 Procurement Forms and Supplements

00 41 13 Bid Form – Appendix A

- 1.1 Bid Form
- 1.2 Contractor's Bid for Public Work - Form 96 (Revised 2013)

00 43 00 Procurement Form Supplements – Appendix A

- 1.1 Contractor Asbestos Certification Form
- 1.2 Asbestos Protocol for Contractors Form
- 1.3 E-Verify Affidavit
- 1.4 Indiana Worker's Compensation Certificate of Compliance
- 1.5 Escrow Agreement - Old National Wealth Management – awards in excess of \$200,000

00 43 39 Minority Business Enterprise Participation Plan – Appendix A

- 1.1 Minority, Women's, and Veteran's Business Enterprise Participation Plan

00 50 00 Contracting Forms and Supplements

00 52 13 Agreement Form – Appendix A

- 1.1 Indiana University Construction Agreement

00 55 00 Notice to Proceed

- 1.1 Contractor is not allowed to begin contracted work until Notice to Proceed is received, and insurance requirements have been reviewed and approved by INLOCC.

00 60 00 Project Forms

00 61 13 Performance and Payment Bond Form – Appendix A

- 1.1 Performance and Payment Bond Form

00 70 00 Conditions of the Contract

00 72 13 General Conditions – Appendix B

- 1.1 AIA A201 – 2017 General Conditions of the Contract for Construction

00 73 00 Supplementary Conditions – Appendix A

- 1.1 Escrow Agreement
- 1.2 E-Verify

00 73 16 Insurance Requirements – Appendix C

- 1.1 Cross-Reference General Conditions, Article 11
 - a. Certificate of Insurance
 - b. Worker's Compensation – State Form 41321 Certificate of Compliance – Worker's Compensation and Occupational Diseases.
 - c. Contractor's Pollution Liability – Construction Contracts
 - d. Builder's Risk Insurance

00 73 36 Equal Employment Opportunity Requirements

- 1.1 Equal Employment Opportunity
 - a. Cross-Reference General Conditions, General Conditions Section 16.5.
 - b. During the performance of this Contract, each Contractor agrees as follows:
The Contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability. The Contractor will take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability. Such action shall include, but not be limited to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by an appropriate agency of the Federal Government setting forth the requirements of these non-discrimination provisions.
 - c. The Contractor will, in all solicitations or advertisements for employees placed by or on the behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability.
 - d. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other Contract or understanding a notice to be provided advising the labor union or worker's representative of the contractor's commitments under Section 202 of Executive Order #11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
 - e. The Contractor will comply with all provisions of Executive Order #11246 of September 24, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor.
 - f. The Contractor will furnish all information and reports required by Executive Order #11246 of September 24, 1965, and by the rules, regulations and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by an appropriate agency of the Federal Government and by the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations and orders.
 - g. In the event of the Contractor's non-compliance with the Equal Opportunity conditions of this Contract or with any of such rules, regulations or orders, this

Contract may be cancelled, terminated or suspended in whole or in part, and the Contractor may be declared ineligible for further Government Contracts, in accordance with procedures, authorized in Executive Order #11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in said Executive Order, or by rule, regulation or order of the Secretary of Labor, or as otherwise provided by law.

- h. The Contractor will include all of Clauses (a. thru f. inclusive, of this article) in every subcontract of purchase order unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order # 11246 of September 24, 1965, so that such provision will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontractor or vendor as the appropriate agency of the Federal Government may direct as a means of enforcing such provisions, including sanctions for non- compliance; provided, however, in the event the contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the appropriate agency of the Federal Government, the contractor may request the United States to enter into such litigation to protect the interests of the United States.
- i. Exempted from the above Equal Employment Opportunity conditions are construction contracts and subcontracts not exceeding \$10,000, suppliers, contracts, and material and equipment contracts not exceeding \$10,000 for standard commercial supplies or raw materials, and contracts and subcontracts under which work is performed outside of the United States where no recruitment of workers within the United States is involved.
- j. In addition to the requirements set forth in Article 13 of the Instructions to Bidders, or elsewhere in the Contract Documents, regarding the participation of Minority, Women's, and Veteran's Business Enterprises
- k. ("MBE/WBE/VBE"), the Contractor is required to comply with the following Mandatory Tier II Reporting Requirement:
 - 1. The Contractor shall take all necessary and reasonable steps to ensure that MBE/WBE/VBEs have the maximum opportunity to compete for and perform work on this Contract. MBE/WBE/VBE utilization in the performance of this Contract must be reported monthly using the IU Online Tier II reporting System. Compliance with Owner's Mandatory Tier II Reporting Requirement is a pre-condition for approval of pay applications. (For more information and training, see <https://supplierdiversity.iu.edu> and click on Online Spend Information in the OTTERS section.)
 - 2. The Contractor shall, upon Owner's written request, provide documentation that contracts have been entered into and payments made to Tier II MBE/WBE firms as reported by Contractor.

00 90 00 Revisions, Clarifications, and Modifications

00 91 13 Addenda

- 1.1 Pre-bid questions shall be submitted to the Owner's Representative for inclusion of all answers and distributed to all bidders via Addenda.

01 00 00 General Requirements

01 10 00 Summary

01 11 00 Summary of Work

- 1.1 All documents included in Contract Documents create the work summary in total for said project.
- 1.2 Work Sequence should be coordinated with Owner and Customer.

01 14 00 Work Restrictions

- 1.1 Schedule construction work between 7:00 AM to 6:00 PM on weekdays. Indicate in the Bid Documents if Work outside of this schedule is required.
- 1.2 The IU Construction Manager will arrange for access to be issued to the Contractor to buildings or rooms. The Contractor is required to fill out a form for the keys and is liable for the cost of rekeying if the keys are lost or not returned. All project sites are to be secured during non-work hours to prevent unauthorized access and safety hazards to project site.
- 1.3 Excessive noise from construction activities may require rescheduling or off hours to avoid quiet week, finals week, graduation ceremonies, or at the request of the Owner.

01 18 00 Project Utility Sources

- 1.1 Notification of Utility Companies – The General Contractor, in accordance with local laws and ordinances, shall notify appropriate utilities, with copy to the Owner's Representative and Owner, not less than 48 hours in advance of any excavation or work in, around or on utility lines.
- 1.2 Protection and Maintenance of Existing Utilities – Existing utilities are shown in the Contract Documents in their approximate locations from available information. The General Contractor shall ascertain exact locations of utilities that may be affected by the work of all Prime Contractors on this Project, and shall be responsible for the protection and maintenance of such utilities, and shall be responsible for any damage or injury that may result from working on or near these utilities.
- 1.3 Utilities Not Indicated – If existing utilities are encountered which are not indicated on the drawings, the General Contractor shall protect such utilities and notify the Owner's Representative and the Owner of their presence. If any such utilities not indicated on the drawings, which are to remain in service, are damaged by any of the Prime Contractors, the General Contractor shall take such action as reasonably required to minimize the damage and shall promptly restore the system to operating condition as directed by the Project Engineer and the Owner's Representative.
- 1.4 Owner-Provided Systems - The Contractor shall in no circumstances tap into Owner-provided systems, including but not limited to steam, without prior notice to the Owner. Upon obtaining the Owner's consent, the Contractor shall schedule the tap-in at a time when Owner's personnel can be present. If Contractor fails to comply with this provision, Contractor shall reimburse the Owner for all costs incurred, including but not limited to all damages incurred and not covered by Builders Risk insurance for any reason, whether to property included or not included within the original scope of work.
- 1.5 Review project requirements for natural gas, electric power, domestic water, sanitary sewer, storm water drainage, chilled water, hot water, and steam with IU Engineering Services and IU Utilities.
 - a. Review with the designated University Information Technology Services (UITS) requirements for telephone and data lines.
 - b. Review requirements for emergency telephones and CCTV with Team Leader.

- 1.6 Review with Engineering Services when utilities need to be rerouted, removed or abandoned in place.
- 1.7 On projects within existing buildings, the university will pay for temporary utility costs incurred by the Contractor based on their responsibility as outlined in 00 51 00 Temporary Utilities.
- 1.8 It is the Contractor's responsibility to convey the utilities to the point of usage and to provide the means of conveying the utilities.

01 20 00 Price and Payment Procedures

01 26 63 Change Orders

- 1.1 Change Directives to the Contract will be done with an IU Change Directive Form. The Contractor is required to include documentation for labor and materials unit cost breakdown with appropriate backup as indicated in the IU General Conditions and AIA A201.

01 29 00 Payment Procedures

- 1.1 Contractors shall use the AIA G702 & G703 with Partial Waiver of Lien for payment.
 - a. The Schedule of Values shall include 3% for project closeout submittals and 3% retainage.
 - b. The Schedule of Values must be approved by the IU Construction Manager before submittal of the first Application for Payment.
 - c. Final payment to the Contractor cannot be made until all change orders are processed, close out documents are received, and Final Waiver of Lien and Consent of Surety are received.

01 30 00 Administrative Requirements

01 31 19 Project Meetings

- 1.1 The IU Construction Manager will schedule the Preconstruction Meeting.
- 1.2 Representatives from the A/E Consultant, the Contractor, the User Representative, and the IU Project Team will attend.
- 1.3 This meeting will explain the paperwork requirements for the Project including EEO policies, Risk Management procedures, General Conditions for the Contract, payment procedures, change orders, the Project start and completion dates, etc.
- 1.4 Dates and times for future Project Progress Meetings will be agreed to.

01 31 23 Project Web Site

- 1.1 Projects will use eBuilder as a repository for the Project at the preliminary design phase.
 - a. This project file will be used by the Project Team for all photographs, meeting minutes, submittals and other documents related to the project.
 - b. Training in the use of the web site will be provided by Capital Planning to Consultants, Contractors, and IU Staff; email ebuilder@iu.edu.

01 32 29 Periodic Work Observation

- 1.1 On projects with a State of Indiana Construction Design Release, a Building Code Official from the Indiana Department of Homeland Security, Fire and Building Code Enforcement Branch will perform periodic inspections. Additional information is available at this link: <http://www.in.gov/dhs/2376.htm>.
- 1.2 The Contractor will perform and provide all testing results to Owner before placing of

concrete, pressure testing closed loop systems, installation of windows and water testing, ceilings, roofing, water proofing, etc..

- 1.3 Inspections and site reviews do not relieve the A/E from the responsibility to monitor construction for compliance with the documents as well as performing typical industry standard milestone inspections, i.e. form board elevation survey, in wall, above ceiling, close loop systems pressure testing, commissioning of startups, etc.

01 33 23 Shop Drawings, Product Data, and Samples

- 1.1 Contractor submittals to be in electronic formats such as .pdf and posted to eBuilder for final review and approval before procurement and installation.
- 1.2 Samples cost the Owner, Consultant and Contractor for shipping and handling, cataloging, reviewing and storing. Consider the importance of requesting physical samples of common construction materials such as roofing, door hardware, concrete masonry, etc.
- 1.3 Limit the number of physical samples to the minimum necessary to verify size, shape, color, and finish. Samples that can be incorporated into the final Work are preferred.
- 1.4 Mock-ups of exterior walls need to include all systems that become part of the wall. Include a sample window, all flashings, mortar, and sealants.
- 1.5 Review Interiors Standards for required samples and control books.

01 35 23 Owner Safety Requirements

- 1.1 Contractor Procedures Manual
 - a. <https://protect.iu.edu/environmental-health/occupational-health/construction-safety.html>
- 1.2 Job Site Safety Checklist
 - a. **Purpose:** The intent of this template is to identify the MINIMUM requirements of a Site Specific Safety Plan (SSSP) for any contractor awarded work at Indiana University (IU). Contractors are encouraged to elaborate and expand upon these requirements.
 - b. **SSSP Deliverable:** The SSSP shall be submitted to the IU Construction Manager at Kick Off Meeting. DO NOT SUBMIT your company's safety manual.
 - c. **SSSP Template** (minimum requirements):
 1. Owner reserves the right to request additional information on a project-by-project basis.
 2. Scope of Work: narrative of the project scope associated with your contract including schedule and major project milestones.
 3. Designated On-Site Safety Representative and Competent Persons.
 4. Safety Orientation Program: process to orient workers to your safety rules and expectations including ongoing toolbox safety talks.
 5. Hazardous Communication Program
 6. 24-hour Emergency Points of Contact
 7. Site Logistics Plan: plan shall address student/faculty/staff/public protection, traffic plan, equipment and laydown areas, site security, tire washing, emergency evacuation muster points, etc.
 8. Minimum PPE Requirements
 9. Accident Procedures
 10. Weekly Safety Audit/Inspection Procedures and Upload to eBuilder
 11. Project Clean Up Plan: detail how your company plans to keep the workplace clean and free of potential hazards.
 12. Hazard Assessment: identification of hazards associated with defined project tasks. Please focus on highly hazardous tasks associated with the work (crane picks, scaffolding, confined space, utility shutdowns, hazardous material

abatement, hot work, trenching, etc.).

- 1.3 Site Specific Safety Plan
 - a. <https://protect.iu.edu/environmental-health/ehs-campus-info.html>
- 1.4 Contractor Safety Program – required training
 - a. <https://protect.iu.edu/environmental-health/training/index.html>
- 1.5 General Safety Considerations
 - a. Report all injuries immediately to the IU Construction Manager/Safety Program Manager.
- 1.6 Asbestos <https://protect.iu.edu/environmental-health/occupational-health/construction-safety.html>
- 1.7 CPF LOTO Program as per 01 94 14 and per <https://inlocc.iu.edu/policies/fire-safety/hot-work-policy.html>
 - a. Energized Work Permit
 - b. IU CPF LOTO Program
 - c. Job Planning Form
 - d. LOTO Template
- 1.8 INLOCC Hot work Permit <https://inlocc.iu.edu/policies/fire-safety/hot-work-policy.html>

01 35 43 Environmental Procedures

- 1.1 The IU Environmental Health and Safety Department will assist with compliance and management of the following with the Project Team:
 - a. OSHA Particularly Hazardous Substances ([29 CFR 1910.120](#)) and online [MSDS search](#) information.
 - b. DOT Hazardous Material ([49 CFR 172.101](#))
 - c. Hazardous Waste Operations and Emergency Response (29 CFR 1910.120)
- 1.2 The Project Team Leader and A/E Consultant need to identify any requirements for abatement prior to final Construction Document completion. They must identify where, who and how this item will managed, if applicable.
- 1.3 Mandatory Environmental Health and Safety Training
 - a. The Contractor shall ensure that appropriate personnel attend and participate in Environmental Health and Safety training conducted through the Owner's Office of Environmental Health & Safety. Please contact IUEHS at iuehs@iu.edu to schedule this.
 - b. Contractors are expected to have knowledge of the types and likely locations of asbestos containing materials generally found in building materials and be able to make visual identification of suspect materials (even when demolition and/or abatement is not a contracted-for part of the work).
 - c. Contractors will be required to provide documentation that each employee has attended Asbestos Awareness Training within the last calendar year (as outlined in the Asbestos Protocol for Contractors Communication of Hazards).
 - d. Contractors are required to stop work immediately upon discovering suspected asbestos containing materials and make a report to the Owner's Project Manager.

01 35 46 Indoor Air Quality Procedures

- 1.1 All indoor air quality requirements are the responsibility of the Contractor:
 - a. Develop a site-specific plan to control demolition and reconstruction materials in renovation areas as guided by the 'Air Quality Considerations' below.
 1. Schedule renovation work during periods of low building occupancy when possible. Isolate work areas from occupied areas using critical barriers, air pressure control and high efficiency particulate air (HEPA) filtration. Minimize the

number of building penetrations necessary for entry into the renovation area. Choose the penetration sites carefully to minimize the potential for occupant exposure. Modify HVAC operations according to specifications of University Environmental Health and Safety and IU staff engineers prior to and during renovation activities to ensure isolation of renovation areas from occupied spaces. Maintain an adequate unoccupied buffer zone around renovation areas according to design specifications. This may require temporarily relocating building occupants in the immediate vicinity of renovation areas. Increase housekeeping activities in adjacent occupied areas during renovation activities that create dust.

2. Identify the specific air quality measures needed for the renovation project, including appropriate performance metrics.
3. Manage air quality issues and specify conditions that would require an emergency response, such as asbestos release or a major water loss.

01 40 00 Quality Requirements

01 41 00 Regulatory Requirements

- 1.1 Indiana University is considered a “political subdivision” of the State of Indiana and therefore is exempt from obtaining local city or county building permits.
 - a. All remodeling, renovation, and additions are considered new construction and may require filing with the State of Indiana, Department of Home Land Security,
 - b. This exemption does not extend to permits required by local utilities, or state and federal agencies.
- 1.2 Refer to <https://www.in.gov/dhs/> for a listing of current State of Indiana Codes, Standards and Rules.
- 1.3 At the link (above), click on “Apps, Forms, Permits”
- 1.4 The Application for Construction Permit for School Facilities is available at this link: <https://forms.in.gov/download.aspx?id=5551>
 - a. This form is required for any IU building that will contain child care, day nurseries, or youth camps.
 - b. Refer to 410 IAC 6-12 And IC 16-41-21 for additional information.
- 1.5 All Applications or other required forms shall be filled out by the A/E Consultant and reviewed by the IU Team Lead.
 - a. The Owner is the “Trustees of Indiana University”
 - b. The University Engineer is the Designated Agent for signature as “Owner”.
 - c. The Architect and/or Engineer of Record will be designated as the “Owner Representative”.

01 50 00 Temporary Facilities and Controls

01 51 13 Temporary Electricity & Lighting

- 1.1 Light and Power
 - a. The General Contractor shall arrange for and pay for all metered temporary electric light and power for the work of all Prime Contractors and their trades and subcontractors as required throughout the work by the Prime Contractors. The General Contractor shall pay all costs for the installation, maintenance and use of equipment for such temporary light and power, including metering of temporary electrical power.
 - b. The General Contractor shall make all necessary arrangements to provide temporary electrical power, to arrange for its distribution, to continue its service throughout construction, to remove same, and to pay for all costs incidental thereto, all as identified

herein.

- c. Electrical power at 120/208/480 volts - 3 phase, 4 wire capability is available within convenient reach of the project.
- d. Temporary lighting that complies with applicable federal and state codes shall be continuously provided in all stairways, corridors, and in all other work areas for all Contractors on the project. The General Contractor shall also provide as needed; area flood lights, guard lights at barricades, obstructions in streets, drives, walks and at all trenches or pits adjacent to public areas within the area of construction by any Contractor on this project.
- e. The service entrance shall terminate in a minimum of two 400 ampere fused NEMA 3R rain tight main switches. From the service entrance location there shall be a minimum of two 400-ampere feeders to a minimum of two fused distribution panel boards on each floor. Such distribution panel boards shall be located at third points of the building and shall contain proper fusing for all temporary wiring extensions. Transformers required for the service outlined shall be provided as a part of the service entrance.
- f. Temporary distribution from these panels shall provide single phase, 120 volt, 20-ampere service to outlets within 50 feet of any portion of the building, and a single phase, 208 volts, for a 10 horsepower maximum capacity within 200 feet of any portion of the building. Outlets and bulbs shall be provided by the General Contractor to produce not less than 1/5 watt per square foot of floor area throughout the building.
- g. All temporary wiring shall include a green equipment-grounding conductor and the entire temporary system shall have equipment grounding continuity. All outlets for the connection of portable electrical equipment shall be of the grounding type. All elements of the temporary electric service shall conform to the regulations of the National Electric Code, the National Electric Safety Code, and the Safety Code for the Construction Industry, and O.S.H.A., which shall include such ground fault service as required to protect operating personnel.
- h. Each Contractor and/or subcontractor shall furnish any necessary wiring and extension cords to reach from the nearest outlet to its point of operation. All such devices shall conform to the above provisions or be rejected for use by the Owner's Representative or Owner.
- i. No permanent power from permanent sources shall be used without the Owner's written permission indicating the conditions whereby it may be used. Consideration will not be given for the use of lights, wiring devices or other electric equipment until the building is in the finishing stages or unless it is in the Owner's interests.
- j. The General Contractor shall maintain strict supervision over the use of the temporary electric service and shall be responsible for damages caused by misuse of it. Violation of safe practices, abuse of the service, or failure to conform to the above standards shall be sufficient cause for the Owner's Representative or Owner to take such action as will correct the condition.
- k. Upon completion of the Project or when directed by the Owner's Representative, all temporary light and power equipment shall be removed by the General Contractor.

01 51 23 Temporary Heating, Cooling, and Ventilating

1.1 Heating and Cooling

- a. The General Contractor shall be responsible for furnishing and installing and subsequent removal of a temporary metered heating/cooling system for use by all Contractors on the Project, within the new building as weather and construction conditions demand, and as required for the installation of any material or for working conditions required by any trade or trades within the building. Temporary heat shall

- be provided to prevent freezing within the building, to provide suitable working conditions, to assure progress of the operation within the established schedule time, and to conform to specific requirements of the Contract Documents. In areas where finishing trades are working or have completed their work, temporary heat shall be maintained at a uniform temperature of 70° F until the completion of the Project.
- b. The General Contractor shall provide and pay for all materials, labor, water, tools, electric wiring, fuel, and electric power, operating services and any items incidental and required for a complete and operable system of temporary heat, so long as any system of temporary heating/cooling is in operation and required by any trade or crafts within the building.
 - c. The General Contractor shall maintain a system of temporary heating/cooling until total completion and final acceptance by the Owner, even if the Owner exercises its right, pursuant to Section 4.5.2 of the General Conditions to take Beneficial Occupancy of some or all of the building. The entire cost of providing temporary heating/cooling shall be the responsibility of the General Contractor until substantial completion.
 - d. Equipment shall be oil or gas fired, electric blower operated, and shall not require a vent from the heated/cooled space. Open flame type units similar to Salamanders shall not be used.
 - e. All spaces where temporary heating/cooling is required shall be maintained at a minimum of 50° F. during working hours and at a minimum of 40° F. during non-working hours, or as required for building construction or any trade requirements. Also, for a minimum of seven days prior to any interior finishing, (wood, painting, varnishing, resilient tile, acoustical ceilings, etc.) and until final acceptance by Owner or during partial occupancy by Owner, spaces shall be maintained according to design conditions on a 24-hour, 7-day basis.
 - f. None of the permanent heating/cooling systems nor any of their component parts shall be available for temporary heating/cooling until the building is in the finishing stages, (finish painting, varnishing, paneling, wood, resilient tile, acoustical ceiling, etc.). At the point at which the permanent heating/cooling system is completely installed as designed, including permanent wiring connections to a permanent power source, the Contractor may make a request, in writing, to the Owner to use the permanent heating/cooling systems to supply temporary heating/cooling for the remainder of the Project. The Owner shall be sole judge of building conditions and heating/cooling system conditions concerning the permission to use the permanent heating/cooling systems for supplying temporary heating/cooling. Furthermore, if Owner grants permission for Contractor to use the permanent heating/cooling systems for temporary heating/cooling, the warranty on such permanent heating/cooling systems, including their component parts, shall not start to run until Contractor ceases its use of the permanent heating/cooling systems.
 - g. The General Contractor shall be responsible for all phases of operation, maintenance, and items of like nature during the time the permanent heating/cooling system is used to furnish temporary heating/cooling. The General Contractor shall assume all responsibility of coordination among other Contractors and/or trades concerning the installation of their permanent systems for use for temporary heating/cooling and extension of the warmth/cooling.
 - h. At the termination of the use of the permanent systems as a temporary heating system, the systems shall be cleaned, equipped with new filters, equipped with new belts if required, etc., and any damage repaired or replaced at the expense of the General Contractor.

01 52 00 Construction Facilities**1.1 Storage and Structures**

- a. Each Contractor shall construct and maintain, in locations approved by the Owner's Representative, all temporary structures, material sheds, storage sheds, or other similar enclosed structures required for the performance of this Contract. All temporary structures are to be removed from the site by the Contractor upon completion of the Project, or sooner, if so requested by Owner's Representative.
 - 1. If on-site storage is not available, review with Owner's Representative and Team Leader to select alternative storage sites.
- b. The General Contractor shall be responsible for and shall cooperate and coordinate with other Contractors requiring storage at the site.
 - 1. All Contractors on this Project shall be restricted to the "Contract Limit Lines" of the construction site and/or to any additional area as shown on the Site Plan and shall verify locations with the Owner's Representative prior to storing any materials.
 - 2. All Contractors on this Project shall confine equipment, storage of materials, and the operations of workers to limits indicated on the drawings. Any area indicated on drawings or designated elsewhere by the Owner for storage of materials shall be returned to its original condition upon completion of the Project at no cost to the Owner.
 - 3. Should any Contractor require additional storage area, acquisition of such additional storage shall be at that Contractor's expense, shall not be on Owner's property and shall not be invoiced or otherwise charged to Owner on monthly pay applications.

01 52 13 Field Offices and Sheds

- 1.1 Contractors' Field Offices – Each Contractor shall provide at all times, for his own use, an adequate, weather tight temporary field office, located on the site in a location approved by the Owner's Representative on new buildings ONLY unless otherwise specified.
 - a. These spaces shall be heated (thermostatically controlled), air conditioned, and lighted.
 - b. Each shall be provided with clean and adequate toilet facilities, including water and sanitary services.
 - c. Internet Access – The Contractor is required to have internet access, as well as printing capabilities, on site at all times during construction operations. This is to conduct Progress Meeting, onsite coordination and ZOOM or similar virtual meeting capabilities.
- 1.2 Review with Team Lead if utilities and restroom facilities are available for the Contractor's use.

01 54 00 Temporary Construction Aids

- 1.1 Hoists, Chutes, Derricks, Scaffold, Stairs, Platforms, Swing Staging, etc.
 - a. Contractor to Provide – Each Contractor shall furnish and maintain all equipment such as temporary hoists, chutes, derricks, scaffolds, staging, stairs, ramps, runways, ladders, and similar items required for the proper execution of its work, and shall provide or arrange for the use of such facilities by all its subcontractors or trades as required to carry out its work, and shall remove or arrange for the removal of all such items when no longer required.
 - b. Legal Requirements – All such apparatus, equipment and construction shall meet the

requirements of the labor laws and regulations applicable thereto and of the authorities having jurisdiction over it.

- c. Safety Requirements – All such apparatus, equipment and construction shall meet the requirements of OSHA and regulations applicable thereto and of the authorities having jurisdiction over it.
- d. Removal of Rubbish--General – No materials, rubbish or debris will be permitted to drop free, but shall be removed by use of the material hoist, rubbish chute (closed, dust-tight type) or other method approved by the Owner's Representative. Rubbish shall be removed frequently; daily from the building, weekly from the site. Specific requirements related to waste disposal and storm water management are set forth in 01 55 29.
- e. Protection of the Work – No materials will be permitted to be passed through the finished openings of the exterior walls without proper protection of the openings in a manner approved by the Owner's Representative. Hoists and chutes shall be so protected as to prevent damage, staining or marring of any permanent work.
- f. Temporary Stairs – Permanent stairs shall be erected as soon as possible and the General Contractor shall provide same with temporary protective treads, risers, handrails and shaft protection. The General Contractor shall provide safe, convenient access from floor to floor as the construction progresses. Permanent ladders and stairs may be used when available, providing same shall be safely prepared for such use. All devices so used shall conform to the Standards prescribed in the Safety Code for the Construction Industry, State of Indiana, to OSHA, and such other codes as are applicable.
- g. Temporary Sidewalks – The General Contractor shall erect temporary sidewalks as required where existing sidewalks are rendered inadequate by work on the Project site. Temporary sidewalks shall be complete with all necessary timber uprights, braces, crossbeams, plank walk, railings and the like, all installed in such manner so as not to interfere with the execution of the work, or safety and convenience of all persons using walks.
- h. Temporary Sidewalk and Materials Bridges – The General Contractor shall erect temporary sidewalks and materials bridges, if required, where building operations are conducted within 30 feet of public sidewalks in order to provide adequate protection to the public and the Owner during the execution of the work of all Prime Contracts. The General Contractor shall construct bridges complete with necessary up-rights, braces, cross beams, plank top and screened guard rails on all sides and ends, and with watertight ceiling, lighting, signs and safety barricades, all in strict accordance with the requirements of local ordinances and regulations.

01 54 13 Temporary Elevators

1.1 Use of Elevators

- a. Temporary Use – The General Contractor may arrange for the temporary use of elevators by all Prime Contractors, if required, during the construction period, to transport equipment and materials only during the finishing stages of the Project.
- b. Temporary Cars – The General Contractor shall furnish the required cars with car switch, gate contact, and all necessary operating and safety devices, city and state tests and certificates.
- c. Temporary Cab Enclosures, Etc. – The General Contractor shall provide the required cab enclosures, temporary hoist way entrances and hoist way doors, temporary protection of hoist way openings, protection of permanent hoist way entrances or other installed finished work, and such other items as are necessary to permit temporary

operation in accordance with local, state and national codes.

1. The General Contractor shall provide all necessary maintenance of the elevators during the period of temporary operation. The General Contractor shall restore elevators to their original perfect condition and furnish guarantee as specified.
2. All costs in connection with operation of the temporary elevators shall be paid by the General Contractor.
3. The General Contractor shall extend all guarantees and warranties for two (2) years from date of acceptance of the Project by the Owner.

1.2 Enclosures and Measures

- a. The General Contractor shall provide temporary enclosures for all exterior openings, as soon as the building structure is erected and otherwise made weather-tight, or whenever necessary in order to provide suitable working conditions within the building.
- b. The General Contractor shall provide suitable means for ventilation of the building and to permit the exit of water vapor from the building at all times. The permanent door enclosures shall not be used as temporary enclosures, but temporary doors with proper hardware to make them self-closing shall be provided.

01 55 00 Vehicular Access and Parking

1.1 Parking Permits are issued by Parking Operations for Contractor's vehicles.

- a. On-site parking spaces may be limited to one (1) space for job site access. No parking spaces shall be fenced or barricaded or within staging area.
- b. Contractors are responsible for payment of all parking permits and fines.
- c. Coordinate with Parking Operations and IU Team Lead for closing of parking spaces for construction purposes.

1.2 Comply with Owner's restrictions for bus stops, handicapped accessible parking, accessible curb ramps, and emergency vehicle access.

1.3 Restrict use of building loading dock by contractor to minimum time required for loading/unloading supplies and materials. Contractor's vehicles cannot be left unattended at loading docks, in fire lanes, at bus stops, or at any designated reserved or handicapped parking space.

1.4 Temporary Access to Site shall be identified on a per project basis.

- a. The Contractor shall keep adjacent city streets free from mud or debris deposited thereon as a result of operations under this Contract. Contractor shall maintain, restore and street clean such streets to their original condition minimizing of dust and debris by of wet down or vacuum as required.
- b. Owner shall either identify parking facilities that may be used by the Contractor for its equipment, personnel, and workers or shall notify Contractor that is no project-related parking available on University property.
- c. Parking of cars will not be permitted on other parking lots, drives or roads of academic or residential buildings.
- d. On IUPUI projects, free shuttle service is provided from the designated Contractor parking area at 1302 N. Indiana Avenue. Contractors will be required to purchase parking permits for this lot. Each prime contractor will be able to purchase (1) one on-campus parking permit which will allow them to park in a lot closer to the project site. Parking permits may be purchased from Parking and Transportation Services located in the west entrance of the Vermont Street Garage. Contractors are prohibited from parking in any IUPUI campus visitor facility.
- e. On Bloomington projects, Contractor's employees are to park at the Green Lot at the Athletics complex. A fee for parking at this lot will be charged to Contractor. Unless otherwise agreed by the parties, Contractor is responsible for transporting its employees

from the Green Lot to the jobsite.

- f. On projects at all other campuses, free parking areas will be designated for Contractor's employees and hang tags will be provided to Contractor by campus parking operations.

01 55 29 Staging Areas

- 1.1 Indicate exterior staging area or point of access to building on drawings along with approved access route to Project Site and have perimeter of area approved by IU Construction Manager and Landscape Services. Fencing must have appropriate red fabric screening and project specific details per IU Construction Fencing Specification.
- 1.2 The General Contractor shall furnish, erect and properly maintain a temporary "chain link fence," 6' 0" high, complete with **solid, Pantone 201** privacy fabric, top and bottom horizontal support, man and vehicle gates as appropriate for the project conditions, which shall remain in place until such time as directed by the Owner to be removed. The fence shall be located on the Contract Limit Line or where the progress of work dictates. The IU Fencing standard can be found on e-Builder in the zIUResources-BL project. File name: Construction Fence All Campuses 2020.pdf.
- 1.3 Indicate location of dumpster and route for debris removal through occupied buildings. Provide red fabric screening at fencing around dumpsters located in open areas. Vehicles will not park within staging area, on hardscape or landscape surfaces in staging area or in surrounding areas. All damage or refresh of areas are the responsibility of the General Contractor for Final Completion.
- 1.4 Review vertical access within building, including use of stairs and elevator with the Team Leader.
- 1.5 Maintain Project site free of waste materials and debris. Perform regular landscaping maintenance to control grass and weeds within all fenced-in areas.

01 56 00 Temporary Barriers and Enclosures

- 1.1 All renovation or construction work inside of occupied buildings will require temporary barriers to prevent unauthorized access and to control dust from entering into adjacent spaces. Note sections for site and air quality.
- 1.2 Indicate on the drawings the location of temporary interior dust partitions of non-combustible wall construction equal to metal studs and dry wall on both sides. Exterior drywall visible to public shall be taped with one coat of joint compound and painted with primer and two coats of paint.
 - a. Provide a wood or hollow metal door frame with a lockable solid core wood or hollow metal door.
 - b. Provide walk-off mats at entry to Project work area.
- 1.3 Designate a single entrance for all materials to be brought into or taken out of the work area. Specify minimum dust control at entrance of two layers of 6 mil polyethylene plastic sheeting over existing doorways. Provide for covering all supply and return air vents with air filters if air handlers to the area cannot be shut down.
- 1.4 Specify cutting of masonry or other materials that will create dust outside of building.

01 56 39 Temporary Tree and Plant Protection

- 1.1 Indicate 6 foot high chain link fencing centered on trunk and to follow around drip line of trees. Provide minimum 8 foot diameter enclosure around small diameter trees.
 - a. Provide for mulch to be applied within enclosure.
 - b. Tree protection fencing to remain in place until removal is approved by IU Landscape Architect.

01 57 13 Temporary Erosion and Sediment Control

- 1.1 Erosion and Sediment Control: Comply with applicable laws and regulations of authorities having jurisdiction, including:
- a. Indiana Department of Environmental Management (IDEM) Construction Stormwater General Permit (INRA00000).
https://www.in.gov/idem/stormwater/files/final_gen_permit_inra00000_construction.pdf.
 - b. The Soil and Water Conservation District of the county where work is performed.
 - c. IU Environmental Health & Safety
 - d. Indiana University's Landscape Architect and IU EHS will review the Stormwater Pollution Prevention Plan (SWPPP) documents before the documents are submitted to the local Soil and Water Conservation District and IDEM.
 - e. The Contractor is responsible by contract with IU to perform all activities stated in the SWPPP documents as defined by the IDEM Construction Stormwater General Permit (INRA00000).

01 57 23 Temporary Storm Water Pollution Control

- 1.1 Site Drainage, Pumping, Storm Water Management
- a. Site Drainage – The General Contractor shall take over the responsibility for site drainage upon entering the premises and shall maintain such drainage during the term of all Prime Contracts in a manner approved by the Owner's Representative and so as not to adversely affect the construction, the building during various stages and the adjacent areas.
 - b. Pumping – The General Contractor shall, during the progress of the work of all Prime Contracts, provide and maintain all required pumps, suction and discharge lines, power, etc., in sufficient number, capacity, and configurations to keep all excavations, pits, trenches, footings, foundations, and the entire property area free from accumulation of water from any source whatsoever, and also keep the Project dry and free of water, at all times and under any and all circumstances and contingencies that may arise.
 - c. Storm Water Management – The Contractor shall be responsible for the management of storm water run-off from the worksite in accordance with the SWPPP and the IDEM Construction Stormwater General Permit (INRA00000).
https://www.in.gov/idem/stormwater/files/final_gen_permit_inra00000_construction.pdf. In addition, the Contractor shall comply with the requirements of the Indiana University Sediment and Erosion Control Standards. The Contractor shall use the Indiana Storm Water Quality Manual published by the Indiana Department of Environmental Management, <https://secure.in.gov/idem/4899.htm>, as a guidance document when choosing best management practices for sediment and erosion control at the site.
 - d. Contractor shall pay Owner for any costs Owner incurs based on Contractor's non-compliance with this Section, including but not limited to repair or remediation costs, fines or penalties imposed on Owner by any regulating authority, and any fees or costs paid to attorneys or consultants arising out of a prohibited storm water discharge.

01 58 13 Temporary Project Signage

- 1.1 Project signs are reserved for use on major capital projects and are not required for small projects. The GC shall provide and maintain one sign per the IU Standard found on e-Builder in zIUResources-BL project. File name: [Construction Sign all Campuses 2020.pdf](#).

- a. IU Team Lead will approve the provided Proof for design, wording and location of the sign at the project site.
 - b. No additional signs will be permitted without the written consent and approval of the Owner and Owner's Representative.
 - c. Signs shall be provided with treated wood posts and 1/2" thick exterior grade substrate or 1/4" aluminum composite panel with a high-density corrugated polypropylene core, all substantially constructed, fastened, and adequately braced.
 - d. All lumber, plywood and bracing shall be painted two coats of exterior paint on all exposed surfaces, in colors designated by the standard design provided by the Owner's Representative.
 - e. All lettering, graphics and colors shall be in accordance with the standard design provided by the Owner's Representative.
 - f. General Contractor shall remove construction sign from site when directed by Owner's Representative.
- 1.2 Contractor's advertising signs are prohibited.
- 1.3 Contractor responsible for all temporary wayfinding, no access and safety signage necessary, interior and exterior.

01 60 00 Product Requirements

01 64 00 Owner-Furnished Products

- 1.1 Owner Furnished Material and Equipment
- a. Cross-Reference General Conditions, Sections 3.2.1(6)(iii)(e) and Article 6
 - b. Self-Performance by Owner – Each Contractor shall permit the Owner to place and install equipment in accordance with a mutually-agreeable schedule before the completion of its Work. The placing and installation of equipment shall not in any way be construed as evidence of the completion or acceptance of the Work or any portion thereof.
 - 1. Contractor responsible for hard wire and connection to infrastructure provided in contract scope.
 - c. Contractor Installation of Owner-Furnished Materials and Equipment – In the event that Owner elects to furnish materials or equipment to the Contractor for installation, such equipment or materials shall be noted, indicated or scheduled by the Owner and notice provided to the Contractor, and shall be carefully examined by the Contractor immediately after delivery to the site, and any and all conditions which would prohibit the proper installation or operation of this equipment shall be noted and the Owner informed thereof before acceptance of the materials or equipment for installation. The Contractor shall assume responsibility for such equipment and materials upon receipt thereof, and shall pay for any damage occurring after delivery.

01 65 00 Product Delivery Requirements

- 1.1 Contractor Furnished Material and Equipment
- a. Cross-Reference General Conditions, Section 3.2.1(6)(iii)(d)
 - b. Contractor, subcontractors, manufacturers and suppliers furnishing materials and equipment under the various Prime Contracts shall identify, ship, address, consign, etc., all such materials and equipment to the appropriate Prime Contractor who may be charged therewith by giving the name of the Contractor, name of the Project, the street or post office address and the city. Under no circumstances may shipments be directed to, or in care of Indiana University. It shall be the sole responsibility of all contractors, etc., to observe this requirement, and failure to do so shall in no way be

construed as a justifiable construction delay.

01 70 00 Execution and Closeout Requirements

01 73 00 Execution

1.1 Construction Loads on Building Structures

- a. The structure is designed to support the loads of the finished building. No provision is included for stresses or loads imposed by construction operations. If the Contractor desires to place such loads in excess of the design load (shown on drawings), it shall submit drawings and calculations prepared by, and bearing the seal of a Professional Engineer of the proposed method for supporting such loads for the Owner's Representative's review and approval.
- b. No loading of any kind in excess of design loads shall be placed on any part of the building structure prior to Owner's Representative's approval of submitted drawings and calculations. The costs of the Owner's Representative's review shall be borne by the Contractor.

01 74 00 Cleaning and Waste Management

1.1 Protective Coverings and Measures

- a. Finished Surfaces – The General Contractor shall protect all finished surfaces, including the jambs and soffits of all openings used as passageways or through which materials are handled, against any possible damage resulting from the conduct of work by all Prime Contractors and their trades and subcontractors.
 1. The finished surfaces shall be clean and not marred upon delivery of the Project to the Owner. The General Contractor shall, without extra compensation, replace, repair or refinish (as determined by the Owner's Representative) all such spaces where painted or finished surfaces prove to have been inadequately protected and are damaged.
 2. Materials Stored on Finished Surfaces – The General Contractor shall provide tight, non-staining wood sheathing under any materials that are stored on finished surfaces and shall provide planking on finished surfaces before moving any materials over those finished areas.
 3. Roof and Waterproof Surfaces – Roof and waterproof surfaces shall not be subjected to traffic, nor shall they be used for storage of material. Where some activity must take place in order to carry out the work of the Prime Contracts, adequate protection, subject to approval by the Owner's Representative, shall be provided by the General Contractor
 4. Glass – All glass shall be protected and kept clean during the entire construction period by the General Contractor. All damaged, etched, defaced or broken glass shall be replaced at the General Contractor's expense.
 5. Flooring – All will be covered and protected throughout the construction project.

01 74 19 Construction Waste Management and Disposal

1.1 Waste Management

- a. Waste Disposal – The Contractor shall be responsible for disposal, recycling or reclamation of all solid or hazardous waste generated by its performance of the Work. The Contractor shall comply with all applicable state and federal regulations in handling, storing, transporting and disposing of solid or hazardous waste.
- b. The Contractor acknowledges its recognition and understanding that "clean fill" is defined by 329 IAC 10-3-1 to consist only of uncontaminated rocks, brick, concrete,

road demolition waste materials or dirt, and expressly does not include painted material and treated wood. Contractor shall dispose of any waste that contains painted materials and treated wood as solid waste.

1. Prior to the removal from the site of any solid waste or clean fill, the Contractor shall inform the Owner's Representative of the intended disposal site for the material. The Owner has the right, but not the responsibility, to reject a site as suitable for the disposal of the material, and the Contractor shall bear any cost or expense associated with identifying an appropriate alternative disposal site.
2. The Contractor shall provide the Owner's Representative with a copy of all transport and material acceptance documents related to the disposal of solid waste or clean fill, such as tare weights and bills of lading, upon receipt by the Contractor.
3. Within 10 days of shipment off-site of any hazardous waste, the Contractor shall provide the Owner's Representative with a copy of all hazardous waste manifests. The Contractor shall provide Owner's Representative with a copy of the manifest signed by the TSD (Treatment Storage and Disposal) company within 10 days of receipt by the Contractor.

1.2 Asbestos

- a. Asbestos Handling – Contractor is expected to be familiar with the appearance and likely locations of asbestos and asbestos containing materials ("ACM"), even if demolition and/or asbestos abatement is not a contracted-for part of the Work, which can be obtained through Asbestos Training to all General Contractors for buildings that are pre-1981, see 1.7.
 1. Technical specifications prepared by the Owner or the Owner's Representative may identify the nature and extent of asbestos to the extent known at the time of issuance of the specifications. However, site conditions as of the time of the preparation of specifications may prevent complete and accurate identification of the exact nature and extent of asbestos or ACM at the Project site.
 2. Contractor may encounter asbestos or ACM during the course of the work. In the event that Contractor observes material that is suspected to be asbestos or ACM. Contractor shall stop work immediately and notify the Owner's Representative, who shall direct next steps in terms of testing, removal and disposal. If the suspicious material is determined to be asbestos or ACM, Contractor may be directed to undertake the removal and disposal of the material by way of a Construction Change Directive or, at the Owner's discretion, a third party may be hired to undertake this work.
 3. If Asbestos Abatement is part of General Contractor Construction Contract, they are responsible for all abatement per scope with the approved 3rd Party Monitoring Consultant hired by the Owner via the EHS PCON Compliance approved list.
- b. Contractor shall pay Owner for any costs Owner incurs based on Contractor's non-compliance with this Section, including but not limited to repair or remediation costs, fines or penalties imposed on Owner by any regulating authority, and any fees or costs paid to attorneys or consultants arising out of a prohibited storm water discharge or improper disposal of solid or hazardous waste, including but not limited to asbestos or ACM.

01 74 23 Final Cleaning

1.1 Final Clean

- a. Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

- b. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- c. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
- d. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - 1. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - 2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - 3. Rake grounds that are neither planted nor paved to a smooth, even- textured surface.
 - 4. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - 5. Remove snow and ice to provide safe access to building.
 - 6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - 7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, tunnels, chases, crawlspaces, equipment rooms, and similar spaces.
 - 8. Sweep concrete floors broom clean in unoccupied spaces.
 - 9. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - 10. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision- obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - 11. Remove labels that are not permanent.
 - 12. Touch up, otherwise repair, and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration
 - 13. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - 14. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - 15. Replace parts subject to unusual operating conditions.
 - 16. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - 17. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - 18. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - 19. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
 - 20. Leave Project clean and ready for occupancy.

21. Remove temporary protection, including protective covering, protective film, etc.
22. Remove marks, stains, fingerprints, and other soil or dirt from painted, decorated, and natural finished walls, ceilings, soffits, woodwork, and other work.
23. Remove spots, mortar, plaster, soil, and paint from ceramic tile, marble, and other finish materials and wash or wipe clean.
24. Clean fixtures, cabinetwork, and equipment to remove stains, paint, dirt, dust, and leave in undamaged, new condition.
25. Clean stainless steel, aluminum, bronze, brass, chrome, and other metallic finishes in accordance with recommendations of the manufacturer.
26. Clean resilient floors thoroughly with a well-rinsed mop containing only enough moisture to clean off any surface dirt or dust and buff dry by machine to bring the surfaces to sheen.
27. Clean chases, equipment rooms and closets, and equipment access areas to remove construction related materials, dirt and dust.
- e. Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare a report.
- f. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

01 77 00 Closeout Procedures

1.1 Substantial Completion

- a. Before requesting inspection for determining date of Substantial Completion, Contractor shall complete the following:
 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Furnish to the Owner a pdf version, searchable and printable, of the Maintenance and Operating Instructions and parts lists for all operating, general, mechanical, electrical, and control equipment and all other manufactured items installed by the Contractor. The operating instructions shall integrate each piece of equipment in any one system in to a numbered step-by-step sequence of operation. The parts listed shall consist of exploded views or parts listing, with all component parts numbered, for each piece of operating or expandable equipment. These operating instructions and parts lists must be furnished to the Owner prior to the time when the equipment is checked out and turned over to the Owner for operation or before the final payment on the Contract will be processed.
 4. Submit As-Built Field Data Set Scans.
 5. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 6. Obtain and submit releases permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 7. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner.
 8. Label with manufacturer's name and model number where applicable.
 9. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 10. Complete startup testing of systems.

11. Submit testing, adjusting and balancing records.
12. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
13. Advise Owner of changeover in heat and other utilities.
14. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
15. Complete final cleaning requirements.
16. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects, including touchup painting.
- b. Submit a written request for inspection for Substantial Completion. On receipt of request, Design Professional will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner may assign its own staff to accompany Design Professional on the inspection and may require Design Professional and Consultants to provide additional inspections. Design Professional will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, on either Contractor's list or additional items identified by Design Professional, which must be completed or corrected before certificate will be issued.
- c. Re-inspection: Contractor shall request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
- d. Results of completed inspection will form the basis of requirements for Final Completion.

01 77 13 Preliminary Closeout Reviews

- 1.1 List of Incomplete Punch Items
 - a. Preparation: Submit one (1) copy of list in PDF format. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
 1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
 2. Organize items applying to each space by major element, including categories for site work, building exterior, roof, ceiling, individual walls, floors, equipment, and building systems.
 3. Include date for completion of each incomplete item.
 4. Include the following information at the top of each page:
 - i. Project name
 - ii. Date
 - iii. Indiana University Project Number
 - iv. Name of Design Professional
 - v. Name of Contractor
 - vi. Page number
 - b. All Punch List items shall be complete within sixty (60) days from original date of punch list inspection.
 - c. Do not use Attic Stock materials, owed to Owner per Contract Documents, for repair or correction of Punch List items.

01 77 16 Final Closeout Review

- 1.1 Prior to Final Completion and Final Payment
 - a. Before requesting final inspection for determining date of Substantial Completion, Contractor shall complete the following:
 1. Prepare and submit Project Record Documents, Record Drawings, Record

- Specifications, Final Completion construction photographs, damage or settlement surveys, and similar final record information.
2. Orient and instruct the maintenance personnel designated by the Owner in the operation and maintenance of all equipment installed by the Contractor.
 3. Submit the following:
 - i. Final approved Lock-Out/Tag-Out manuals as identified in the Project Specifications.
 - ii. Certified copy of Design Professional's Substantial Completion inspection list of Punch List items endorsed and dated by Design Professional. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - iii. Evidence of final, continuing insurance coverage complying with insurance requirements.
 - iv. Pest-control final inspection report and warranty.
 - v. Demonstration and training DVDs.
 - vi. Evidence of completion of Contractor documentation submittals for LEED credits that involve Contractor input.
 4. Submit a written request for final inspection for acceptance. On receipt of request, Design Professional will either proceed with inspection or notify Contractor of unfulfilled requirements. Design Professional will conduct the inspection to verify that construction is in compliance with Contract Documents and authorities having jurisdiction. Owner may assign its own staff to accompany Design Professional on the inspection and may require Design Professional and Consultants to provide additional inspections. Design Professional will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 5. Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

01 78 00 Closeout Submittals

INDIANA UNIVERSITY DELIVERABLES REQUIREMENTS
FOR CONSTRUCTION DOCUMENTS AND AS-BUILT & RECORD DOCUMENTS
(Updated April 2020; COBie requirements updated January 2025; BIM requirements
updated July 1, 2025)

- 1.1 Cross-Reference to General Conditions, Section 3.11.4
- 1.2 Document Deliverables Matrix
 - a. The following matrix outlines the document deliverables required for three different project categories; indicating the associated responsible parties. All deliverables identified in this article are to be provided as indicated.

Responsible Parties A/E = Architect/Engineer C = Contractor

Category 1: Projects with an estimated project cost at or over \$5 million:				
Construction Documents Deliverables	Resp. Party	Qty	Format	Due Date
IU BIM Proficiency Matrix	A/E, C	1 set	.xlsx	Prior to selection as required
IU BIM Execution Plan	A/E, C	1 set	.docx	30 days after contract awarded

Design BIM Model(s)	A/E	1 set	.rvt	30 days after contract awarded
Construction Document CAD Drawings	A/E	1 set	.dwg & .pdf	30 days after contract awarded
Addenda	A/E	1 set	.docx & .pdf	30 days after contract awarded
COBie Data (COBie setup)	A/E	1 set	.xlsx	30 days after contract awarded
Record Document CAD Drawings and all project Affidavit(s)	A/E	(see note)	(see note)	* 1 set each .pdf & .dwg as well as 1 set hard copy (paper) prior to Final Payment
As-Built Field Mark-ups - Files and/or Scans	C	1 set	.pdf	At Substantial Completion
Operations & Maint. Manuals (O&M), with LOTO	C	1 set	.pdf & hard	At Substantial Completion
COBie Construction Data	A/E, C	1 set	.xlsx	Prior to Final Payment
Record BIM Model(s)	A/E	1 set	.rvt	Prior to Final Payment
Finish Binder	A/E	1 set	Hard	Prior to Final Payment

Category 2: Projects with an estimated project cost above \$150,000 to under \$5 million:

Construction Documents Deliverables	Resp. Party	Qty	Format	Due Date
Construction Document CAD Drawings	A/E	1 set	.dwg & .pdf	30 days after contract awarded
Addenda	A/E	1 set	.docx & .pdf	30 days after contract awarded
Specifications	A/E	1 set	.docx & .pdf	30 days after contract awarded
COBie Data (COBie setup)	A/E	1 set	.xlsx	30 days after contract awarded
Record Document CAD Drawings and all project Affidavit(s)	A/E	(see note)	(see note)	* 1 set each .pdf & .dwg as well as 1 set hard copy (paper). Prior to Final Payment
As-Built Field Mark-ups - Files and/or Scans	C	1 set	.pdf	At Substantial Completion
Operations & Maint. Manuals (O&M), with LOTO	C	1 set	.pdf & hard	At Substantial Completion
COBie Construction Data	A/E, C	1 set	.xlsx	Prior to Final Payment
Finish Binder	A/E	1 set	Hard	Prior to Final Payment

Category 3: Projects at or under \$150,000:

Construction Documents Deliverables	Resp. Party	Qty	Format	Due Date
Construction Document CAD Drawings	A/E	1 set	.dwg & .pdf	30 days after contract awarded
Addenda	A/E	1 set	.docx & .pdf	30 days after contract awarded
Specifications	A/E	1 set	.docx & .pdf	30 days after contract awarded
Record Document CAD Drawings and all project Affidavit(s)	A/E	(see note)	(see note)	* 1 set each .pdf & .dwg as well as 1 set hard copy (paper). Prior to Final Payment
As-Built Field Mark-ups - Files and/or Scans	C	1 set	.pdf	At Substantial Completion
Operations & Maint. Manuals (O&M), with LOTO	C	1 set	.pdf	At Substantial Completion

COBie Construction Data	A/E, C	1 set	.xlsx	Prior to Final Payment
Finish Binder	A/E	1 set	Hard	Prior to Final Payment

Responsible Parties A/E = Architect/Engineer C = Contractor

Responsible Party shall notify the project Team Lead when files are loaded/provided, yet not be relieved of responsibility when files delivered do not meet Indiana University – Capital Projects' (IU-CP) requirements, or are defective. IU-CP has full discretion with respect to verification of all files and the responsible party shall be notified of acceptance.

Standard Deliverable Time Points: All digital/electronic deliverable files are to be submitted via e-Builder [www.e-builder.net], while project category required hard copies be delivered to appropriate IU-CP offices. Specific requirements for deliverables associated with each of the three above categories may vary; however, the time points establishing the submission of contractual document deliverables for these categories do not. The following time points are based on long-standing practices followed by architects, engineers and contractors.

- Bid Document Deliverable: Consists of the “As Bid” contract or construction drawings, specifications, bidding directions and any addendums. The design professional electronically transmits in .pdf format the full set of the bid documents to IU-CP’s printing contractor who is responsible for paper reproduction and distribution to contractors who have registered to receive the bid documents in order to publically offer a bid proposal for construction of the project. A/E shall assure IU-CP and the project’s e-Builder file is included in plan distribution.
- Contract or Construction Documents Deliverable: Consists of a “For Construction” set of construction drawings and specifications, which incorporate all addendum items and accepted alternates. Any non-accepted alternates should be removed from the set. Revision clouds are not required. This deliverable is to be submitted to IU-CP with files as they were natively created - in Revit .rvt for model/BIM (if applicable) and AutoCAD .dwg format for drawings, Word .docx and Adobe .pdf format for specifications. Within 30 days following the award of bid for contract for construction, the design consultant must provide IU-CP with one set of files in digital/electronic format as follows:
 1. CAD Files: one file each (representing every sheet in the construction document set) and with Addenda and alternates incorporated as listed above. Native CAD files shall be in .dwg format, one file for each sheet in the complete set with all reference files fully bound. These documents must comply with IU-CP CAD Standards. Use of an AutoCAD export method is recommended to bind each file. Do not create a zip file that includes reference files. Files shall be named with a numerical pre-fix followed by the sheet number and brief sheet name to assure uploaded files are arranged in the same order as the sheet index of the construction set.
 2. PDF Files (representing every sheet in the construction document set) and with Addenda and alternates incorporated as listed above. These documents must be stamped and signed by the design professional. Combine all sheets into one PDF file (per volume) and arranged in order per the sheet index of the construction set.
 3. Revit File: a full design model (for each discipline and central file as applicable). Native files shall be in .rvt format. Refer to IU-CP BIM Guidelines and standards for Architects, Engineers and Contractors.
 4. Specifications Files with Addenda and alternates incorporated shall be in native Word .docx (one file for each spec section) and Adobe .pdf formats as a combined file of all sections, in order (other than those provided by IU-CP Business Office for Divisions 0 & 1).
 5. COBie Documentation: When the scope of work designates installation of operating building equipment requiring on-going regular maintenance, a COBie Design submittal is also

required to be submitted in standard COBie xlsx workbook format, with worksheet info completed for each of the following tabs:

- (Tab2) Company
- (Tab3) Level (when applicable based on project scope)
- (Tab4) Space
- (Tab5) Component
- (Tab6) System

See link for required template file: <https://app.e-builder.net/public/publicLanding.aspx?QS=3c82e39216f54b958a16dcb6a393602d>

- As-built and Record Documents Deliverable:

1. As-built (or Field Data Set): Changes are recorded by the contractor, resulting in an “as-built” set (paper or electronic) documents, which are maintained by the contractor through the project’s construction and then submitted at the time of substantial completion by the contractor to the A/E designer (A/E designer will use these to create the Record Drawings) and to IU-CP via e-Builder. Final payments will not be processed until this deliverable is received and approved.
 - PDF Files (a color .pdf of each sheet in the construction document set), indicating any/all field changes – red for added elements and green for deletions. Each sheet shall indicate “As-built”; and if there are no changes, indicate “No Changes” on the sheet. Combine all sheets into one PDF file (per volume) and arranged in order per the sheet index of the construction set.
2. Record Drawings: Consists of an updated construction drawing set (or drawing files) which incorporate all contractor as-builts, addenda, accepted alternates, ASI, CCD, etc. Any non-accepted alternates should be removed from the set. Revision clouds and notation are not required, as a clean set showing only what was constructed is desired. This deliverable is to be submitted to IU-CP as a set of files, each one as they were natively created - in Revit .rvt (if applicable) and AutoCAD .dwg format for drawings, Word .docx and Adobe .pdf format for specifications. Final payments to Architect and/or Engineer will not be processed until this deliverable is received and approved. Provide IU-CP with one set of files in digital/electronic format as follows:
 - CAD Files; one file each (representing every sheet in the construction document set). Native CAD files shall be in .dwg format, one file for each sheet in the complete set with all reference files fully bound. These documents must comply with IU-CP CAD Standards. Use of an AutoCAD export method is recommended to bind each file. Each sheet shall indicate “Record Drawing”. Do not create a zip file that includes reference files. Files shall be named with a numerical pre-fix followed by the sheet number and brief sheet name to assure uploaded files are arranged in the same order as the sheet index of the construction set.
 - PDF Files (representing every sheet in the construction document set). Each sheet (.pdf file) shall indicate “Record Drawing”. Combine all sheets into one PDF file (per volume) and placed in order per the construction set.
 - Revit File; a full design model (for each discipline and central file as applicable). Native files shall be in .rvt format. Refer to IU-CP BIM Guidelines and standards for Architects, Engineers and Contractors.
3. O&M (Operations & Maintenance) Manuals: The contractor shall submit to IU-CP, up to five pdf files of the O&M manuals, along with the Construction Operations Building Information Exchange (COBie) file, and all necessary LOTO documentation. Final payments will not be processed until this deliverable is received and approved.
4. COBie Documentation: When the scope of work designates installation of operating building

equipment requiring on-going regular maintenance, a COBie Design submittal is also required to be submitted in standard COBie xlsx workbook format, with worksheet info completed for each of the following tabs:

- (Tab2) Company
- (Tab3) Level (when applicable based on project scope)
- (Tab4) Space
- (Tab5) Component
- (Tab6) System

** Refer to the Document Deliverables Matrix above for additional deliverables (hard copies, finish binder, etc.) and their format(s).

Specific requirements for Contractor's field record of changes to contract drawings:

The Contractor shall keep at the construction site a complete set of paper or electronic prints of the contract drawings, reproduced at Contractor expense. During construction, these prints shall be marked to show all deviations in actual construction from the contract drawings. The color red shall be used to indicate all additions and green to indicate all deletions. The drawings shall show the following information, but not be limited thereto:

- a. The locations and description of any utility lines and other installations of any kind or description known to exist within the construction area. The location includes dimensions and elevations of permanent features.
- b. The locations and dimension of any changes within the building or structure, and the accurate location and dimension of all underground utilities and facilities.
- c. Correct grade or alignment of roads, structures, and utilities if any changes were made from contract plans.
- d. Correct elevations if changes were made in site grading from the contract plans.
- e. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor including, but not limited to, fabrication erection, installation, and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.
- f. The topography and grades of all drainage installed or affected as part of the project construction.
- g. All changes or modifications from the original design and from the final inspection.
- h. Where contract drawings or specifications allow options, only the option actually used in the construction shall be shown on the as-built drawings. The option not used shall be indicated as deleted.

These deviations shall be shown in the same general detail utilized in the contract drawings. Markings of the prints shall be pursued continuously during construction to keep them up to date. This information shall be maintained in a current condition at all times until the completion of the work. The resulting field-marked data shall be referred to and marked as "As-Built Field Data" and shall be used for no other purpose. They shall be made available for inspection by IU's representative whenever requested during construction and shall be jointly inspected for accuracy and completeness by IU's representative and a responsible representative of the Contractor prior to submission of each monthly pay estimate. Failure to keep the As-Built Field Data current (including Equipment-in-Place lists in the COBIE spreadsheet) shall be sufficient justification to withhold a retained percentage from the monthly pay estimate.

Submittal Standards

- To obtain current IU Standards:
 - Log into the e-Builder system

- Go to the project zIUResources
- Go to Documents
- Go to Design Resources
- BIM (Building Information Modeling) - refer to requirements in the IU-CP Building Information Modeling (BIM) Guidelines for Architects, Engineers, and Contractors.
- CAD (Computer Aided Design) - refer to the Indiana University and National CAD Standards as outlined.
- COBIE (Construction Operations Building Information Exchange) - for template go to e-Builder as stated above.
- GIS/SITE – for Site, Civil, Landscape and Utilities guidance go to e-Builder as stated above.

File Format Standards

- BIM - Autodesk Revit .rvt - Revit version should closely be coordinated with entire team and Owner and indicated in IU BIM Execution Plan
- CAD - Autodesk AutoCAD .dwg - format should be provided in the version in which it was created.
- PDF - Adobe pdf format should be configured to allow for text searches and printing. Pdfs should also be rotated to drawing/sheet orientation.
- RVT – (see BIM above).

Applicable Definitions

- Affidavit – Signed letter affirmation to the University. A Code Affidavit would be the Architect/Engineer's assurance of project's design meeting current required restrictive codes and laws (such as ADA), and will also list any/all unique deviations allowed by the State to be taken, such as any variance(s). Environmental Affidavit would be the Architect/Engineer's assurance of project's design meeting current required environmental codes and laws, and will also list any and all unique deviations that may have been allowed by the legal jurisdiction. Check with your project's IU-CP assigned Team Leader for required affidavits on project.
- As-Built Documents - As-built documents are the collection of paper drawings or electronic drawings that typically reside in the contractor's onsite trailer or office that contain mark-ups, annotations, and comments about changes that have been made to the contract documents during the construction phase.
- As-Built Model - Design Intent Models that have been updated throughout the construction process. These changes and updates have been communicated from the Contractor to the Design Team through the comments, annotations, and mark-ups from the As-Built Documents. These typically, but not always, are discipline-specific models.
- Building Information Model (BIM) - A digital, 3-D and informational representation of physical and functional characteristics of a facility; a shared knowledge resource for information about a facility forming a reliable basis of decisions during life-cycle, which is defined as existing conception to demolition.
- BIM Execution Plan (BEP) - A plan that is created from IU-CP BIM Execution Plan Template that is to be submitted thirty (30) days after contract award. The BEP helps to define roles and responsibilities within a project team.
- BIM Proficiency Matrix (BPM) - A matrix that was designed to measure the expertise of a firm as it relates to using a BIM process on projects. It will be used by Indiana University as one of the many selection criteria during the selection process.
- C.O.B.i.e. – Construction Operations Building Information Exchange – COBie spreadsheet provided by the contractor represents the installed equipment data in the spreadsheet that will link into designer provided space, and installation information.

- LOTO – Lockout/Tagout – All appropriate and required documentation relative to installed and/or provided equipment, inclusive of servicing and maintenance of machines and equipment whereby the unexpected energization or startup of the machines or equipment, or release of stored energy, could harm employees. See OSHA 1910.147 - The control of hazardous energy (lockout/tagout): <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.147> .
- Operations and Maintenance Manuals (O&M's) – Includes all manufacturers' warrantee information, product data and maintenance requirements and recommendations as would be required to properly and safely maintain installed building elements and equipment and maintain the warrantee status of same. Also shall include all temperature control drawings, fire protection system documents, security system documents, and Interior Finishes binders (in format as required by UAO Interiors Dept.)
- Record Drawing - The production of Record Drawings is the capturing of the As-Built Documents' annotations, comments, and mark-ups in a drawing format only. This requirement is separate of any updating of any models.

Related Documents: See VPCPF website: <https://cpf.iu.edu/capital-projects/consultants-contractors/standards.html> and e-Builder project zIUResources.

Building Design Standards
 CADD Standards
 GIS Drawing Procedure
 Engineering Deliverables
 Interiors Standards Site and Landscape Standards
 Space Planning Guidelines

01 78 36 Warranties

- 1.1 Submit written warranties in pdf form on request of Design Professional for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- 1.2 Provide warranty documents in pdf form in an orderly sequence based on the table of contents of the Project Manual.
 - a. Table of Contents: Include the following information:
 1. Product or work item, including scope.
 2. Name, responsible principal, address, and telephone number of Contractor.
 3. Beginning date of warranty or bond.
 4. Proper procedure in case of failure.
 5. Events that may affect validity of warranty.
 6. Cross-referenced to Specification Section number in Project Manual.

01 79 00 Demonstration and Training

- 1.1 <https://app.e-builder.net/public/publicLanding.aspx?QS=de2f65e8c5624b7ab4b92ee7e4290d82>

01 80 00 Performance Requirements

01 81 13 Sustainable Design Requirements

- 1.1 U.S. Green Building Council LEED "Gold" certification is required for all new construction and for renovation projects over \$5 million project cost - <https://cpf.iu.edu/capital-projects/leed-projects/index.html>

- 1.2 See <https://sustain.iu.edu/commitment/energy/index.html> for more information.
- 1.3 Schedule LEED progress meetings no less than one per design phase, provide copy of LEED Design Submittal prior to bidding and LEED Construction Submittal prior to project closeout.

01 86 13 Fire Suppression Performance Requirements

- 1.1 Fire Alarm Panel functionality is to remain functional when projects are Phased and Beneficial Occupancy has occurred.
 - a. These typical systems must remain monitored by Operations and Facilities.

01 86 19 HVAC Performance Requirements

- 1.1 Heating and Cooling of project site must be maintained during construction. If building systems are unable to maintain conditioned environment, the General Contractor is responsible for provide temporary heat/cooling.

01 88 13 Special Construction for Accessibility

- 1.1 Follow the construction requirements of the 2010 ADA Standards for Accessible Design http://www.ada.gov/2010ADASTandards_index.htm and the requirements of the current edition of the Indiana Building Code.
- 1.2 Design requirements for vehicle parking for persons with physical disabilities are found in the Indiana Code IC 5-16-9: <http://iga.in.gov/legislative/laws/2020/ic/titles/005#5-16-9>.
- 1.3 The following alternative lifts may be considered:
 - a. Inclined or radius wheelchair lifts: Garaventa
 - b. Vertical platform lifts: American Stair Glide or Porch-Lift by ThyssenKrupp
 - c. Limited Use, Limited Access (LULA) elevators

Appendix A – Procurement and Contracting Requirements

VPCPF Support Resources - Construction Procurement
2901 East Discovery Parkway
Bloomington, IN 47408
812-855-5294
bidtab@iu.edu

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00 43 00 Procurement Form Supplements

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Asbestos Protocol for Contractors Form

E-Verify Affidavit

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00 43 39 Minority Business Enterprise Participation Plan

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Performance and Payment Bond Form

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Revised December 1, 2023

ARTICLE 1 - DEFINITIONS

- 1.1 Bidding Documents include the Notice to Bidders, Instructions to Bidders, the Bid Form, other sample bidding and contract forms and the proposed Contract Documents (as defined in Division 00), including any Addenda issued prior to receipt of bids.
- 1.2 All definitions set forth in Division 00 and 01, the General Conditions of the Contract for Construction, AIA Document A201, ("GENERAL Conditions") or in other Contract Documents are applicable to the Bidding Documents.
- 1.3 Addenda are written or graphic instruments issued by the Owner's Representative prior to the execution of the Contract which modify or interpret the Bidding Documents by addition, deletions, clarifications or corrections. Addenda become part of the Contract Documents when the Construction Contracts are executed.
- 1.4 A Bid is a complete and properly signed proposal to do the Work for the sum stipulated therein supported by data called for by the Bidding Documents.
- 1.5 Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described as the base to which Work may be added or deducted for sums stated in Alternate Bids. The Base Bid may be held for a period not to exceed sixty days before awarding Contracts.
- 1.6 An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from the amount of the Base Bid if the corresponding change in project scope or materials or methods of construction described in the Bidding Documents is accepted. All Alternate Bids may be held for a period not to exceed ninety days before award and incorporation into the contract by proper Change Directive.
- 1.7 A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials or services as described in the Contract Documents.
- 1.8 A Bidder is one who submits a Bid for a prime contract with the Owner for the work described in the proposed Contract Documents.
- 1.9 A Sub-bidder is one who submits a bid to a Bidder for materials or labor for a portion of the Work.
- 1.10 A Day means a calendar day unless otherwise specified.
- 1.11 Contract Documents means these Instructions to Bidders, Division 00 and 01, the General Conditions of the Contract for Construction Between Owner and Contractor, Notice to Bidders, Bid Forms, Notice to Proceed, Drawings, Specifications, Construction Agreement, Addenda issued prior to execution of the Construction Agreement, any other documents listed in the Agreement, approved Schedules (per General Conditions §3.10.4), and Modifications issued after execution of the Construction Agreement. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Construction Change Directive or (3) a written order for a minor change in the Work issued by the Owner's Representative.

ARTICLE 2 – MULTI-PRIME PROJECTS WITH OR WITHOUT CONSTRUCTION MANAGER AS ADVISOR

2.1 Type of Bid

- 2.1.1 If this Project is bid as a multiple prime project with Construction Manager as Advisor,

Separate Contracts will be awarded to multiple Prime Contractors, as indicated below in Section 2.2 Division of the Work, and the requirements set forth in the remainder of this Article apply.

- 2.1.1 The Bid Proposals for each Prime Contract shall be on the basis of a Lump Sum Base Bid, plus furnishing supplementary information and supplementary documents as requested in the Bid Form.

2.2 Division of the Work

- 2.2.1 The Work of this Project has been divided into the following parts, for which Separate Contracts will be awarded:

- ☐ 3.1.1 General Construction Work
- ☐ 3.1.2 Mechanical Construction Work
- ☐ 3.1.3 Electrical Construction Work
- ☐ 3.1.4 Other _____

- 2.2.2 These Instructions to Bidders, Notice to Bidders, Bid Form, Agreement, Notice to Proceed, Division 00 and 01, General Conditions of the Contract of Construction between Owner and Contractor,, Contract for Construction, Drawings and all the Specifications apply to each of the listed Prime Contracts. Also all Addenda issued during bidding apply to each of the listed Prime Contracts.

- 2.2.3 The scope of work for each Prime Contract is indicated on the Drawings and in the Specification Sections.

2.3 Assignment of Coordination and Authority to Approve Pay Applications

- 2.3.1 If the Owner has hired a Construction Manager as Advisor (“CM”) for this Project, the Owner will assign the coordination of the work of all Prime Contractors to the CM and each Prime Contractor shall accept assignment of coordination as a condition of its Contract.
- 2.3.2 Said assignment of coordination of the work of the Prime Contractors to the CM is for the purpose of placing with one entity, namely the CM, the full and complete responsibility for coordinating and expediting all the Work required for the construction of this Project.
- 2.3.3 Each Prime Contractor shall provide the Owner, and not to the CM, with insurance, bonds, and such other documents as may be required under the terms of its contract and Indiana law.
- 2.3.4 The Owner will make monthly progress payments directly to each Prime Contractor under the terms set forth in the General Conditions and Supplementary General Conditions and Addenda thereto, and upon the written approval of the CM and Owner’s Representative of each monthly payment request submitted.
- 2.3.5 If there is no CM for this Project, the Owner will assign the coordination of the work for all other Prime Contractors (including but not limited to the Contractors for Mechanical and Electrical Construction Work) to the General Contractor, and each Prime Contractors shall accept assignment of coordination as a condition of its Contract. The duties assigned to the CM in Sections 2.3.2 through 2.3.4 shall be assigned to the

General Contractor. On a multiple-Prime Project, the General Contractor shall report to the Owner's Representative any circumstances known to it that will assist the Owner's Representative in making a determination as to whether to withhold certification of an Application for Payment submitted by another Prime Contractor.

ARTICLE 3 – SINGLE PRIME PROJECTS

3.1 Type of Bid

- 3.1.1 If this Project is bid as a single prime project, the requirements set forth in the remainder of this Article apply.
- 3.1.2 The Bid Proposal shall be on the basis of a Lump Sum Base Bid, plus furnishing supplementary information and supplementary documents as requested in the Bid Form.

3.2 Division of the Work and Coordination

- 3.2.1 The Contractor shall be responsible for performance of or the provision via subcontracts of all work (general, mechanical, electrical) necessary for the completion of the work in full and complete accordance with the Bidding documents. The Contractor shall ensure that subcontractors at every tier comply with the same requirements to which the Contractor is obligated.
- 3.2.2 The Contractor shall ensure that the requirements set forth in Instructions to Bidders, all Addenda issued prior to receipt of Bids, the Bid Form, Agreement, General Conditions, and all Sections of Division 00 and 01 - General Requirements of the Specifications apply to each subcontract for work on this Project.
- 3.2.3 The scope of work for each Separate Contract is indicated on the Drawings and in the Specification Sections listed below:
- 3.2.4 The Contractor has the full and complete responsibility for coordinating and expediting all the Work, including that of all of its subcontractors, required for the construction of this Project.

ARTICLE 4 - PROCUREMENT OF BIDDING DOCUMENTS

- 4.1 Bidding Documents are on file and may be examined and/or obtained for bidding purposes as stated in the Notice to Bidders.
- 4.2 Bidding Documents used for bidding purposes shall remain the property of the Owner. Bidding Documents should be returned to Eastern Engineering within 21 days after the date set for opening of bids or deposit will be forfeited.

ARTICLE 5 - EXAMINATION OF SITE AND BIDDING DOCUMENTS

- 5.1 The site shall be carefully examined prior to bidding to ascertain the location of the work, existing conditions, and all other matters which may affect the work under this Contract. Each bidder by making his bid represents that he has visited the site and familiarized himself with the local conditions under which the Work is to be performed.
- 5.2 The Bidding Documents shall be carefully examined to ascertain the character, quality and

quantity of the work to be performed, of materials and items to be furnished, of equipment and facilities needed during construction, of utilities and of all other matters which may affect the work under the Contract. Each bidder by making his bid represents that he has read and fully understands the Bidding Documents.

- 5.3 Boring information, water levels, indications of surface and subsurface conditions and similar information given on the drawings or in the specifications are furnished only for the convenience of the Bidders. Logs of available subsurface explorations, borings and drawings of existing site conditions may be examined by arrangement with the Owner. The Owner, Owner's Representative and their Consultants make no representation regarding the character and extent of the soil data or other surface or subsurface data and conditions to be encountered during the work and assume no responsibility and make no guarantee as to the accuracy or completeness of the information.
- 5.4 Each Bidder by careful examination, shall inform itself as to the nature and location of the work, the conformation of the ground, subsoil and ground water conditions, the character, quality and quantity of the materials to be encountered, the character of equipment and the facilities needed preliminary to and during the prosecution of the work, the general and local conditions and all other matters which can in any way affect the work. Each Bidder shall make its own deductions of surface and subsurface conditions which may affect methods or cost of construction of the work and Bidder agrees that, if it is awarded the Contract, it will make no claim for damages or other compensation, should it encounter conditions during the progress of the work different from those as calculated and/or anticipated by it.

ARTICLE 6 - QUALIFICATION OF BIDDERS

- 6.1 Each Bidder shall be thoroughly experienced in the work to be performed and capable of completing the work on schedule.
- 6.2 Each Bidder shall demonstrate that it is authorized to perform public works in the State of Indiana by submitting to the Owner a properly executed Contractor's Bid for Public Work Indiana State Form 96 (Revised 2013).
- 6.3 Each Bidder shall demonstrate that it is financially able to complete the Contract for this Project by submitting its most recent full-year audited, or Independently Reviewed, financial statement and subsequent quarterly financial statements, if requested.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

- 7.1 Each Bidder shall examine the Bidding Documents carefully and, not later than ten (10) days prior to the date of receipt of bids, shall make written request for interpretation or correction of any ambiguity, inconsistency or error therein which it may discover. Verbal questions will not be answered.
- 7.2 Request for interpretation, correction or clarification of the Bidding Documents shall be in writing to the Owner's Representative.
- 7.3 Interpretation of the Bidding Documents will be given by the Owner's Representative in the form of written Addenda no fewer than two (2) days before the bid opening date. Addenda will be distributed to each Bidder and shall become a part of the Bid Documents.
- 7.4 Bidders shall ascertain the status of Addenda two (2) days prior to the Bid opening date. Failure of any Bidder to receive any Addenda shall not relieve the Bidder from the obligations of his

bid, unless Bidder acknowledges in writing, prior to Bidding that he has not received the Addenda, in which case he is not liable therefore.

ARTICLE 8 - SUBSTITUTIONS

- 8.1 Where one or more specific materials, trade names, or articles of certain manufacturers are mentioned, it is done to establish a basis of durability, efficiency, appearance, and simplification of maintenance, and not for the purpose of limiting competition. Other materials or articles may be used if approved in writing by Owner. Approval may be obtained during the bidding period only. After bids are opened substitutions will not be considered. However, the establishment of proof that said "equal" product is equal to the product specified shall be the responsibility of the Contractor if said equality is questioned by the Owner.
- 8.2 Any proposed substitution of equipment or materials for that which is not specified shall first be approved in writing by the Owner not less than seven (7) days prior to the date established for receipt of bids by the Owner.

ARTICLE 9 - PRE-BID CONFERENCE

- 9.1 A pre-bid conference will be held to answer Bidders' questions regarding the Bidding Documents.
- 9.2 An Addendum will be issued confirming any information conveyed at pre-bid conference and no verbal response tendered during pre-bid conference shall have legal standing unless so confirmed by Addendum.

ARTICLE 10 – ASBESTOS

- 10.1 Unless expressly included in Project Specifications, Bidder shall not include in its bid price the cost of removal of the asbestos or asbestos containing materials ("ACM").
- 10.2 Each Bidder is expected to familiarize itself with Division 01 Section 01 74 1 9 regarding the required protocol should asbestos or ACM be encountered on the Project.

ARTICLE 11 - DRUG FREE WORKPLACE: DRUG TESTING PROGRAM

- 11.1 Owner maintains a drug free workplace, as provided in the Drug-free Workplace Act of 1988. By entering into a Contract with Owner, Contractor acknowledges compliance with this Act and will maintain a drug-free workplace.
- 11.2 The laws of the State of Indiana (IC 4-13-18 as amended) contain certain special provisions regarding drug testing of employees of public works Contractors and Subcontractors. Contracts entered into between a Contractor and the Trustees of Indiana University estimated to be in excess of \$150,000.00 will be governed by these provisions. These provisions require, among other things, that a written plan for a program to test the Contractor's employees for drugs, which must be in full compliance with I.C. 4-13-18 **must be submitted with the bid**.
- 11.3 The successful Bidder will be required to comply with all applicable provisions of I.C. 4.13.18 with respect to each Bidder's Subcontractors, as the term "Subcontractor" is defined in the statute. In particular, the successful Contractor must require each of its subcontractors to furnish Contractor with the Subcontractor's I.C. 4-13-18-6 compliant drug plan and requiring each subcontractor to implement the employee drug testing program described in the

subcontractor's plan.

- 11.4 The successful Bidder must submit, along with each application for payment under the Contract, an affidavit, dated and signed by the Contractor, substantially as follows:

This is to certify that in the performance of this Contract, neither the undersigned Contractor, nor (so far as the undersigned has knowledge) any of its Subcontractors, has violated the "Drug Testing Program" provision of the General Conditions of the Contract.

ARTICLE 12 - RECOMMENDED EMPLOYMENT OF APPRENTICES

- 12.1 Owner strongly recommends that Contractor employs apprentices from each building trades craft involved in the Project to the maximum extent feasible. In doing so, the Contractor shall consider whether such apprentices are indentured into a Joint Apprenticeship Training Program or other comparable bona fide apprenticeship training program, registered and certified with the U.S. Department of Labor, Bureau of Apprenticeship and Training and shall use as a guide the Apprenticeship Standards of the Labor-Management Contract for the appropriate jurisdictional area when determining the appropriate ratio of apprentices from each respective craft.

ARTICLE 13 – MINORITY, WOMEN'S AND VETERAN'S BUSINESS ENTERPRISES

- 13.1 MBE/WBE/VBE Participation Plan

Indiana University is committed to diversity and non-discrimination in all aspects of its operations. The Office of the President created the University Business Diversity Department and approved the Business Diversity Initiative to ensure that certified MBEs, WBEs, and VBEs are included in all invitations for quotes and bids, and that all prospective bidders are notified of Indiana University's expectation for diversity, including but not limited to MBE/WBE/VBE participation in procurement contracts for professional services, materials, supplies and equipment, and in contracts for the construction, architectural services, renovation or repair of university facilities and equipment. This expectation extends to all tiers of contractor utilization. Each Prime contractor should actively solicit and include certified minority-, women- and veteran-owned subcontractors in bid submissions.

The Minority, Women's, and Veteran's Business Enterprise Participation Plan (form included in specifications) **must be submitted with the bid.** This Participation Plan will be considered during the proposal evaluation process.

Indiana University's annual MBE, WBE, and VBE participation goals parallel those set by the Indiana Department of Administration for its own business diversity efforts. The State MBE/WBE/VBE participation goals may be found at <https://www.in.gov/idoa/mwbe/minority-and-womens-business-enterprises/participation-goals/>.

- 13.1.1 "Minority Business Enterprise" (MBE) means an individual, partnership, corporation, limited liability company, or joint venture of any kind that is owned and controlled by (1) or more persons who are (a) United States citizens; and (b) members of a racial minority group: African American, American Indians, Hispanics, Asian Americans, or other similar minority group as defined by 13 CFR 124.103
- 13.1.2 "Women-owned Business Enterprise" (WBE) means an individual, partnership, corporation, limited liability company, or joint venture of any kind that is owned and

controlled by (1) or more persons who are (a) United States citizens; and (b) whose gender is female.

- 13.1.3 “Veteran-owned Business Enterprise” (VBE) means an Indiana firm with its principal place of business location in Indiana and is currently certified by the Department of Veterans Affairs as a veteran-owned business.

In order to count toward participation goals, the MBEs, WBEs and/or VBEs must be certified by the State of Indiana, the City of Indianapolis, or the Indiana Minority Supplier Development Council or other entity recognized by the state or federal government that provides certification of the sort.

Owner retains the discretion to hold payment, and/or to reject future bids submitted by the successful Contractor in the event that Contractor misrepresents either MBE/WBE/VBE participation in this Project, or its efforts to obtain MBE/WBE/VBE participation in this project, or fails to report MBE/WBE/VBE spend on this project.

13.2 Mandatory Tier II Reporting Requirement

The successful Contractor shall take all necessary and reasonable steps to ensure that MBE/WBE/VBEs have the maximum opportunity to compete for and perform work on this Contract. MBE/WBE/VBE utilization in the performance of this Contract must be reported monthly using the IU Online Tier II reporting System. Compliance with Owner’s Mandatory Tier II Reporting Requirement is a pre-condition for approval of pay applications. (For more information and training, see <https://supplierdiversity.iu.edu> and click on Online Spend Information in the OTTERS Section.)

ARTICLE 14 BID SECURITY AND FORFEITURE

- 14.1 Bids shall be submitted with Bid Security in the form of a Bid Bond, Certified Bank Draft, or Cashier's Check, in the amount of five (5%) percent of the Bid, made payable to: "The Trustees of Indiana University, Bloomington, Indiana."
- 14.2 The Bid Security of the unsuccessful Bidders will be destroyed, after signing of a Contract or the rejection of bids.
- 14.3 Should the successful Bidder refuse to enter into a Contract for the performance of the Work in accordance with the terms of its Bid, the amount of the Bid Security shall be forfeited to the Owner as liquidated damages, not as a penalty.

ARTICLE 15 - BIDDING PROCEDURES

- 15.1 All Bids must be prepared in the format provided by the Owner and submitted in accordance with these Instructions to Bidders.
- 15.2 The Bid Form must include the following information:
- Major Subcontractors
 - Alternate Proposals
 - Unit Prices
 - Completion Date

- Addenda Acknowledgment

15.3 In order to be complete, the Bid must include the following:

- ☐ Bid Form
- ☐ Contractor's Bid for Public Work – Form 96 (Revised 2013)
- ☐ Bid Bond – 5% of Bid
- ☐ Drug Testing Program, which must be in full compliance with Indiana Code 4-13-8
- ☐ Contractor Asbestos Certification
- ☐ Asbestos Protocol for Contractors
- ☐ Completed MBE/WBE/VBE Participation Plan; Certification of MBE/WBE/VBE status if Bidder is itself an MBE/WBE/VBE

Check boxes have been included above to assist the Bidder to ensure that its bid will not be rejected based on its failure meet these requirements.

- 15.4 One Bid Form and one copy of all other required documents shall be submitted, with all blank spaces appropriately filled in, with prices given in words and numerals, using ink or typewriter, with handwritten ink signature, or electronic signature if submitting electronically. The written prices shall govern where there is a discrepancy. Any modification shall be initialed.
- 15.5 Verbal proposals or modifications of proposals will not be considered for purposes of award of contract.
- 15.6 A Bid is invalid if it has not been received prior to the time and date for receipt of bids indicated in the Notice to Bidders, or prior to any extension thereof issued to the Bidders.
- 15.7 No Bidder shall modify, withdraw or cancel its bid or any part thereof for sixty (60) days after the time designated for the receipt of bids in the Notice to Bidders.
- 15.8 Bids shall be submitted as indicated in the Notice to Bidders, and received before 2:00 P.M. Eastern Time on the bid opening date.

ARTICLE 16 - BID OPENING

- 16.1 Bids will be opened publicly and read aloud.
- 16.2 Bids shall be valid and binding for a period of not less than sixty (60) days after the bid opening date. Alternate bids may be held for a period not to exceed ninety (90) days before award and incorporation into the contract by proper Change Directive.
- 16.3 Bid opening date shall be as indicated in the Notice to Bidders, or as changed by Addendum. Bids shall be received no later than 2:00 P.M. Eastern time.

ARTICLE 17 - REJECTION OF BIDS

- 17.1 The Bidder acknowledges the right of the Owner to reject any or all Bids and to waive any informality or irregularity in any Bid received.
- 17.2 The Bidder acknowledges and agrees that the Owner has the right to reject its bid if the bid is in any way incomplete, irregular, conditional, modified or obscure, or if the Bidder fails to furnish with its Bid any of the items identified in Sections 15.2 and 15.3.

ARTICLE 18 - SUBMISSION OF POST-BID INFORMATION

- 18.1 Upon request by the Owner's Representative and Owner, a selected Bidder(s) shall, within 48 hours thereafter, submit the following:
- 18.1.1 A statement of costs for each major item of work included in its bid.
 - 18.1.2 A designation of the work to be performed by the Bidder with its own forces.
 - 18.1.3 A list of names of the subcontractors (firms doing work at the site) or other persons or organizations (including those who are to furnish materials or equipment) proposed for such portions of the work as may be designated in the bidding documents or, if no portions are so designated, the names of the subcontractors proposed for the principal portions of the work. The Bidder will be required to establish to the satisfaction of the Owner's Representative and the Owner the reliability and responsibility of the proposed Subcontractors to furnish and perform the work described in the Sections of the Specifications pertaining to such proposed Subcontractors' respective trades. The Owner's Representative will notify the Bidder in writing if either the Owner or the Owner's Representative, after due investigation, has reasonable and substantial objection to any person or organization on such list. If the Owner or Owner's Representative has a reasonable and substantial objection to any person or organization on such list, the Bidder shall submit the name of another person or organization, and continue to do so until all names of persons and organizations submitted are acceptable to the Owner and Owner's Representative.

Subcontractors and other persons and organizations proposed by the Bidder and accepted by the Owner and the Owner's Representative must be used on the work for which they were proposed and accepted and shall not be changed except with the written approval of the Owner and the Owner's Representative.

ARTICLE 19 – PERFORMANCE AND PAYMENT BOND, ESCROW AGREEMENT, AND OTHER REQUIRED DOCUMENTS

- 19.1 A Bidder selected as a Prime Contractor shall be required to provide a Performance and Payment Bond in the full amount (100%) of its Total Contract price. The Bond shall be made with a Surety Company with a rating of, "A-," or above in the most recent edition of the "A.M. Best's Key Rating Guide." The Bond shall be written in the form provided by the Owner, "Performance and Payment Bond," and shall be delivered to the Owner within thirteen (13) calendar days of the date of the Notice to Proceed. Said Bond shall remain in full force and effect for a period of at least two (2) years after date of final acceptance of the Project. The bond shall be issued in the name of The Trustees of Indiana University and filed with VPCPF Support Resources – Construction Procurement.
- 19.2 The Bidder shall require the attorney in fact who executes the required Bond on behalf of the surety to affix thereto a certified and current copy of its power of attorney indicating the monetary limit of such power.
- 19.3 If awarded the Contract, the Bidder shall execute, along with the Construction Agreement, a formal Escrow Agreement as contemplated Division 00 Section 00 73 00.
- 19.4 If awarded the Contract, the Bidder shall provide to the Owner its Corporate Authority Signature Certificate and its W9 at the same time it returns the executed Construction

Agreement.

ARTICLE 20 - AWARD OF CONTRACTS AND FORM OF AGREEMENT

- 20.1 The Owner will award the Contract(s) on the basis of the lowest and best bid(s) in accordance with Indiana law, utilizing any stated alternates accepted and shall issue to the successful Bidder(s) a Notice to Proceed.
- 20.2 No awards will be made on the day of opening bids.
- 20.3 The selected Bidder(s), upon notification, shall enter into written contracts by executing a Construction Agreement with the Owner.
- 20.4 The Construction Agreement shall be copy bound in with the Specifications.

ARTICLE 21 – MISCELLANEOUS

- 21.1 If the Owner has hired a Construction Manager for this Project, the successful Bidder will be required to execute the following Addenda with regard to insurance requirements: “The Contractor shall add the Construction Manager as an additional insured on all insurance coverages required for this Project and shall provide Construction Manager with documentation that this coverage has been obtained.”

IU plans to make masks optional starting March 4

By IU Today

February 18, 2022

With COVID-19 cases declining rapidly at IU and throughout the state, the university intends to make masks optional at all campuses beginning March 4. The action will coincide with the anticipated expiration of state and county public health orders on that date.

Classrooms, residence halls, dining spaces, building common areas and IU Athletics venues are all examples of indoor spaces where mask use will be optional.

Masks will continue to be worn in health-care settings and research spaces.

Dr. Aaron Carroll, chief health officer for IU, says personal choice should increasingly drive decisions related to mask wearing and other precautions: “One-way masking — an individual’s decision to continue wearing a mask — is encouraged for anyone more comfortable wearing a mask in public spaces.”

IU will continue to distribute KN95 and N95 masks.

IU Fort Wayne follows protocols established by Purdue University Fort Wayne.

More information on IU’s COVID-19 policies can be found at <https://www.iu.edu/covid/>.

Also see: <https://www.iu.edu/covid/prevention/masks-and-ppe.html>



INDIANA UNIVERSITY
CAPITAL PROJECTS

MANDATORY Electronic Bid Submittal

Only bids submitted electronically through the IU Plan Room website by 2:00 pm on bid day will be valid - www.iuplanroom.com.

Bidders must be registered on the plan room, and signed in to the plan room, in order to submit a bid.

To attend the virtual Bid Opening, click on *Zoom Meeting link for Bid Openings* on the home page of the plan room website. To view bid results after the bid opening, click on *VPCPF Construction Procurement – Bid Tabs & Awards* on the home page of the plan room website.

BID SUBMITTAL PROCEDURE

1. Save your completed IU Bid Form and additional required forms in Adobe PDF format. All bid documents may be scanned into one pdf, or separate pdf documents may be uploaded. Please keep the number of documents to a minimum. Title your bid as follows:

“[your company name] – Bid for «IU Project_Number» - «Project_Title”

2. Go to www.iuplanroom.com and click on the *Sign In/Register* tab. If you are not already registered on IU Plan Room, you must create a User ID and Password and be signed in to submit your bid.
3. Click on the project listing.
4. Click on *Submit Bid* next to the job name on the information tab. Attach bid form and required supplemental bid documents per the project specifications.

EXCEPTION: **Do not upload financial statements to IU Plan Room.** Financial statements may be requested from the apparent low bidder.

5. Click on *Submit Bid* at bottom of screen.
6. You will receive a confirmation screen, stating that, “Your Bid Submission has been saved successfully,” as well as an email confirmation, indicating your submission was received.

For assistance with uploading, please contact Eastern Engineering:

- FishersPlanRoom@easternengineering.com Phone: 317-598-0661, Ext. 313

Indiana University reserves the right to disqualify any submittal received after the time and date indicated above. Indiana University reserves the right to select the firm or firms that best meets the needs of the University based on the submitter’s qualifications and experience.

Submittals that are incomplete, do not follow the format requested below, or otherwise unclear or contrary to the guidelines of this request may be rejected as non-responsive.

00 41 13 Bid Form

Bid Form

Contractor's Bid for Public Work – Form 96

BID FORM

for

BL411 Central Chilled Water Plant – Chiller 3 & 4 Replacement
Indiana University Bloomington
Bloomington, Indiana
IU 20240165

TO: The Trustees of Indiana University
Bloomington, Indiana

****Submit bid online via www.iuplanroom.com****

FROM:

Bidder's Name _____

Address _____

City, State, Zip Code _____

Phone Number _____ FAX Number _____

CONTACTS:

Bid / Contract Information: Name: _____

Phone: _____ E-mail: _____

Proposed Project Manager: Name: _____

Phone: _____ E-mail: _____

Indicate if your firm is a certified minority-, women-, or veteran-owned business ____ Yes ____ No
If “Yes”, please attach a copy of certification

FOR: **Unified Bid** to include General, Mechanical, and Electrical Construction Work

Bidders:

LUMP SUM BASE BID

The undersigned Bidder, with a complete understanding of existing conditions at the Project Site and a complete understanding of the Bidding Documents, including any Addenda acknowledged hereinafter, for BL411 Central Chilled Water Plant – Chiller 3 & 4 Replacement on the Indiana University Bloomington campus, as prepared by Burns & McDonnell Engineering Company Inc., hereby proposes to complete the project, in full and complete accordance with the requirements of the Bidding documents, for the LUMP SUM BASE BID PRICE of:

_____ Dollars \$ _____
(written amount) (numerals)

MAJOR SUBCONTRACTORS

Subcontractors and other persons and organizations proposed by the Bidder and accepted by the Owner and the Owner's Representative must be used on the work for which they were proposed and accepted and shall not be changed except with the written approval of the Owner and the Owner's Representative.

If requested, the supplemental Subcontractors and Products List will be submitted by email to the Owner, bidtab@iu.edu, and Burns & McDonnell Engineering Company Inc., jrlee@burnsmcd.com, within 48 hours of the bid opening. The understanding of the Owner and the design team is that these same Major Subcontractors will be the same subcontractors listed below.

The Contractor proposes to utilize the following primary subcontractors for the work indicated.

List one major subcontractor per trade. Any deviation could result in the Owner removing the bid from consideration.

Indicate which are certified by the State of Indiana as an MBE, WBE, or VBE company by circling the M/W/VBE after the name.

Mechanical: _____ M/W/VBE

Electrical: _____ M/W/VBE

Structural: _____ M/W/VBE

ALTERNATE PROPOSALS

1. Alternate proposals are requested under Alternates of the Bidding Documents. (See Specification Index)
2. The alternate proposal shall indicate the amount to be added to or deducted from the Lump Sum Base Bid if the alternate proposal is accepted by the Owner.
3. The alternate proposal shall include all costs necessary for the complete installation of the materials or items indicated for the alternate proposal, including materials, labor, equipment, operations, administration, overhead, profit, and taxes (as applicable).
4. The alternate proposal shall also include all costs for changes in the work (including work of other Separate Contracts) that will be made necessary by acceptance of the alternate proposal.
5. The Bidder shall submit prices for all the alternates listed below in the manner indicated. Cross out (Add) or (Deduct) as applicable. If there is no change in price to the Lump Sum Base Bid, write in "No Change".

Alternate <u>No. 1</u> :	Cost for replacement and installation of pump PS-4 in Division 23 21 13. Cost includes removal of existing pump PS-4, branch piping and accessories.

(Add) (Deduct) _____ Dollars \$ _____
(written amount) (numerals)

TAX EXEMPTIONS

The undersigned Bidder has informed himself and all his prospective sub-contractors and suppliers of the tax exempt status of the Owner, as set forth in the General Conditions, and therefore, has not included these taxes in his Lump Sum Base Bid price.

SUBSTITUTIONS

The undersigned Bidder has based his bid upon the materials, products, articles, equipment, brands, manufacturers and processes described in the Bidding Documents or upon approved equivalents. Proof of equivalency of substitutions is the responsibility of the Bidder, but the Architect/Engineer shall be the sole judge of equivalency. Proposed equivalent substitutions shall be equal in all respects to the requirements of the Bidding Documents, including but not limited to the design, quality, physical size, performance characteristics, strength, previous history of use, and to the method of installation, attachment, or connection to related or adjoining work. Determination of equivalency of proposed substitutions shall be by the Architect/Engineer, before the bid opening date, as described in paragraph entitled "Substitutions" in the Instructions to Bidders.

COMPLETION DATE

The Undersigned Bidder agrees to coordinate and expedite his work and shall take into consideration any lead time and schedule parameters with all contractors, and that this Work will be completed no later than **March 5th, 2027**.

ASSIGNMENT OF COORDINATION

The undersigned Bidder agrees to the assignment of Mechanical and Electrical work to the successful General Contractor for the responsibility of complete coordination of the work as stated in the Instructions to Bidders.

PERFORMANCE AND PAYMENT BOND

The undersigned Bidder agrees, if awarded the Contract, to deliver to the Owner a satisfactory Performance Bond, in the full amount (100%) of the total Contract price, not later than the date of execution of the contract. The cost of the Bond shall be included in the Lump Sum Base Bid contained in this Proposal.

SUPPLEMENTAL AND REQUIRED DOCUMENTS

Bid Security; State Form 96 (Revised 2013); Written Drug Testing Program, which must be in full compliance with IC 4-13-18; a completed Minority, Women's and Veteran's Business Enterprise Participation Plan; Contractor Asbestos Certification; Asbestos Protocol for Contractors.

ADDENDA

The following Addenda have been received by the undersigned Bidder; and all costs resulting from these Addenda have been included in the preparation of this Bid Form:

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

Addendum No. _____ Dated _____

SIGNATURES**1. When a Bidder is an Individual:**

_____	_____
Witness	Bidder

Date: _____	Address: _____

2. When a Bidder is a Partnership:

Name of Partnership

Date: _____	Address: _____

_____	_____
Partner	Partner

3. When Bidder is a Corporation:

Name of Corporation

Date: _____	Address: _____

By: _____
President

Attest: _____
Secretary

CORPORATE SEAL

END

****Submit bid online via www.iuplanroom.com****



CONTRACTOR'S BID FOR PUBLIC WORK - FORM 96

State Form 52414 (R2 / 2-13) / Form 96 (Revised 2013)
Prescribed by State Board of Accounts

PART I

(To be completed for all bids. Please type or print)

Date (month, day, year): _____

1. Governmental Unit (Owner): _____

2. County : _____

3. Bidder (Firm): _____

Address: _____

City/State/ZIPcode: _____

4. Telephone Number: _____

5. Agent of Bidder (if applicable): _____

Pursuant to notices given, the undersigned offers to furnish labor and/or material necessary to complete the public works project of _____

(Governmental Unit) in accordance with plans and specifications prepared by _____

_____ and dated _____ for the sum of

_____ \$ _____

The undersigned further agrees to furnish a bond or certified check with this bid for an amount specified in the notice of the letting. If alternative bids apply, the undersigned submits a proposal for each in accordance with the notice. Any addendums attached will be specifically referenced at the applicable page.

If additional units of material included in the contract are needed, the cost of units must be the same as that shown in the original contract if accepted by the governmental unit. If the bid is to be awarded on a unit basis, the itemization of the units shall be shown on a separate attachment.

The contractor and his subcontractors, if any, shall not discriminate against or intimidate any employee, or applicant for employment, to be employed in the performance of this contract, with respect to any matter directly or indirectly related to employment because of race, religion, color, sex, national origin or ancestry. Breach of this covenant may be regarded as a material breach of the contract.

CERTIFICATION OF USE OF UNITED STATES STEEL PRODUCTS (If applicable)

I, the undersigned bidder or agent as a contractor on a public works project, understand my statutory obligation to use steel products made in the United States (I.C. 5-16-8-2). I hereby certify that I and all subcontractors employed by me for this project will use U.S. steel products on this project if awarded. I understand that violations hereunder may result in forfeiture of contractual payments.

ACCEPTANCE

The above bid is accepted this _____ day of _____, _____, subject to the following conditions: _____

Contracting Authority Members:

_____	_____
_____	_____
_____	_____

PART II

(For projects of \$150,000 or more – IC 36-1-12-4)

Governmental Unit: _____

Bidder (Firm) _____

Date (month, day, year): _____

These statements to be submitted under oath by each bidder with and as a part of his bid.
Attach additional pages for each section as needed.

SECTION I EXPERIENCE QUESTIONNAIRE

1. What public works projects has your organization completed for the period of one (1) year prior to the date of the current bid?

Contract Amount	Class of Work	Completion Date	Name and Address of Owner

2. What public works projects are now in process of construction by your organization?

Contract Amount	Class of Work	Expected Completion Date	Name and Address of Owner

3. Have you ever failed to complete any work awarded to you? _____ If so, where and why?

4. List references from private firms for which you have performed work.

SECTION II PLAN AND EQUIPMENT QUESTIONNAIRE

1. Explain your plan or layout for performing proposed work. *(Examples could include a narrative of when you could begin work, complete the project, number of workers, etc. and any other information which you believe would enable the governmental unit to consider your bid.)*

2. Please list the names and addresses of all subcontractors *(i.e. persons or firms outside your own firm who have performed part of the work)* that you have used on public works projects during the past five (5) years along with a brief description of the work done by each subcontractor.

3. If you intend to sublet any portion of the work, state the name and address of each subcontractor, equipment to be used by the subcontractor, and whether you will require a bond. However, if you are unable to currently provide a listing, please understand a listing must be provided prior to contract approval. Until the completion of the proposed project, you are under a continuing obligation to immediately notify the governmental unit in the event that you subsequently determine that you will use a subcontractor on the proposed project.

4. What equipment do you have available to use for the proposed project? Any equipment to be used by subcontractors may also be required to be listed by the governmental unit.

5. Have you entered into contracts or received offers for all materials which substantiate the prices used in preparing your proposal? If not, please explain the rationale used which would corroborate the prices listed.

SECTION III CONTRACTOR'S FINANCIAL STATEMENT

Attachment of bidder's financial statement is mandatory. Any bid submitted without said financial statement as required by statute shall thereby be rendered invalid. The financial statement provided hereunder to the governing body awarding the contract must be specific enough in detail so that said governing body can make a proper determination of the bidder's capability for completing the project if awarded.

SECTION IV CONTRACTOR'S NON – COLLUSION AFFIDAVIT

The undersigned bidder or agent, being duly sworn on oath, says that he has not, nor has any other member, representative, or agent of the firm, company, corporation or partnership represented by him, entered into any combination, collusion or agreement with any person relative to the price to be bid by anyone at such letting nor to prevent any person from bidding nor to include anyone to refrain from bidding, and that this bid is made without reference to any other bid and without any agreement, understanding or combination with any other person in reference to such bidding.

He further says that no person or persons, firms, or corporation has, have or will receive directly or indirectly, any rebate, fee, gift, commission or thing of value on account of such sale.

SECTION V OATH AND AFFIRMATION

I HEREBY AFFIRM UNDER THE PENALTIES FOR PERJURY THAT THE FACTS AND INFORMATION CONTAINED IN THE FOREGOING BID FOR PUBLIC WORKS ARE TRUE AND CORRECT.

Dated at _____ this _____ day of _____, _____

(Name of Organization)

By _____

(Title of Person Signing)

ACKNOWLEDGEMENT

STATE OF _____)
COUNTY OF _____) ss

Before me, a Notary Public, personally appeared the above-named _____ and swore that the statements contained in the foregoing document are true and correct.

Subscribed and sworn to before me this _____ day of _____, _____.

Notary Public

My Commission Expires: _____

County of Residence: _____

BID OF

(Contractor)

(Address)

**FOR
PUBLIC WORKS PROJECTS
OF**

Filed _____, _____

Action taken _____

00 43 00 Procurement Form Supplements

Contractor Asbestos Certification Form

Asbestos Protocol for Contractors Form

E-Verify Affidavit

Indiana Worker's Compensation Certificate of Compliance

Escrow Agreement

Old National Wealth Management – awards in excess of \$200,000

CONTRACTOR ASBESTOS CERTIFICATION

TO: INDIANA UNIVERSITY

The Contractor certifies that:

No asbestos containing material was selected as a building material for this project. For all materials used on the project which were marked on the material or on the packaging the following or similar wording "May contain mineral fibers" the contractor will have on file, with copies provided to the owner, either of the following – (1) The manufacturer's certification that the material does not contain asbestos or (2) Laboratory results from an EPA accredited laboratory indicating the material does not contain asbestos in accordance with EPA and OSHA requirements.

IU Project Name and Number: _____

Contractor Firm: _____

Contractor Name: _____

Contractor Signature: _____ Date _____

Asbestos Protocol for Contractors Communication of Hazards

Asbestos-containing materials (ACM) exist in many buildings constructed prior to January 1, 1981. Pursuant to the OSHA Construction Industry Asbestos Standard 29 CFR 1926.1101, "Communication of Hazards," a building owner is required to inform contractors doing demolition or renovation of the presence, location and quantity of ACM found at the work sites in its buildings. The IU Environmental Health and Safety Department (EHS) performs the asbestos inspection of buildings on the IU campuses and, if necessary, will conduct or oversee the safe removal of all known and accessible ACM prior to renovation or demolition work.

EHS generates a post-inspection Asbestos Notice of each work site, which identifies building materials that are visible or otherwise known to be present at the site at the time of inspection as being "Non-ACM" or "ACM."

The inspection, and therefore the information contained in the notice, is limited to what is visible to the inspector at the time of the inspection. This means that during the course of construction work, it is possible to encounter ACM that was not identified on the notice because of the physical limitations on the Asbestos Inspector's ability to see and identify ACM at the time of the inspection. Contractors are expected to have knowledge of the types and likely locations of ACM generally found in building materials and to be able to make visual identification of ACM and must provide documentation that each employee has attended Asbestos Awareness Training within the last calendar year.

Under no circumstances are contractors permitted to disturb ACM. Contractors are required to stop work immediately upon discovering suspected ACM and to make a report to the owner's Project Manager. The Project Manager may direct the contractor to the EHS office if a disturbance has occurred and/or to coordinate additional surveying.

For the Contractor

I understand and agree that the employees and agents of my company and/or the employees and agents of my company's subcontractor(s) are prohibited from disturbing ACM.

I understand and agree that, upon the discovery of ACM or suspected ACM at the worksite, work shall be stopped immediately and a report of the discovery made to the owner's Project Manager. I agree that my employees, agents and/or the employees and agents of my subcontractor(s) will comply with the directions of the Owner's Project Manager with regard to responding to the discovery or disturbance of ACT.

I understand and agree that failure on the part of my employees and agents and/or the employees and agents of my subcontractor(s) to comply with the above requirements may result in fines being imposed against my company or the owner, or both, by the Indiana Department of Environmental Management (IDEM), or by other federal, state, county or municipal authorities. I agree I will reimburse the owner for any costs incurred by the owner based on violations of this protocol by my employees or agents and/or the employees or agents of my subcontractor(s), including but not limited to fines, penalties, attorneys fees and/or court costs.

I have read and understand these requirements:

Contractor Signature

Date

IU Project Number

Printed Name

IU Project Title

This affidavit will be requested of the contractor awarded the project

E-VERIFY AFFIDAVIT

The undersigned, being first duly sworn, states and deposes that:

1. He or she is a representative of the Company identified below, and is authorized to make this affidavit on behalf of the Company.
2. Pursuant to Indiana Code 22-5-1.7-11, a contractor, vendor or other service provider who enters into an agreement to provide work or services to The Trustees of Indiana University, Bloomington, Indiana, is required to enroll in and verify the work eligibility status of all its newly hired employees through the electronic verification of work authorization program of the Illegal Immigration Reform and Immigration Responsibility Act of 1996, as amended (the “E-Verify Program”).
3. Based on the above, the undersigned hereby confirms that:
 - a) The Company has enrolled in, and is participating in, the E-Verify Program; and
 - b) The Company does not knowingly employ any unauthorized aliens.

I swear or affirm, under the penalties for perjury, that the foregoing statements are true.

Company Name

Signature

Printed Name

Title

IU Project Number

IU Project Title

IU Project Title continued

STATE OF _____)
)SS:
COUNTY OF _____)

Before me, a Notary Public in and for said County and State, personally appeared _____, the _____ of _____, who being first duly sworn, acknowledged the execution of this E-Verify Affidavit, and stated that the facts and matters therein set forth are true and correct to the best of his or her knowledge.

Witness my hand and Notarial Seal this ____ day of _____, _____.

Notary Public

Printed Name

My Commission Expires: _____

My County of Residence: _____

CERTIFICATE OF COMPLIANCE
Worker's Compensation and Occupational Diseases
State Form 41321 (R3 /1-13)

This is to certify that, pursuant to 631 IAC 1-1-30, as of this date the named Employer is in compliance with the following sections of the Indiana Worker's Compensation Act and the Occupational Diseases Act, as set out below. IC 22-3-2-5, 22-3-5-1, 22-3-5-2, 22-3-7-34.

☐ Self-Insured		
☐ <u>INSURANCE COMPANY NAME</u>		
Policy number	Effective Date	Expiration Date

NOTE: Coverage may expire prior to the date indicated if cancelled by Employer or the insurance carrier following notice to the Board pursuant to IC 22-3-5-5.

This document may be reproduced. Additional original certifications may be purchased from the Indiana Worker's Compensation Board. For further information contact the Compliance Division at (317) 232-5922

Employer:

Validation Stamp:

VALID

Certification Date (month, day, year)	Verifier
Executive Administrator:	

(Certificate is not valid unless stamped, signed and initialed.)

This form will be requested from the contractor awarded the project.

Request form online: <https://wcbgateway.wcb.in.gov/WCBToolsAngular/certificateofcompliance>

Email form to bidtab@iu.edu. Reference the IU project number and title in the subject line of the email.

ESCROW AGREEMENT
(Contracts in Excess of \$200,000.00)

THIS ESCROW AGREEMENT is made as of «Commitment_NoticeToProceedDate», between **The Trustees of Indiana University** (“Owner”) and «Company_Name» of «Company_City» (the “Contractor”), and **Old National Wealth Management** (the “Escrow Agent”).

Concurrently herewith, the Owner and the Contractor have entered into a Construction Contract which is in excess of Two Hundred Thousand Dollars (\$200,000.00) dated «Commitment_NoticeToProceedDate», covering «PROJECT_NAME».

1. The Construction Contract requires Owner to retain certain funds in an escrow account for payments to Contractor, and the Owner and Contractor have agreed that such funds shall be placed in an escrow account pursuant to the terms of this Escrow Agreement. This Escrow Agreement shall have no application to situations where payment is withheld by the Owner pursuant to provisions of the Construction Contract or other provisions unrelated to this Escrow Agreement, such as where those provisions are intended to protect the Owner from loss on account of: defective work not remedied; claims filed on reasonable evidence; failure of the Contractor to make payments when due to subcontractors, or for material or labor; reasonable doubt that the contract can be completed for the balance then unpaid; damage to another Contractor; failure or refusal of the Contractor to prosecute the work in strict compliance with applicable progress schedules; any similar provisions; or for any other reason described in contract provisions entered into between the Owner and Contractor and not related to this Escrow Agreement. Additionally, this Escrow Agreement shall not be construed as a waiver of Owner’s rights to said deposited funds as security or payment for damages which might become due Owner from Contractor under the terms of said Construction Contract.
2. The Escrow Agent shall promptly invest all escrowed principal in the trust department master savings account, or such other interest-bearing account as shall be selected by the Escrow Agent in its reasonable discretion.
3. The interest or other income earned on funds in the account shall accrue until termination of the agreement
4. The income from and earnings on and all gains derived from the investment and reinvestment of the funds (escrow income) shall be held in the escrow account(s). The Escrow Agent Fee of \$350.00 is a one-time fee which shall be taken first from any earnings on account deposits.
5. The Escrow Agent shall provide to the Owner monthly statements with the balances and earnings for the account.
6. The Escrow Agent may commingle the escrow funds with other escrow funds or invested construction funds held by it pursuant to other escrow agreements or trust instruments to which Owner or Contractor are parties. To expedite the handling of the investments and reinvestments of the escrow funds, the Escrow Agent may cause all savings accounts, securities, obligations and investments (other than bearer instruments) to be registered in its own name, or in the name of its nominee or nominees, or in such form that title may pass by delivery.

7. The Escrow Agent shall hold all of the escrow funds and shall release the principal and income thereof only upon the execution and delivery to it of an escrow release executed by the Owner and by the Contractor specifying any portion or portions of the principal and income of the escrow funds to be released and the person or persons to whom such portions are to be released. Such release of escrow funds shall be no more than sixty (60) days from date of receipt by the Escrow Agent of the release executed by the Owner and Contractor.
8. Each signatory to this agreement warrants that it has full and complete authority to enter into this Escrow Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

OWNER & ADDRESS

The Trustees of Indiana University
2901 East Discovery Parkway
Bloomington IN 47408
«Company_Zip»

CONTRACTOR & ADDRESS

«Company_Name»
«Company_Address»
«Company_City», «Company_State»,

BY: _____
Donald S. Lukes
Treasurer

BY: _____

ESCROW AGENT

**Old National Wealth Management
P.O. Box 207, Evansville, IN 47702-0207**

BY: _____

Attest: _____

00 43 39

Minority Business Enterprise Participation Plan

Minority, Women's and Veteran's Business Enterprise
Participation Plan

MINORITY, WOMEN'S AND VETERAN'S BUSINESS ENTERPRISE PARTICIPATION PLAN

The Bidder/Firm must submit with its bid/proposal a Minority, Women's and Veteran's Business Enterprise Participation Plan. Minority Business Enterprise (MBE), Women's Business Enterprise (WBE) and Veteran's Business Enterprise (VBE) are defined below. In this Plan, the Bidder/Firm must show that there are certified by the State of Indiana (see below) MBE/WBE/VBE(s) participating in the project. Participation may be as a subcontractor or second tier participation with common suppliers. The Bidder/Firm must indicate the name of the MBE/WBE/VBE(s) with which it will work; the contact name and phone number of the MBE/WBE/VBE(s); the service supplied by the MBE/WBE/VBE(s); and the specific dollar amount from the project that will be directed toward each MBE/WBE/VBE. Please note: If the Trade is an overhead item for your entire business, please calculate the proportion of the business that will actually apply to the project in question.

Documentation of the Bidder's/Firm's good faith effort to meet the participation goal must be submitted at bid time; see Page 3 of this form.

Contractors will find a listing of all MBE/WBE/VBE suppliers certified by the State of Indiana at the following website: www.in.gov/idoa/mwbe/2743.htm

Failure to provide a completed Plan at the time of bid/proposal submission will result in the rejection of the bid/proposal. A completed plan shall include evidence of the good faith efforts of the Bidder/Firm to include Minority, Women's and Veteran's Business Enterprises in the project. Indiana University reserves the right to verify all information included in the Minority, Women's and Veteran's Business Enterprise Participation Plan before making final determination of the Bidder's/Firm's responsiveness and responsibility.

By submission of the bid/proposal, the Bidder/Firm thereby acknowledges and agrees to be bound by the IU Business Diversity Initiative. Questions involving the Minority, Women's and Veteran's Business Enterprise Participation Plan should be directed to the IU Supplier Diversity Department at 317/278-5384.

Definitions:

- a. "Minority-owned Business Enterprise" (MBE) means an individual, partnership, corporation, limited liability company, or joint venture of any kind that is owned and controlled by (1) or more persons who are (a) United States citizens; and (b) members of a racial minority group: African American, American Indians, Hispanics, Asian Americans or other similar minority group as defined by 13 CFR 124.103
- b. "Woman-owned Business Enterprise" (WBE) means an individual, partnership, corporation, limited liability company, or joint venture of any kind that is owned and controlled by (1) or more persons who are (a) United States citizens; and (b) whose gender is female.
- c. "Veteran-owned Business Enterprise" (VBE) means an Indiana firm with its principal place of business located in Indiana and is currently certified by the Department of Veterans Affairs as a veteran-owned business.

MBE/WBE/VBE PARTICIPATION PLAN

PROJECT # _____ BID/PROPOSAL DUE DATE _____
PROJECT NAME _____
BIDDER/FIRM _____
ADDRESS _____
CITY/STATE/ZIP _____
PHONE: () _____
EMAIL: _____
URL: _____

MBE, WBE, VBE Participation Plan

BIDDER/FIRM _____ PROJECT # _____

PROJECT NAME _____

The following certified minority, women and/or veteran -owned firms will be participating in the project according to the following schedule. Indicate whether each firm is an MBE, WBE or VBE by selecting the MBE, WBE or VBE box below.

E-mail each firm's certification document, within 48 hours post-bid, to the Owner @ bidtab@indiana.edu.

1.	Firm:	Trade:	Amount:
	MBE ☐ WBE ☐ VBE ☐	Contact:	
	Phone:	E-mail:	
2.	Firm:	Trade:	Amount:
	MBE ☐ WBE ☐ VBE ☐	Contact:	
	Phone:	E-mail:	
3.	Firm:	Trade:	Amount:
	MBE ☐ WBE ☐ VBE ☐	Contact:	
	Phone:	E-mail:	
4.	Firm:	Trade:	Amount:
	MBE ☐ WBE ☐ VBE ☐	Contact:	
	Phone:	E-mail:	

If additional room is necessary, please attach a separate page.

By my signature, I certify that the above statements are true and accurate, all as of the date below. I also understand that any changes to this plan must be approved by Indiana University and documented by Construction Change Directive.

Agent of Bidder

Date

MBE, WBE, VBE Participation Plan

BIDDER/FIRM _____ PROJECT # _____

PROJECT NAME _____

Describe below your good faith efforts to obtain certified minority, women's and veteran's business enterprise participation for this project. Be sure to attach a copy of all solicitation efforts, e.g., ads that were published or networking events, etc.

As part of the Bidder/Firm's good faith efforts, list below the MBE/WBE/VBE contractors you individually contacted, requesting a quote for this project. Please ensure that reasonable time and information is provided to the potential MBE/WBE/VBE contractors to allow for a response.

Check all that apply:

MBE, WBE, VBE firms contacted (company name and commodity)	Method of contact (i.e. phone or fax number, e-mail or mailing address AND contact name)	MBE	WBE	VBE	Quote Received Not Low	No Response
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐

If extra space is necessary, please attach additional pages.

PAGES 1, 2, AND 3 OF THIS DOCUMENT MUST BE SUBMITTED WITH THE BID

00 52 13 Agreement Form

Indiana University Construction Agreement

CONSTRUCTION AGREEMENT

This contract made Notice To Proceed Date, by and between Contractor and The Trustees of Indiana University, Bloomington, Indiana (“Owner”).

Article I. Scope of Work: The Contractor shall perform all labor, furnish all materials and equipment necessary to complete the contract for all work, all in accordance with the Contract Documents prepared by Architect of Record,

Titled: IU Project # - IU Project Name

which Contract Documents are made a part of this contract, and shall do everything required by this Agreement and Contract Documents.

Article II. The Contract Documents: The Contract Documents are the Notice to Bidders, Instructions to Bidders, Bid Forms, Division 00 and 01, the General Conditions of the Contract for Construction Between Owner and Contractor, Supplementary Conditions, Notice to Proceed, Drawings, Specifications, this Construction Agreement, Addenda issued prior to execution of this Construction Agreement, any other documents listed in this Construction Agreement, approved Schedules (per General Conditions §3.10.4), and Modifications issued after execution of this Construction Agreement. A Modification is (1) a written amendment to the Contract signed by both parties; (2) a Construction Change Directive; or (3) a written order for a minor change in the Work issued by the Owner’s Representative.

The following is an enumeration of the Specifications and Drawings:

Specifications

Owner - Contractor Agreement
Conditions of the Contract (General and Supplementary)
Specifications Sections of Divisions 0 through 33, all as listed on the Table of Contents in the Specification.

Drawings

All as listed on the Title Sheet of the Drawings.

Article III. Contract Price: The Owner shall pay to the Contractor for the performance of this contract, subject to any additions or deductions provided herein, in current funds as follows:

Commitment Item	Award Amount
Total Contract Amount	

Article IV. Time of Completion: Construction Period. No project schedule extensions will be allowed unless approved by Indiana University via a CCD.

Article V. Required Documents: Along with this executed Construction Agreement, the Contractor shall provide the Owner with an Executed Escrow Agreement, if required, its Corporate Authority Signature Certificate, and its W9. The Contractor acknowledges and agrees that the insurance documentation required by the General Conditions, Article 11, was to be submitted to the Owner within fourteen (14) calendar days of the date of the Notice to Proceed.

Article VI. Assignment of Coordination: The coordination of the work of all contractors shall be assigned to the General Contractor on this Project. Said assignment of coordination of the work of all Contractors to the General Contractor is for the purpose of placing with one contractor, namely Company Name, the full and complete responsibility for coordination of and expediting all the work required for the construction of this Project. The Contractor expressly accepts this assignment of coordination as a condition of its Contract.

Article VII. Terms of Payments: The Owner will make monthly progress payments directly to the Contractor under the terms set forth in the General Conditions, and Addenda thereto, and upon the written approval of the Owner's Representative for each monthly payment request submitted. On a multiple-Prime Project, the General Contractor shall report to the Owner's Representative any circumstances known to it that will assist the Owner's Representative in making a determination as to whether to withhold certification of an Application for Payment submitted by another Prime Contractor based on any of the reasons set forth in Section 9.5.1 of the General Conditions.

In witness whereof, the parties hereto have executed this Agreement, the Day and Year first above written:

"Owner"

"Contractor"

The Trustees of Indiana University

Company Name

By:

By:

Donald S. Lukes, Treasurer

Name/Title

SEAL

SEAL

ATTEST:

ATTEST:

Andrea Havill, Secretary

Name/Title

00 61 13

Performance and Payment Bond Form

Performance and Payment Bond Form

Bond #

PERFORMANCE AND PAYMENT BOND

KNOW ALL MEN: That we

(Here insert the name and address or legal title of the Contractor) hereinafter called the Principal, and

hereinafter called the Surety or Sureties, are held and firmly bound unto The Trustees of Indiana University, hereinafter called the Owner, in the sum of:

for payment whereof the Principal and the Surety or Sureties bind themselves, their heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has, by means of a written Agreement, dated: _____ entered into a contract with the Owner for

a copy of which Agreement is by reference made a part hereof:

NOW THEREFORE, the condition of this Obligation is such that, if the Principal shall faithfully perform the Contract on its part and shall fully indemnify and save harmless the Owner from all cost and damage which the Owner may suffer by reason of failure to do so and shall fully reimburse and repay the Owner all outlay and expense which the Owner may incur in making good any such default,

and further that, if the Principal shall pay all persons who have contracts directly with the Principal for labor or materials, and all employees, persons, firms, or corporations who have just claims and demands for labor or materials furnished or used in connection with the prosecution of the work under the contract, failing which such persons shall have a direct right of action against the Principal and Surety under this obligation, subject to the Owner's option and priority, then this obligation shall be null and void, otherwise it shall remain in full force and effect.

The said surety for value received hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the contract, or to the work to be performed thereunder, or the specifications accompanying them, shall in any way affect its obligations on this bond, and it

does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the contract, or to the work or to the specifications.

PROVIDED, however, that no suit, action or proceeding by reason of any default whatever shall be brought on this Bond after two years from the date of final payment.

AND PROVIDED, that any alterations which may be made in the terms of the Contract, or in the work to be done under it, or the giving by the Owner of any extension of time for the performance of the Contract, or any other forbearance on the part of either the Owner or the Principal to the other shall not in any way release the Principal and the Surety or Sureties, or either or any of them, their heirs, executors, administrators, successors or assigns from their liability hereunder, notice to the Surety or Sureties of any such alterations, extension or forbearance being hereby waived.

Signed and Sealed this _____ day of _____ 20 _____

In presence of :

_____)	_____ (SEAL)
_____)As to	_____
_____)	_____
_____)	_____ (SEAL)
_____)As to	_____
_____)	_____
_____)	_____ (SEAL)
_____)As to	_____
_____)	_____ (SEAL)

00 73 00 Supplementary Conditions

Escrow Agreement

Requirements for Contractors on Public Works Projects

ESCROW AGREEMENT

Pursuant to IC 5-16-5.5 and the Contract Documents, Contractor and Owner agree that Owner shall retain a certain percentage from progress payments and place that retainage in an escrow account under the control of a bank, savings and loan institution or the State of Indiana or an instrumentality thereof, selected by mutual agreement of the parties ("Escrow Agent"), for the purpose of accumulating and sharing the benefits which might accrue through normal interest payments. The parties shall execute a formal Escrow Agreement with the Escrow Agent, and the retainage shall be promptly invested with the Escrow Agent until such retainage is ordered released by the Owner or by other legal action, at which time the amount withheld plus accrued interest shall be paid to the Contractor, less service charges as specified in the Escrow Agreement. The Escrow Agreement shall be executed by the Contractor in accordance with Section 3.1.5 of the General Conditions and shall be one of the Contract Documents.

REQUIREMENTS FOR CONTRACTORS ON PUBLIC WORKS PROJECTS

A. E-Verify.

1. Contractor shall enroll in and verify the work eligibility status of all newly hired employees of the Contractor through the E-Verify program as described in IC 22-5-1.7-3. Contractor is not required to verify the work eligibility status of all newly hired employees through the E-Verify program if the E-Verify program no longer exists. Prior to commencing the Work, Contractor shall sign and provide an affidavit, in a form acceptable to Owner, affirming that the Contractor does not knowingly employ any unauthorized aliens. Neither Contractor nor any of its Subcontractors may knowingly (a) employ or contract with an unauthorized alien or (b) retain an employee or contract with a person that the Contractor or Subcontractor subsequently learns is an unauthorized alien. If Contractor uses a Subcontractor to provide work or services for any portion of the Work, Contractor must obtain certification from the Subcontractor that the Subcontractor, at the time of certification (a) does not knowingly employ or contract with any unauthorized aliens, and (b) has enrolled and is participating in the E-Verify program.
2. Prior to commencing any work, Contractor agrees, and represents to Owner, that Contractor and all subcontractors of any tier that furnishes any portion of the Work, either directly or indirectly to Contractor (collectively referred to herein as "Subcontractors"), will submit the E-Verify case verification number for each individual who is required to be verified under IC 22-5-1.7 prior to commencing work in

connectionwith the Project.

- B. Contractor agrees, and represents to Owner, that at least 15% of the ContractPrice (at the time this Agreement is executed) is comprised of any combination of the following:
1. Work performed by Contractor's employees;
 2. Services supplied directly by Contractor's employees; or
 3. Materials supplied directly by Contractor.
- C. Contractor agrees, and represents to Owner, that Contractor and Subcontractors will comply with the following employee related programs and laws during theProject:
1. Contractor and Subcontractors will not pay cash to any employee forany work performed on the Project.
 2. Contractor and Subcontractors are, and will continue to be duringthe Project, in compliance with the following:
 - (a) The Federal Fair Labor Standards Act of 1938, as amended andIC 22-2-2-1 through IC 22-2-2-8;
 - (b) IC 22-3-5-1 and IC 22-3-7-4; and (c)IC 22-4-1 through IC 22-4-39.5.

Appendix B –

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AIA A201-2017 General Conditions of the Contract for Construction as amended by Indiana University

VPCPF Support Resources - Construction Procurement
2901 East Discovery Parkway
Bloomington, IN 47408
812-855-5294
bidtab@iu.edu



AIA® Document A201® – 2017

General Conditions of the Contract for Construction

for the following PROJECT:

(Name and location or address)

THE OWNER:

Indiana University

THE ARCHITECT:

(Name, legal status and address)

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ADDITIONS AND DELETIONS:

The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

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Written Interpretations

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ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) including the attached Exhibits and consist of the Agreement, Conditions of the Contract (these Conditions, as modified, Indiana University Division 00 and 01, Drawings, Specifications, Construction Agreement), and Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Construction Change Directive, or (3) a written order for a minor change in the Work issued by the Owner Representative. The Contract Documents also include but are not limited to the Project Bid Documents (including the Instructions to Bidders, Division 00 and 01, and Contractor's Bid Form and Proposal, Notice to Proceed, Substantial Completion), and any other documents specifically agreed to by Owner and Contractor to be included in the Contract Documents. Performance and Payment Bonds as covered in Indiana University Division 00 and 01 shall be considered a part of the Contract Documents.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Owner Representative or the Owner Representative consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Owner Representative or the Owner Representative consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Owner Representative shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Owner Representative duties. Notwithstanding the above, Owner shall be considered a third-party beneficiary of the contracts or agreements between Contractor and Subcontractor.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project. By bidding to perform the Work, Contractor acknowledges and agrees that the Contract Documents are sufficient to provide for the completion of the Work and include Work, whether or not shown or described, which reasonably may be inferred from drawings and specifications to be required or useful for the completion of the Work in accordance with applicable laws, codes, statutes, and customary standards of the construction industry.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors, such as Furniture, Fixtures, Equipment (FFE), whereby Contractor is obligated to assist for a fully functional and completed project.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, the Drawings, Specifications, Estimates, Schedules, Building Information Model for the Project - studies, surveys, models, sketches, drawings,

specifications, other similar materials electronic data, information and other documents, including those in electronic form, prepared, provided or procured by Architect during the course of furnishing services to Owner on this Project.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker shall be the Architect for the purpose of rendering initial decisions on Claims. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated or intended results. Details of preparation, construction, installation, and finishing encompassed by the Contract Documents shall conform to the best practices of the respective trades. Where specific recognized standards are mentioned in the Specifications, it shall be interpreted that such requirements shall be complied with and met.

(Paragraph deleted)

§ 1.2.2 Contractor shall promptly call to the attention of the Owner and Owner Representative any discrepancy or conflict in figures, Drawings, or Specifications that affect its Work. In the event of conflicts or discrepancies between and among the Contract Documents, the Owner Representative shall determine which takes precedence over the other. Any part of the Work shown on the Drawings but not specifically mentioned in the Specifications, or vice versa, shall be considered as part of the Work, the same as though included in both. In the event of an inconsistency or conflict between Drawings and Specifications, or within either document not clarified by addendum, the better quality or the greater quantity or scope of the Work shall be provided, and the provision of a Contract Document imposing the greater obligation upon the Contractor or affording the greater right or remedy to the Owner shall govern, in accordance with the Owner's interpretation. Likewise, the Work to be undertaken by Contractor shall include all incidental work necessary for the completion of the Project even though it may not be specifically described in the Specifications or Drawings.

§ 1.2.3 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.4 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.5 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.2.6 On the Drawings, given dimensions shall take precedence over scaled measurements, large scale drawings over small scale drawings, and drawings of a later date over drawings of an earlier date. Unless expressly authorized, drawings shall not be scaled for dimensions. If figured dimensions are not given on the Drawings, the Contractor shall timely request the same from the Owners Representative.

§ 1.2.7 When references to laws, codes, regulations or standards of technical associations or organizations are included in the Contract Documents, the most current edition is intended and shall govern unless otherwise specified.

§ 1.2.8 Whenever a product is specified by proprietary designations, model numbers, catalog numbers, manufacturer trade names, or similar references, no substitution may be made unless it is accepted in writing by the Owner Representative.

§ 1.2.9 The layout of mechanical and electrical systems, equipment, fixtures, piping, ductwork, conduit, specialty items, accessories shown on the Drawings are diagrammatic, and all variations in alignment, elevation and details required to

avoid interferences and satisfy all architectural and structural limitations are not necessarily shown. Actual layout of the Work shall be carried out without affecting the architectural or structural integrity and limitations of the Work and shall be performed in such sequence and manner as to avoid conflicts, provide clear access to all control points, including valves, strainers, control devices and specialty items of every nature related to such systems and equipment, obtain maximum headroom, and provide clearances as required for operation and maintenance.

§ 1.2.10 A typical or representative detail on the Drawings shall constitute the standard for workmanship and material throughout corresponding parts of the Work. Where necessary, and where reasonably inferable from the Contract Documents, the Contractor shall adapt such representative detail for application to the Work subject to the prior approval of the Owner Representative.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Instruments of Service shall be and become the property of Owner, whether the Project is completed or not, and Owner shall retain all common law, statutory and other reserved rights, including copyrights. As such, the Instruments of Service may be used by Owner for information and reference and in connection with Owner's use and occupancy of the Project. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

Except as otherwise provided where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement. If Contractor is sending any notice via email with the intent to satisfy any notice requirement under the Contract Documents, then Contractor shall clearly identify in the email the purpose of the notice and the specific notice requirement it is purporting to satisfy.

(Paragraphs deleted)

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form and be consistent with Owner's established policies – <http://policies.iu.edu/policies/categories/information-it/data-management/DM-02.shtml> and as further set forth in Division 00 and 01. The parties will use AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk

and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees. Contractor shall comply with and be consistent with the consistent with Owner's established policies – <http://policies.iu.edu/policies/categories/information-it/data-management/DM-02.shtml> and as further set forth in Division 00 and 01.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is The Trustees of Indiana University as such in the Agreement and is referred to throughout the Contract Documents and is singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Owner Representative does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative. The Owner may at its sole option assign one or more full or part time engineers, CMA (Construction Manager Administrator) or other representatives to observe the performance of the Work. The duties, responsibilities and limitations of authority of any such representatives will be as provided in the Contract Documents or as otherwise stated to Contractor in writing by Owner.

(Paragraph deleted)

§ 2.2 Information and Services Required of the Owner

§ 2.2.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.2.2 To the extent reasonably required for Contractor's performance of the Work, Owner shall furnish surveys in its possession or in the possession of its Architect or other consultant describing the physical characteristics, legal limitations and utility locations for the site of the Project. Such items are for informational purposes only and neither Owner nor Architect shall be liable for inaccuracies or omissions therein, nor shall any inaccuracies or omissions in such items relieve Contractor of its responsibility to perform its Work in accordance with the Contract Documents. Contractor shall in every instance exercise proper precaution relating to the safe performance of the Work. Contractor shall confirm the location of each utility with the appropriate local utility company, shall relocate or dispose of each on-site utility and shall cap each utility as required by the Work or the Specifications. Contractor shall not be entitled to additional compensation resulting from its failure to confirm the location of the site utilities or existing structures prior to the opening of its Request For Price Response, if applicable. Contractor also shall employ and pay a competent registered surveyor to provide all lines, marks, and levels necessary to the Construction of the Work including, but not limited to, a permanent benchmark and baseline.

§ 2.2.3 The Owner shall furnish information or services required of the Owner by the Contract Documents and in the Owner's possession or control with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.2.4 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

(Paragraphs deleted)

§ 2.3 OWNER'S RIGHT TO STOP THE WORK

If the Contractor fails to correct Work which is not in accordance with the requirements of the Contract Documents as required by Section 12, persistently fails to carry out the Work in accordance with the Contract Documents, or fails to clean up as required by Section 3.15 and Division 00 and 01, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause thereof has been eliminated. However, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1. The stoppage of Work pursuant to this Section 2.3 shall not entitle the Contractor to an adjustment of the Contract Sum, the Contract Time or the Contract Schedule.

§ 2.4 Owner's Right to Carry Out the Work

If Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents, fails to remove and replace rejected Work as provided by this Article, or fails in any respect to perform the Work in strict accordance with the Contract Documents, and fails within a ten (10) day period after receipt of written notice from Owner Representative to commence and continue correction of such default or neglect with diligence and promptness, Owner may after such ten (10) day period, and without prejudice to other remedies Owner may have, correct and remedy any such default, neglect or deficiency, and may exclude Contractor from all or part of the site, take possession of all or part of the Work, suspend Contractor's services related thereto, and take possession of Contractor's tools, appliances, construction equipment and machinery at the site and incorporate in the Work all materials and equipment stored at the site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's Representative, their respective representatives and other contractors full and unhindered access to the site to enable Owner to exercise the rights and remedies under this Subparagraph.

§ 2.4.1 All claims costs, losses and damages incurred or sustained by Owner in exercising such rights and remedies will be charged against Contractor and its surety and Owner shall be entitled to a corresponding decrease in the Contract Price. Owner may, with or without a Change Order being issued, deduct from payments then or thereafter due Contractor the costs of correcting such default, neglect or deficiency, including Owner's expenses and compensation for Architect's additional services made necessary by such default, neglect or deficiency. Such direct, indirect and consequential costs will include, but not be limited to fees and charges of engineers, architects, attorneys and other professionals, all court and arbitration costs and all costs of repair and replacement of work or property of Owner or others destroyed or damaged by correction, removal or replacement of Contractor's defective Work. If payments then or thereafter due Contractor are not sufficient to cover such amounts, Contractor shall pay the difference to Owner.

§ 2.4.2 If an order for relief in favor of Contractor is entered under the United States Bankruptcy Code, and Contractor is not performing its obligations hereunder, Owner may cause such Work to be performed by others until such time as Contractor, or its representative or trustee in bankruptcy, either rejects or accepts the agreement and gives Owner adequate assurance of Contractor's ability to perform further Work and Owner shall offset against the Contract Sum for the cost thereof.

§ 2.4.3 Owner's reasonable exercise of its rights under the Contract Documents, including but not limited to: ordering changes in the Work, performance of separate Work consistent with Owner's obligations hereunder, carrying out Contractor's Work by Owner, exercising any of Owner's remedies in suspension of the Work or requirements for correction of non-conforming Work, withholding payment for just cause or otherwise exercising in good faith Owner's rights and remedies under this Agreement shall not be construed as intentional interference with Contractor's performance of the Work or otherwise be deemed actionable or support any claim against the Owner.

§ 2.5 OWNER'S RIGHT TO REJECT DEFECTIVE WORK

The Owner shall have the right, but not the duty, to approve all materials and workmanship incorporated, or to be incorporated, into the Work and may reject as defective any work that is not, in the judgment of the Owner and the Owner's Representative, in strict accordance with the requirements of the Contract Documents. Work so rejected shall be promptly removed and corrected by the Contractor. No Work which the Owner expressed its intention to inspect shall be closed or covered by the Contractor until it has been duly inspected and approved by the Owner. Should the Contractor close or cover uninspected Work then the Contractor shall, at its own cost and expense, uncover all such Work so that it may be inspected. After Owner's inspection is complete, Contractor shall then properly repair or replace all affected Work.

§ 2.6 OWNER'S CONFIDENTIAL INFORMATION

The Owner may designate to Contractor such information or documents that Owner wishes to be kept confidential in connection with the Work or the Project. Such designation shall be in writing. Information designated by the Owner as "Confidential" shall not be disclosed, communicated or transmitted to any person or entity other than Contractor's employees, agents or subcontractors as may be necessary for the performance of the Work. Contractor shall require its subcontractors, vendors, material suppliers and the like to comply with this requirement. Documents designated as "Confidential" (and all copies thereof) shall be immediately returned to the Owner upon request. The requirements of this Section 2.6 shall survive Owner's final acceptance of the Work or earlier termination of the Contract.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. All references in the Contract Documents to 'Contractor' shall include, unless explicitly stated otherwise, third parties under contract with or control of the Contractor or third parties for whom Contractor is otherwise responsible. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in strict accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Owner Representative in the administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.1.4 No later than seven (7) calendar days after the date of the Notice to Proceed, the Contractor shall deliver to the Owner certified as true and accurate and with no material changes as of the date of delivery: (i) Contractor's required payment and performance bond; (ii) all required Certificates of Insurance, including a Certificate of Compliance for worker's compensation insurance or, if applicable, a Worker's Compensation Exemption Certificate Clearance.

§ 3.1.5 Contractor shall expeditiously execute the Construction Agreement with the Owner and shall, along with the executed Construction Agreement, provide the Owner with its executed Escrow Agreement, as contemplated in Contract Documents and with its Corporate Authority Signature Certificate and W9, as contemplated by Division 00 and 01.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents. By executing the Contract, the Contractor further represents to the Owner that:

1. the Contractor has a high level of experience and expertise in the business administration, construction, management, workplace health and safety supervision and superintendence of projects of similar size and complexity and that it will perform the Work with the care, skill and diligence of such a contractor
2. Contractor and, to the best of its knowledge, its Subcontractors are financially solvent, able to pay all debts as they mature and have sufficient working capital to complete the Work and all obligations thereunder
3. Contractor is able to furnish the plant, tools, materials, supplies, equipment and labor required to complete the Work
4. Contractor is authorized to do business in the State of Indiana
5. Contractor's execution of the Contract and its performance thereof are within its authorized powers
6. Contractor has (i) studied the Contract Documents, understands their provisions and confirmed that they are sufficiently detailed and complete to permit the Contractor to perform the Work in accordance with the Contract Documents, within the Contract Time and for the Contract Sum; (ii) inspected the Project site; and (iii) investigated and satisfied itself as to:
 - a. the site and locality where the Work is to be performed and the conditions and difficulties to be encountered, including access thereto
 - b. in accordance with the provisions Section 3.2 and Contract Documents, Division 00 and 01, the type and condition of the soil including the quality and quantity of the subsurface and surface materials or obstacles to be encountered
 - c. the availability of utilities and/or new temporary utilities by Contractor, if necessary, be provided by Contractor (all Lock Out/Tag Out (LOTO) safety fulfilled) and access thereto;
 - d. conditions affecting transportation, disposal, handling and storage of materials, supplies and equipment
 - e. materials, supplies or equipment which are to be furnished by the Owner, if any, for the Contractor's use
 - f. The type and availability of tools, equipment and facilities to perform the Work

- g. the availability and adequacy of labor and trades and, if applicable, union wage scales, benefits, working conditions, craft jurisdictions, area practices and collective bargaining agreements affecting the Work
- h. prevailing weather and climatological conditions;
- i. all laws applicable to the Work and to the Contractor; and
- j. all other factors which may affect the Contractor's performance of the Work.

§ 3.2.1.1 Contractor represents that it has studied all surveys and investigative reports of subsurface and latent physical conditions referred to in the Contract Documents and has made such additional surveys and investigations necessary for the performance of the Work at the Contract Sum and in accordance with the requirements of the Contract Documents, that it has correlated the results of all such data with the requirements of the Contract Documents, and that the Contractor enters into the Contract on the basis of its own examination, investigation and evaluation of all such matters and risks associated with the Work, and not in reliance upon any opinions, statements or representations of the Owner, Owner Representative or any of their respective officers, agents, servants or employees.

§ 3.2.1.2 Contractor has executed the Contract based on its own examination, investigation and evaluation of the matters set forth in Section 3.2.1.1 above and not in reliance on any representation of the Owner, Owner Representative or any of their respective employees or agents which is not expressly set forth in the Contract Documents. No failure by the Contractor to consider or evaluate such matters shall relieve the Contractor from its responsibility to properly estimate the difficulty, cost and expense of performing the Work. Contractor shall not be entitled to, and Owner shall not be liable for, an adjustment to the Contract Sum, Contract Time or Contract Schedule which results directly or indirectly from Contractor's failure to properly examine, investigate or evaluate the matters set forth in Section 3.2.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3, take field measurements of any existing conditions related to that portion of the Work and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Owner's Representative any errors, inconsistencies or omissions discovered by or made known to the Contractor or for which Contractor should have reasonably known as a request for information in such form as the Owner's Representative may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 In the event of error, inconsistency, or omission reasonably discoverable in the Contract Documents, Contractor shall not proceed until written clarification has been issued by Owner's Representative. If Contractor fails to make such request for clarification, no excuse will be entertained for failure to carry out the Work per Contract Documents. Neither the Owner nor Owner's Representative will be bound by oral clarifications.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7. Contractor shall not be liable to Owner or Owner's Representative for damages resulting from errors, inconsistencies or omissions in the Contract Documents unless Contractor recognized or in the proper performance of its duties under Section 3.2 should have recognized such error, inconsistency, omission or difference and knowingly or negligently failed to report it to Owner's Representative.

§ 3.2.5 Where there is a conflict in or between the Contract Documents, including the Drawings and Specifications, in resolving conflicts, errors, discrepancies and disputes concerning the nature, character, scope or extent of Work to be performed or furnished by Contractor, or other rights and obligations of Owner and Contractor, the provision of a Contract Document expressing the greater quantity, quality or scope of the Work, or imposing the greater obligation upon Contractor or affording the greater right or remedy to Owner shall govern, without regard to the party who drafted such provision.

§ 3.2.6 Only changes or interpretations covered by Addenda or written from Owner's Representative will be permitted during construction of the Work. Contractor shall perform no portion of the Work at any time without Contract

Documents or where required, received Shop Drawings, Product Data, or Samples for such portion of the Work.

§ 3.2.7 Before ordering material or performing any Work, Contractor shall verify all measurements at the Project site. Any differences between dimensions on the Drawings and actual measurements shall be brought to the Owner Representative's attention for consideration before the Work proceeds. Where actual measurements require more material and work than the Drawings call for, such material and Work shall be supplied at the cost of Contractor. No extra compensation will be allowed because of differences between actual measurements and dimensions indicated on the Drawings. Contractor shall assume full responsibility for the accuracy of measurements obtained at the work site.

§ 3.2.8 Mechanical and Electrical, Low Voltage and AV Drawings are diagrammatic only. Actual work involved shall be installed from received Shop Drawings with all measurements obtained at the Project site by Contractor.

§ 3.2.9 Dimensions which are lacking from the Drawings shall be obtained from Owner's Representative or field verified. In no case will Contractor assume that the Drawings are scaled.

§ 3.2.10 Contractor may not rely upon and, except as otherwise provided in this Section, shall have no right of claim against Owner or Owner Representative with respect to any graphical or written representation of any exploration, testing, boring or other forms of reports of subsurface or other existing physical conditions or structures at or contiguous to the site which have been utilized and relied upon by Owner Representative or Owner in preparing the Contract Documents.

§ 3.2.11 Notwithstanding the dimensions given on the Drawings and Specifications and other Contract Documents, it shall be the obligation and responsibility of Contractor to take such measurements as will ensure the proper matching and fitting of all items and components of the Work covered by the Contract with other elements of the Work and with contiguous work of others and with the work performed by predecessor trades or contractors. When Contractor proceeds with its Work, Contractor accepts the conditions of the work performed by such predecessor trades and contractors that may impact or affect Contractor's Work, and Contractor assumes the responsibility with respect to those existing conditions of such predecessor activity that they will not adversely impact the performance and acceptability of Contractor's Work under the Contract.

§ 3.2.12 Contractor shall verify measurements, lines and grades of existing work, conditions and structures at the site, and when indicated dimensions are not in agreement with Contractor's field measurements, shall notify Owner and Owner Representative immediately, in writing, requesting clarification. If such existing work, conditions and structures do not fit properly with the Work to be done by Contractor, Contractor shall make at Contractor's expense such alterations to its Work as may be necessary to assure proper fit and connections that meet the approval of Owner Representative. Contractor shall be responsible for the accuracy of all field measurements and shall not rely on any data furnished by or prepared by Owner and Owner Representative. The exactness of grades, elevations, dimensions or locations shown on Drawings issued by the Owner Representative or Work installed by other contractors is not guaranteed by the Owner Representative or the Owner. Consequently, prior to ordering any materials or performing any work, Contractor shall satisfy itself as to the accuracy of all grades, elevations, dimensions, and locations and in all cases of interconnection of its work with existing or other Work, shall verify, at the site, all dimensions relating to such existing or other work. If a minor change in the Work is necessary because of actual field conditions, the Contractor shall submit detailed drawings of such change to the Owner Representative for approval before making the change. Any significant dimensional differences shall be submitted to the Owner Representative before proceeding with the Work. Any errors resulting from Contractor's failure to so verify shall be promptly rectified by Contractor at no additional cost to the Owner. No increase in the Contract Sum or the Contract Time shall be allowed because of differences between actual dimensions and dimensions on the Drawings.

§ 3.2.13 Contractor is responsible for their own layout and for the protection and preservation of all installed engineering data and layout points and shall take all necessary precautions to insure that said data or points are not damaged, destroyed, altered or changed. Re-engineering, if required, shall be performed at Contractor's expense.

§ 3.2.14 The Contractor shall establish and maintain benchmarks and all other grades, lines and levels necessary for the Work, report errors, omissions or inconsistencies to the Owner and Owner Representative before commencing the Work and, if applicable, review the placement of the building(s) and permanent facilities on the site with the Owner and Owner Representative after all lines are staked out and before foundation work is started. If a survey reveals any encroachments by the Contractor or its Subcontractors on adjacent properties caused by construction (except for

encroachments arising from errors or omissions in the Contract Documents, not reasonably discoverable by the Contractor) such encroachment shall be the sole responsibility of Contractor and Contractor shall correct such encroachment within thirty (30) days after discovery or as soon thereafter as is reasonably possible, at Contractor's sole cost and expense, either by removal of the encroachment and subsequent reconstruction on the Project Site, or agreement with the Owner if the adjacent property is owned by The Trustees of Indiana University or by agreement with any third party owner in a form and substance satisfactory to Owner..

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention and an English-speaking superintendent present on-site, full-time, when the Contractor, subcontractor or supplier are on-site. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely written notice to the Owner and Owner Representative, and shall propose alternative means, methods, techniques, sequences, or procedures. The Owner Representative shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Owner Representative objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures. The Contractor shall be responsible for scheduling, coordinating and expediting the work of its Subcontractors and the other Owner entities involved to complete project 100%.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors. Contractor shall remove or cause to be removed from project any person or entity for whom Contractor is responsible, that the Owner or Owners Representative determines to be detrimental to the Project.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.3.4 Neither Contractor nor its employees, Subcontractors, Sub-subcontractors or their agents and employees shall engage in sexual harassment in violation of Title VII of the Civil Rights Act of 1964 or discrimination based on sexual orientation in violation of University policy. In addition, Contractor will ensure that Indiana University students, employees and guests are protected from lewd, offensive or harassing conduct by Contractor's employees, Subcontractors, Sub-subcontractors and their agents and employees.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Owner Representative in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.2.1 The Contractor has based the Contract Price on the exact materials specified in the Contract Documents. The Contract Price is not contingent upon the approval of any substitute or "equal" product, material or method. If the Contractor proposes, in writing, an alternate product, material, equipment or method then:

- .1 The product, material or method called for in the Contract Documents is intended to establish the standard of quality and design; however, an "equal" product, material, equipment or method may be used if approved in writing as "equal" by the Owner's Representative.
- .2 The terms "or approved equal" is deemed to be included after all products, materials, equipment or methods described in the Contract Documents.

- .3 Proposed substitutions shall be supported by appropriate certifications or other materials necessary to support the proposed substitution. All costs associated with the evaluation of a proposed substitution (including but not limited to the cost of Additional Services rendered by the Owner's Representative) shall be borne by the Contractor.
- .4 The Owners Representative shall be the sole judge of equivalency.
- .5 Acceptance of a proposed substitution shall not relieve the Contractor from responsibility for compliance with all the requirements of the Contract Documents. The Contractor shall be completely responsible for the cost of any changes to other parts of its Work or the work of other Contractors caused by such substitution, including the cost of all necessary design or redesign services.
- .6 The Contract Time shall not be extended and the Contract Price shall not be increased as the result of any substitution.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees, subcontractors and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned or safety protocols and requirements associated with all Safety protocols.

§ 3.4.4 Labor shall be performed in a workmanlike manner, by mechanics skilled in their respective trades. Standards of Work required throughout shall be of such grade as will bring results of good workmanship. Mechanics whose Work is unsatisfactory to Owner or Owner's Representative, or are considered by either Owner or Owner Representative to be careless, incompetent, unskilled or otherwise objectionable, shall be dismissed from the Work upon written notice from the Owner Representative or Owner. Neither Owner nor Owner Representative shall be responsible for any increased costs or delays caused by such dismissal.

§ 3.4.5 All labor used throughout the Work and in performance of the Contract shall be acceptable to Owners Representative and of a standing or affiliation that will permit the Work to be carried on harmoniously and without delay, and that will in no case cause any disturbance, interference or delay to the progress of the Work. Contractor agrees to proceed with his Work without interruption, regardless of any trade or craft affiliations or the lack thereof on the part of any workmen on the Project. Contractor agrees that where its Work is stopped or delayed or interfered with by strikes, slowdowns or work interruptions resulting from the acts or failures to act of its employees in concert, or by the breach of any of the terms of this provision, then Owner may treat such stoppage, delay or interference as a breach of the Contract and proceed in accordance with the Contract Documents.

§ 3.4.6 Contractor will use best efforts to cooperate with Owner and any other affected parties to resolve any jurisdictional disputes that may arise during the prosecution of Contractor's Work, and shall abide by the procedures contained in and any decisions rendered under any applicable plan for settlement of jurisdictional disputes. Contractor shall, in all cases, continue to Work while any jurisdictional dispute remains unresolved. Contractor shall Work in harmony with Owner and all other contractors and subcontractors to assure that no labor disputes of any kind involving the Owner, other contractors and subcontractors, or other third parties, or their respective employees or agents shall occur or be manifested on the Project, and Contractor shall only employ persons on the Project who will Work at all times in harmony with other persons and trades employed on the Project. If Contractor has labor agreements with any organized labor unions, Contractor shall work in harmony with any and all contractors or subcontractors who employ personnel that are not represented by an organized union.

§ 3.4.7 Contractor shall not be relieved of its obligations under the Contract by any jurisdictional dispute, work stoppage, slowdown or any other circumstances involving its employees that cause, create or aggravate any interference, delay, suspension or other form of impairment to performance or completion of any work by any contractor, subcontractor or other third party on the Project. If any such work stoppage, slowdown or any other action does occur due to any type of labor dispute or a picket line established for any reason, Contractor shall immediately adopt any and all measures (including, but not limited to, a separate gate) as necessary to eliminate and avoid delay or disruption to Contractor's Work or any other work of others at the Project. If a labor dispute involving Contractor does occur and, in the judgment of Owner, such dispute causes or threatens to cause delay or disruption to the orderly and efficient progress of construction, then such occurrence shall be deemed a default hereunder and just cause for termination of the Contract as provided in Article 14 hereof or other action or remedy permitted by the Contract Documents or applicable laws.

§ 3.4.8 Contractor shall abide by, recognize and respect any split gate, reserve gate or similar system on the Project and agrees that the existence of a split gate, reserve gate or similar system shall not be grounds for any form of picket lines,

strikes or walk-outs. Should any workers or employees of Contractor performing any work for the Project engage in a strike, boycott or other work stoppage or cease to work, due to picketing or a labor dispute of any kind or nature, whether involved with or caused by employees of Owner, any other contractor or subcontractor, supplier, trade, union or entity, the failure or refusal of those workers or employees to perform Contractor's Work shall be considered a default under this Contract, and the remedies for defaults set forth in Article 14 and elsewhere herein shall apply.

§ 3.4.9 Whenever, in the Contract Documents, an article, material, apparatus, equipment, or process is called for by trade name or by the name of a patentee, manufacturer, or dealer or by reference to catalogs of a manufacturer or dealer, it shall be understood as intending to mean and specify the article, material, apparatus, equipment, or process designated, or any approved equal thereto in quality, finish, design, efficiency and durability and equally serviceable for the purposes for which it is intended. Whenever material or equipment is submitted by Contractor for approval as being equal to that specified, the submittal shall include sufficient information and data to demonstrate that the material or equipment conforms to all of the requirements of the Contract Documents. The decision as to whether or not such material or equipment is equal to that specified shall be made by the Owner's Representative in consultation with Architect. Neither the approval of substituted material or equipment nor the furnishing of the material or equipment as specified will relieve the Contractor of responsibility for failure of the material or equipment to perform the functions required by the Contract Documents due to the faulty design, material, or workmanship. Approval by Owner shall be issued in writing.

§ 3.4.10 Not later than fourteen (14) days from the date of Notice to Proceed, Contractor shall provide to Owner and Owner's Representative a list identifying the name of the manufacturer proposed to be used for each of the products identified in the Specifications and the name of the installing Subcontractor.

§ 3.4.11 Materials shall conform to manufacturer's standards in effect at the date of issuance of the Contract Documents if there is no standard set forth otherwise in the Contract Documents and shall be installed in strict accordance with manufacturer's directions.

§ 3.4.12 Where the Contract Documents require the Work, or any part of same, to be above the standards required by applicable laws, ordinances, rules, regulations or any statutory provisions pertaining to the Work, or above the quality of normal construction or trade standards, such Work shall be performed and completed by Contractor in strict accordance with the Contract Documents.

§ 3.4.13 In the event any of the material or equipment specified, supplied and installed under this contract should fail to produce capacities or meet design or performance specifications as published or warranted by the manufacturer of the material or equipment involved, or fail to meet the requirements of the Contract Documents, Contractor shall remove and replace such material or equipment with replacement material or equipment that will meet all such requirements without cost to the Owner.

§ 3.4.14 Except in the case of emergency, no substantial field operations shall be performed outside of regular working hours without the prior notifications of and approval by the Owner's Representative and Owner. Contractor will not be entitled to additional compensation for work performed outside of regular working hours except by the prior written approval of the Owner. Overhead and profit for overtime work shall be limited to the base cost of the premium portion of the overtime.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Owner's Representative that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Owner's Representative, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.5.3 As part of the above warranty, it is expressly understood and agreed that Contractor warrants that Contractor's Work shall be waterproof and weatherproof in every respect.

§ 3.5.4 Any and all warranties which are available on any material or equipment or other service which is part of the Work will be provided to Owner at no additional cost. Upon achieving Substantial Completion of the Work, Contractor shall assign to Owner all warranties obtained or obtainable by Contractor from manufacturers and suppliers of equipment and materials incorporated into the Work by written instrument of assignment in a form acceptable to Owner. Contractor shall furnish Owner with copies of all warranties, guarantees, operating manuals relative to equipment installed, and a complete set of reproducible drawings with all field changes noted on them relating to the improvements constructed under the Contract. The assignment of such manufacturer and supplier warranties shall not relieve Contractor of any of its own warranty obligations under this Section, which shall remain in full force and effect.

§ 3.5.5 Contractor warrants that the performance of the Work shall not limit, void or otherwise compromise or diminish any equipment or manufacturer warranty that is to be issued under the Contract or the Contract Documents, and that the Work under this Contract shall be and remain merchantable and fit for their particular purpose, and in strict conformance with the Contract Documents, including but not limited to requirements established by interpretations and decisions rendered by Owner's Representative in accordance with the Contract Documents. All Work not conforming to these standards shall be considered defective.

§ 3.5.6 For a period of two (2) years from the date of Substantial Completion and acceptance of the Work by Owner, as evidenced by the date of the Owner's Representative Certificate of Substantial Completion. For the same period, the Contractor warrants to Owner to make good, at his own expense, any defects, shrinkage, warpage or other faults in work required under this Contract arising out of defective materials or workmanship, ordinary wear and tear excepted.

§ 3.5.7 In addition to all of Contractor's warranties and obligations to correct defective Work provided by law or as set forth in any of the Contract Documents, Contractor agrees, upon notice from Owner or Owner's Representative, immediately to repair, restore, correct and cure, at Contractor's expense, all defects and omissions in workmanship and materials and all failures to comply with the Contract Documents which appear within two (2) years from the date of Substantial Completion and acceptance of the Work by Owner. Contractor shall pay for, and if requested, correct, repair, restore and cure any damage or injury, whenever the same shall occur or appear, resulting from any defects, omissions or failure in workmanship and materials, and indemnify, hold harmless, and defend Owner against any and all claims, losses, costs, damages and expenses, including attorney fees, suffered by Owner as a result of such damage or injury, whenever such damage or injury shall occur or appear. The period within which Contractor shall be obligated to correct Work shall be extended with respect to portions of Work, including corrective work, first performed after final completion and acceptance of the Project. Contractor's obligations under this Section shall survive completion and acceptance of the Work and Project and termination of the Contract. Contractor shall maintain the insurance coverage required under this contract during the two-year warranty period and corrected work extended period.

§ 3.5.8 Instead of requiring correction or removal and replacement of nonconforming Work, Owner may elect to accept such Work in the condition as provided. Contractor shall bear all direct, indirect and consequential costs attributable to Owner's evaluation of and determination to accept such defective work, to include but not be limited to fees and charges of Owner's Representative, attorneys and other professionals. If any such acceptance occurs prior to Architect's and Owner's Representative's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price to account for such costs and damages. If the acceptance occurs after such recommendation of final payment, such costs and damages shall be paid by Contractor and Surety to Owner. The acceptance of nonconforming Work by Owner shall be by written Change Order, signed by Owner's Representative. No person has authority to accept nonconforming work except pursuant to such written Change Order. The terms of this Subsection are not limited by any other limitation on Owner's right to recover consequential damages.

§ 3.5.9 Notwithstanding anything to the contrary contained herein with respect to warranties, it is understood and agreed that the foregoing warranties and guarantees shall not affect, limit or impair Owner's right against Contractor with regard to latent defects in the Work which do not appear within the applicable warranty period following acceptance of the Work and which could not, by the exercise of reasonable care and due diligence, be ascertained or discovered by Owner within such warranty period. Contractor shall be and remain liable and responsible to correct and cure any such latent defects which are reported to Contractor by Owner in writing within thirty (30) days after such latent defect first appears or could, by the exercise of reasonable care and due diligence, be ascertained or discovered by Owner.

§ 3.5.10 At the time of final completion and acceptance of the Work by Owner, and as a condition of final payment by Owner to Contractor, in addition to any other closeout requirements set forth in the Contract Documents, Contractor shall execute and deliver to Owner the Contractor Warranty.

§ 3.5.11 The warranties provided herein shall be in addition to and not in limitation of any other warranty required by the Contract Documents or otherwise available or prescribed by law.

§ 3.6 Taxes

§ 3.6.1 The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.6.2 Indiana Gross Income Tax. In accordance with Indiana Gross Income Tax, as amended, Owner is a withholding agent for the payment of Indiana Gross Income Tax on contracts with Indiana University and is required to withhold the Indiana Gross Income Tax from a Non-Resident Contractor at the current statutory rate, less an annual exemption of \$1,000. The term "Non-Resident Contractor" does not include a contractor that is a corporation organized under the laws of a state other than Indiana but that is licensed, qualified and registered with the Indiana Secretary of State to do business in Indiana.

§ 3.6.3 Indiana Gross Retail Tax. Materials and equipment purchased for incorporation into the Work are not subject to the Indiana Gross Retail Tax (sales tax). A general exemption certificate must be filed with the vendor by Contractor and Owner will furnish the certificate to Contractor upon request.

§ 3.6.4 Federal Excise Tax. Owner is exempt from payment of Federal Excise Tax and will furnish Contractor an exemption certificate upon request

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded. All connection charges, assessments or inspection fees imposed by any governmental agency or utility company are the Contractor's responsibility and shall be included in the Contract Sum.

§ 3.7.2 The Contractor shall comply with and give written notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 Contractor represents and warrants that it is familiar with all applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities. If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide written notice to the Owner and the Owner Representative before conditions are disturbed and in no event later than 7 days after first observance of the conditions. The Owner Representative will promptly investigate such conditions and, if the Owner Representative determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both, in accordance with Article 7. If the Owner Representative determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Owner Representative shall promptly notify in writing the Owner and Contractor, stating the reasons. If either party disputes the Owner Representative's determination or recommendation, that party may submit a Claim as provided in Article 15.

(Paragraph deleted)

§ 3.7.4.1 In each such case of a concealed or unknown condition as set out in §3.7.4 an increase or decrease in the Contract Price or an extension or shortening of the Contract Time, or any combination thereof, may be allowable, but only to the extent that (1) evidence of such conditions could not with the exercise of reasonable competence and diligence have been discovered or foreseen by Contractor prior to the Effective Date of the Contract, (2) Contractor, by the terms of the Contract and Contract Documents, has not assumed the risk of such conditions and (3) Contractor has explicitly fulfilled all of its requirements provided by §3.7.4 and its subparts. Contractor shall in no event be entitled to an increase in the Contract Price in excess of costs, overhead and profit to perform authorized additional or changed Work to address the conditions, without additional allowances for delays or suspension of Work. If Owner and Contractor are unable to agree as to the amount or length of the adjustment to the Contract Price or Contract Time, a claim may be made therefore as provided in the Contract Documents.

§ 3.7.4.2 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Owner Representative. Upon receipt of such written notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

- .1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;
- .2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum; and
- .3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent English-speaking superintendent and necessary assistants who shall be in attendance full time at the Project site during performance of the Work. The superintendent shall represent the Contractor and have authority to act on behalf of Contractor in every manner and in all respects, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Owner Representative of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Owner Representative may notify the Contractor, stating whether the Owner or the Owner Representative (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Owner Representative to provide written notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Owner Representative has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's written consent, which shall not unreasonably be withheld or delayed. The Owner and Owner Representative shall have the right to require Contractor to remove a superintendent to which Owner has a reasonable objection and replace him or her

with one who is satisfactory to Owner. Contractor's superintendent shall remain on site until completion of the Punch List work.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 Within fourteen (14) calendar days of the date of the Notice to Proceed letter, the Contractor shall submit for the Owner's and Owner's Representative information a Contractor's construction schedule for the Work, refer to Contract Documents and Division 00 and 01 for more information. The schedule shall contain detail appropriate for the Project, including (1) the date of Notice to Proceed, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The Construction Schedule also shall be a detailed schedule or other form satisfactory to the Owner and Owner Representative and shall: (i) provide graphic representation of all activities and events that will occur during the performance of the Work; (ii) identify each phase of construction and occupancy; and (iii) show critical Milestone Dates. Upon approval by the Owner, the schedule shall be the baseline Construction Schedule and shall be deemed a Contract Document. The baseline schedule shall only be modified by an approved Construction Change Directive. The baseline schedule shall be updated monthly showing the status of the Work and Project. If not approved, the Contractor promptly shall revise the Construction Schedule in accordance with the requirements of the Owner and the Owner Representative and resubmit for approval. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be updated at appropriate intervals as required by the conditions of the Work and Project. A submitted Construction Schedule not approved by the Owner that exceeds current time limits shall not relieve the Contractor of its obligation to meet those time limits, shall not make the Owner or Owner's Representative liable for any damages incurred by the Contractor as the result of extended performance or failure to meet time limits set forth in the most recent approved Construction Schedule. Similarly, a Construction Schedule showing completion of the Work prior to the date required by the Contract Documents shall not create any rights to early completion of the Contractor and each Subcontractor and/or Material Supplier shall furnish sufficient labor forces, construction plant and equipment, and shall work such hours, including night shifts and overtime operations, as may be necessary to ensure the execution of the Work in accordance with the approved schedule. The initial schedule and revisions thereof shall not exceed then current time limits under the Contract Documents.

§ 3.10.2 Within fourteen (14) calendar days of the date of the Notice to Proceed, the Contractor shall promptly submit a submittal schedule for the Owner Representative approval, refer to Division 00 and 01 for more information. The Owner Representative approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Owner Representative reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent Owner approved schedules submitted to the Owner and Owner Representative.

§ 3.10.4 The Contractor shall monitor the progress of its Work and the Work of its Subcontractors for conformance with the Construction Schedule and promptly submit to the Owner and the Owner Representative a written progress report of any delays or potential delays. Compliance with the Construction Schedule is a condition precedent to receiving payment pursuant to Article 9. The Construction Schedule shall be updated to reflect actual conditions or as requested by the Owner or the Owner Representative. If any report indicates delays or potential delays, the Contractor shall propose a plan to correct the delay, including overtime and/or additional labor. A progress report shall not constitute an adjustment in the Contract Time, any Milestone Date, or the Contract Sum.

§ 3.10.5 Before Contractor starts the Work at the site, a conference attended by Contractor, Owner, Owner Representative and others as appropriate will be held to discuss the schedules and other preliminary matters, along with procedures for handling Shop Drawings and other submittals and for processing Applications for Payment, and to establish other procedures and understandings bearing upon coordination, performance and completion of the Work.

§ 3.10.6 The Owner, if it deems necessary, may direct Contractor to Work overtime, in addition to any overtime required to meet the approved progress schedule as incorporated in the Contract Documents, and if so directed Contractor shall Work said overtime. Provided that Contractor is not in default under any of the terms or provisions of the Contract or of any of the other Contract Documents, Contractor will be reimbursed for such actual additional wages

paid, if any, at rates which have been approved by Owner Representative and Owner plus taxes imposed by law on such additional wages, plus workmen's compensation insurance and levies on such additional wages if required to be paid by Contractor.

§ 3.10.7 If the progress of the Work or of the Project be delayed by any fault or neglect or act or failure to act of Contractor or any of its officers, agents, servants, or employees, then Contractor shall, in addition to all of the other obligations imposed by the Contract upon Contractor in such cases, and at its own cost and expense, work such overtime as may be necessary to make up for all time lost and to avoid delay in the completion of the Work and of the Project. If, after written notice is given by Owner's Representative, Contractor refuses to work overtime required to make up lost time or to avoid delay in the completion of the Work and of the Project, Owner may hire others to perform the Work and deduct the cost from Contractor's Contract amount.

§ 3.10.8 Should the progress of the Work or of the Project be delayed by any fault, neglect, or failure to act of Contractor so as to cause any additional cost, expense, liability or damage to Owner or Owner Representative or any damages or additional costs or expenses for which Owner or Owner Representative may or shall become liable, Contractor shall and does hereby agree to compensate Owner and Owner Representative for and indemnify them against all such costs, expenses, damages and liability.

§ 3.10.9 The Owner may order a postponement or rescheduling of any date or time for the performance of any part of the Work that interferes with the operations of other Contractors, use of the Owner's premises by the Owner, its tenants or invitees. At the Owner's request, Contractor shall schedule or reschedule any portion of the Work which adversely affects other Contractors.

§ 3.11 Documents and Samples at the Site.

§ 3.11.1 The Contractor shall keep at the construction site a complete set of all Drawings and Specifications, Addenda, Written Amendments, Change Orders, Construction Change Directives, Field Orders and written interpretations and clarifications related to the Project in good order and annotated to show all changes made during construction. Contractor also shall maintain a set in electronic form. These documents, together with all approved samples and a counterpart of all approved Shop Drawings, including the red line As-Built shall be available to Owner and Owner Representative for reference. Upon achieving Substantial Completion of the Work, separate copy sets of these documents, samples, and Shop Drawings shall be delivered to each of Owner and Owner Representative as a condition precedent of achieving Substantial Completion. During construction, these prints shall be marked to show all deviations in actual construction from the Contract Documents. The color red shall be used to indicate all additions, and green to indicate all deletions. The drawings shall show the following information, but not be limited thereto: (a) the locations and description of any utility lines and other installations of an kind or description known to exist within the construction area (the location includes dimensions to permanent features); (b) locations and dimensions of any changes within the building or structure, and the accurate location and the dimension of all underground utilities and facilities; (c) correct grade or alignment of roads, structures, and utilities if any changes were made from Contract Documents; (d) correct elevations if changes were made in site grading from the Contract Documents; (e) changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor including, but not limited to, fabrication, erection, installation, and placing details, pipe sizes, installation material, dimensions of equipment foundations, etc.; (f) the topography and grades of all drainage installed or effected as part of the Project construction; (g) all changes or modifications from the original design and from the final inspection; and (h) where Contract drawings or specifications allow options, only the option actually used in the construction shall be shown on the As-Built drawings: (i) if sheet does not have any changes, those sheets must be marked NO CHANGE at top and included in the as built set. The option not used shall be deleted. These deviations shall be shown in the same general detail utilized in the Contract drawings. Marking of the prints shall be pursued continuously during construction to keep them up-to-date. This information shall be maintained in a current condition at all times until the completion of the Work. The resulting field marked data shall be referred to and marked as "As Built Field Data" and shall be used for no other purpose. They shall be made available for inspection by the Owner Representative whenever requested during construction and, if requested by Owner, shall be jointly inspected for accuracy and completeness by the Owner Representative and responsible representative of the Contractor prior to submission of a monthly pay application. Failure to keep the As Built Field Data (including equipment and place lists) current shall be sufficient justification to deny applicable payment from the monthly pay application.

§ 3.11.2 Contractor shall provide Owner and Owner Representative with the master set of Drawings and Specifications in digital and paper form annotated as per ¶3.11.1 incorporating the revisions and changes made during construction up to acceptance of the Project. These updated documents shall reflect all changes to the original construction documents to indicate the as-built conditions, including revisions in site and building area tabulations. These Drawings and Specifications shall be certified as to their correctness by the signature of Contractor.

§ 3.11.3 Owner and Owner Representative reserve the right to review the as-built documents at any time during the life of the Project. Contractor shall present to Owner and Owner Representative for review updated as-built documents on a monthly basis as a condition precedent for submitting an application for payment.

§ 3.11.4 With regard to as-built, record documents and COBIE construction Data submittals, Contractor shall comply with the requirements set forth in Division 00 and 01.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Owner Representative is subject to the limitations of Section 4.2.7. Informational submittals upon which the Owner Representative is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Owner Representative without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Owner Representative, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Owner Representative or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors. Shop Drawings shall show: (i) the job title, names of Contractor or Subcontractor, the date and the location of each item shown; (ii) the design, dimensions, connections, and other details necessary to ensure that they accurately interpret the Drawings and Specifications; and (iii) adjoining work in sufficient detail to show proper connection with the same. Where adjoining work requires Shop Drawings, they shall be coordinated and submitted at the same time so that connections can be properly received.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Owner Representative that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Owner Representative.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Owner Representative's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified in writing the Owner Representative of such deviation at the time of submittal and (1) the Owner Representative has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change

Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Owner Representative's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Owner Representative on previous submittals. In the absence of such notice, the Owner Representative's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Owner Representative will specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's signed approval of the submittals when submitted to the Owner Representative. The Owner and the Owner's Representative shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Owner Representative have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Owner Representative will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Owner Representative at the time and in the form specified by the Owner Representative.

§ 3.12.11 Contractor shall furnish a copy of approved submittals to each Subcontractor and each separate contractor whose performance may be affected by the Work shown or described therein.

§ 3.12.12 A submittal schedule of Working Drawings and Shop Drawings submissions shall be submitted by Contractor for Owner Representative's approval on a form acceptable to Owner Representative within fourteen (14) days of the effective date of the Notice To Proceed. Contractor's proposed submission schedule shall allow adequate time for review and approval by Owner Representative and to allow the suppliers and manufacturers sufficient time to fabricate, manufacture, inspect, test and deliver their respective equipment and products to the Project site in a timely manner so as to not delay the complete performance of the Work. The proposed submission schedule shall be in conformance with the completion dates specified in the Contract. Contractor shall prepare and submit Working Drawings and Shop Drawings in accordance with the approved submission schedule.

§ 3.12.13 Unless otherwise specified in the Contract Documents, Working Drawings shall be numbered consecutively and shall accurately and distinctly present (1) all working and erection dimensions, (2) arrangements and sectional views, (3) necessary details, including complete information for making connections between Work under this Contract and work under other contracts, (4) electrical wiring connections between all equipment furnished under the Contract, including all internal wiring between internal components of equipment, (5) kinds of materials and finishes, and (6) parts lists and description thereof.

§ 3.12.14 Unless otherwise specified in the Contract Documents, Shop Drawings will present, where applicable, such data as dimensions, weight and performance characteristics. This data shall show conformance with the performance characteristics and other criteria incorporated in the Contract Documents. Each drawing or page shall include (1) submittal date and revision dates, (2) project name, division number and descriptions, (3) Detailed Specifications

Section number and page number, (4) identification of equipment, product or material, (5) name of Contractor and subcontractor, (6) name of supplier and manufacturer, (7) relation to adjacent structure or material, (8) field dimensions, clearly identified, (9) ASTM, Federal and other Specification references, (10) space for Owner Representative's stamp, (11) identification of deviations from the Contract Documents, (12) Contractor's stamp, initialed or signed, dated and certifying to review of the submittal, certification of field measurements and compliance with the Contract Documents, and (13) location at which the equipment or materials are to be installed (both physical location and location relative to other connected or attached material). Owner Representative will return unreviewed any submittal which does not contain complete data on the Work and full information on related matters or otherwise fails to comply with this Section. Stock or standard drawings will not be accepted for review unless full identification and supplementary information is shown thereon in ink or typewritten form.

§ 3.12.15 Contractor shall check and approve all Working Drawings and Shop Drawings before transmitting them to Owner Representative to determine that they comply with requirements of the Contract Documents. Drawings which are incomplete or are not in compliance with the Contract Documents shall not be submitted for processing. Contractor shall place its signature or initials on its stamp of approval on all Working Drawings and Shop Drawings submitted to and Owner Representative to indicate compliance with this requirement. Contractor's approval shall constitute a representation that all quantities, dimensions, field construction criteria, materials, catalog numbers, performance criteria and similar data have been verified and that, in its opinion, the submittal fully meets the requirements of the Contract Documents. Delays incurred by the contractor due to incomplete or non-compliant working drawings or Shop Drawings and are not excusable for purposes of adding additional time to the project Substantial Completion date.

§ 3.12.16 If the Working Drawings or Shop Drawings show departures from the requirements of the Contract Documents, Contractor shall make specific mention thereof in its letter of transmittal, otherwise approval of such submittals by Owner Representative shall not constitute approval of the departure. Approval of the drawings shall constitute approval of the subject matter thereof only and not of any structure, material, equipment or apparatus shown or indicated.

§ 3.12.17 The approval of Working Drawings and Shop Drawings shall be general and shall not relieve Contractor of responsibility for the accuracy of such drawings, nor for the proper fitting and construction of the Work, nor for the furnishing of materials or Work required by the Contract and not indicated on the Drawings. No Work called for by Working Drawings or Shop Drawings shall be done until such drawings have been approved by Owner Representative.

§ 3.12.18 Contractor shall comply with any further show drawing requirements set forth in the Division 00 and 01.

§ 3.13 Use of Site
(Paragraph deleted)

§ 3.13.1 Contractor shall confine construction equipment, the storage of materials and equipment and the operations of workers to the Project site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws and Regulations, rights-of-way, permits and easements. Contractor shall not unreasonably encumber the premises with construction equipment or other materials or equipment, and shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any land or areas contiguous thereto, resulting from Contractor's operations at the site or the performance of the Work. Should any claim be made against Owner or Owner Representative by any such owner or occupant, Contractor shall promptly attempt to settle or otherwise resolve such claim directly with such other party, by agreement or otherwise. Contractor shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold Owner and Owner's Representative harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any such other party against Owner or Owner Representative to the extent based on a claim arising out of Contractor's site operations or performance of the Work.

§ 3.13.2 Contractor, its Subcontractors, and any separate contractor under direct contract with Owner shall be responsible for securing their own Work and their own equipment at the close of each workday.

§ 3.13.3 Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work and shall take all necessary precautions for the safety of, and provide the necessary protection to prevent damage, injury or loss to (i) all employees on the Work and other persons and organizations who

may be affected thereby, (ii) all the Work and all materials or equipment to be incorporated therein, whether in storage on or off the site, and (iii) other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and underground facilities not designated for removal, relocation or replacement in the course of construction. See Article 10.

§ 3.13.4 If Owner or Owner Representative requires Contractor to relocate materials which have been stored on site or within the building, Contractor shall relocate such materials at no additional cost to Owner.

§ 3.13.5 Contractor shall maintain the existing building in a weather tight condition throughout the construction of the Project, and shall repair any and all damage thereto caused by its construction operations. Contractor or the operations of the subcontractors shall take all precautions necessary to protect the existing building and its occupants during the course of the construction and performance of Contractor's Work.

§ 3.13.6 Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

§ 3.13.7 Contractor shall perform Work so as not to interfere with Owner's ongoing activities and so as not to create any hazards to Owner's employees or members of the public using Owner's property. Site specific plan for all vehicular, pedestrian, special events and construction traffic, flow and staging is to be diagrammed and coordinated with Owner Representative for best communication and collaboration necessary so as to no impede the Owner activities or Contractor as is comparable to Article 10 requirements.

§ 3.13.8 Contractor shall be responsible for securing temporary utilities at the Project, including electricity, light, heat and water. Contractor shall be responsible for the cost of all temporary utilities, including the cost of placing utilities in service, their continued operation during the construction of the Project, and their discontinuance thereafter.

§ 3.13.9 Pumping, draining and control of surface and groundwater shall be carried out so as to avoid endangering any adjacent facility or property, or interrupting, restricting or otherwise infringing, or interfering with the use thereof. All such work shall be performed in compliance with state and federal regulations and any other authority applicable to the site with respect to surface and groundwater and shall be at no additional cost to the Owner.

§ 3.13.10 The discharge of any substance other than stormwater into any storm drain, inlet, creek, or ditch, including street gutters and curb inlets, is strictly prohibited, unless the substance is only of the following exempt discharges: water line flushing, landscape irrigation, diverted stream flows, rising groundwater infiltration, uncontaminated pumped groundwater, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian, habitats and wetlands, dechlorinated swimming pool discharges, street wash water, or discharges from firefighting activities. The discharge of sediment-laden runoff waters from construction sites is included as a prohibited discharge. Contractor shall pay Owner for any costs Owner incurs based upon Contractor's noncompliance with this provision, including but not limited to repair or remediation costs, fines or penalties imposed on Owner by any regulating authority, and any fees or costs paid to attorneys or consultants arising out of a prohibited discharge. Failure to comply with this provision may also, at the Owner's sole option, result in Owner's termination of this Contract. In the event that Owner terminates the Contract based on a violation of this provision, Contractor agrees that Owner shall have no further liability to Contractor, with the exception of payment of any monies for Work Contractor performed prior to the date of termination.

§ 3.13.11 Only materials and equipment that are to be used in the Work shall be brought to and stored on the Project Site by the Contractor. Equipment no longer required for the Work shall be promptly removed from the Project Site. Contractor shall be solely responsible for protecting construction materials and equipment stored at the Project Site from weather, theft, damage and all other adversity. The Contractor shall ensure that at all times, the Work is performed in a manner that provides reasonable vehicular and pedestrian access to site of the Work and all adjacent areas. To the fullest extent reasonably possible, the Work shall be performed in such manner that public areas adjacent to the site of the Work shall be free from all debris, building materials, equipment or hazardous conditions.

§ 3.13.12 Neither Contractor nor any entity for which the Contractor is responsible, shall erect any sign on the Project Site without the Owner's prior written consent. Such consent may be withheld in the Owner's sole discretion.

§ 3.13.13 Without limiting any other provision of the Contract Documents, Contractor shall use its best efforts to minimize any interference with the occupancy or beneficial use of (i) any areas in buildings adjacent to the site of the Work and (ii) the Project itself in the event of Partial Occupancy, as permitted in Section 9.9. Without the Owner's prior written approval, Contractor shall not permit any workers to use any existing facilities at the Project Site, including without limitation, lavatories, toilets, entrances and parking areas other than those designated by the Owner for Contractor's use.

- .1** Without limiting any other provision of the Contract Documents, the Contractor shall comply with all rules and regulations promulgated by the Owner and provided by the Owner at the preconstruction meeting regarding Contractor's use and occupancy of the Project Site during performance of the Work. The Contractor shall give the Owner immediate written notice if Contractor finds compliance with any portion of such rules and regulations to be impractical. Such notice shall set forth the problems caused by such compliance and suggest alternatives through which the same results intended by such rules and regulations can be achieved. The Owner, in its sole discretion, may adopt such alternatives, develop new alternatives, or require compliance with the existing rules and regulations.
- .2** The Contractor shall comply with all insurance requirements and collective bargaining agreements applicable to use and occupancy of the Project Site and the Work.

§ 3.13.14 In addition to the requirements identified in this Section, Contractor shall comply with the requirements set forth in Indiana University Division 00 and 01.

§ 3.14 Underground Facilities

§ 3.14.1 Underground Facilities consist of all pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other manmade facilities or structures, and any encasements containing such facilities, which have been installed at or below the surface of the ground for the purpose of furnishing, storing, removing or transmitting electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, computer signals or data, sewage, drainage, traffic or other control systems, or water.

§ 3.14.2 The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to Owner or Owner Representative by the owners of such Underground Facilities or by others. Owner and Owner Representative shall not be responsible for the accuracy or completeness of any such information or data. Contractor shall have the sole responsibility for reviewing and checking all such information and data, for locating all Underground Facilities, shown or indicated in the Contract Documents, for coordination of the Work with the owners of such Underground Facilities during construction, for the safety and protection thereof and for repairing any damage thereto resulting from the Work or Contractor's operations, the cost of all of which having been included in the Contract Price.

§ 3.14.3 If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents and of which Contractor could not reasonably have been expected to be aware, Contractor shall immediately but in no event later than two (2) calendar days after becoming aware thereof and before further disturbing conditions affected thereby (except in an emergency as permitted elsewhere herein), notify the owner of such Underground Facility and give written notice to Owner and Owner Representative. Owner and Owner Representative will promptly review the Underground Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground Facility, and the Contract Documents will be amended or supplemented to the extent necessary.

§ 3.14.4 However, Owner and Owner Representative shall not be liable to Contractor for any claims, costs, losses or damages incurred or sustained by Contractor for any claims, costs, losses or damages caused by or arising from any assessment, penalty or other liability imposed upon Contractor by utility companies or third parties.

§ 3.15 MATERIALS FOUND AT THE PROJECT SITE

§ 3.15.1 All existing equipment and materials as listed in the Drawings and Specifications, removed from existing facilities shall remain the property of Owner. Such equipment and materials shall be stored on-site at locations identified by Owner and Owner Representative. Only existing equipment and materials, listed in the Drawings and Specifications, removed from existing facilities shall be the property of Contractor and shall be removed from the site.

§ 3.15.2 Construction materials such as gravel, stone, or sand found in excavations shall not be used for purposes other than indicated on the Drawings and Specifications without written approval of Owner and Owner Representative. When such approval is given, it shall state explicitly the provisions under which it is granted.

§ 3.15.3 Contractor shall give prior written notice to utility companies, make all arrangements and provide all services necessary to discontinue utilities or place same in service.

§ 3.15.4 In addition to the requirements identified in this Section, Contractor shall comply with the requirements set forth in the Indiana University Division 00 and 01.

§ 3.16 CUTTING AND PATCHING

§ 3.16.1 The Contractor shall be responsible for cutting, fitting or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting and patching shall be restored to the condition existing prior to the cutting, fitting and patching, unless otherwise required by the Contract Documents.

§ 3.16.2 The Contractor shall not damage or endanger a portion of the Work or any fully or partially completed construction of the Owner or Separate Contractors by excavating, cutting, patching or otherwise altering such construction. The Contractor shall not cut or otherwise alter such construction by the Owner or a separate contractor except with written consent of the Owner and such contractor. Such consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold from the Owner or a separate contractor the Contractor's consent to cutting or otherwise altering the Work. All excavating, cutting and/or patching shall be performed in such a manner as to protect other structures, monuments, brick sidewalks, trees and other landscaping.

- .1 Cutting and patching shall be performed by the proper trades or crafts necessary for the material involved, at the cost of the contractor requiring the cutting and patching.
- .2 Patching shall mean the restoration of a surface or item to its original condition to match the existing adjoining surfaces unless otherwise indicated, noted, detailed or specified. When patching involves painting, special coating, vinyl fabric or other applied finishes, the entire surface affected (i.e. wall or ceiling) shall be refinished as a part of this requirement.
- .3 Cutting and patching includes cleaning and restoration of all surfaces soiled by the cutting and patching work.

§ 3.16.3 Contractor shall locate and protect from injury utilities of all kinds, either above or below grade, inside or outside of any structure, found in the area affected by its Work. Contractor shall be responsible for all damage caused to such utility by the operation of equipment or delivery of materials or as the direct or indirect result of any of its Work and shall repair all such damage at its expense and as a part of the Work included in the Contract Documents. The Contractor shall not be entitled to any increase in the Contract Sum or the Contract Time on account of such damage to any utility. Upon discovery of any utility by Contractor, such utility shall be indicated on the As Built Drawings.

§ 3.17 Cleaning Up

§ 3.17.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project and shall leave the site clean and ready for occupancy by the Owner. Additional requirements are set forth in Division 00 and 01.

(Paragraph deleted)

§ 3.17.1.1 The Contractor shall be responsible for keeping the site of the Work and adjacent premises as free from material, debris and rubbish as is practicable, and shall remove same from any portion of the Site, if, in the opinion of the Owner or Owner Representative, such material debris or rubbish constitutes a health and safety issue, nuisance or is objectionable in any way to the Owner. The Contractor further agrees to remove all machinery, materials implements, barricades, staging, false work, debris and rubbish connected with or caused by its Work immediately upon completion

of the Work and to clean all structures and Work as required by the Contract Documents, including Division 00 and 01, to the satisfaction of the Owner and the Owner Representative and to leave the premises in a condition that will allow the Owner's immediate and unrestricted use of the Work and all areas affected by the Work. With respect to renovation projects, the Contractor acknowledges that Owner in such cases, may continue to occupy and must maintain continuous operations in the building in which the Work is located. In such cases, it is critical that the Owner's operations are not interfered with, including, without limitation, any interruption in utilities or unreasonable noise, dust, odor, vibration or hazardous condition. The Contractor shall perform its Work and limit its use of the Project Site in such manner as to minimize any interference with Owner's occupancy and operations in the building consistent with applicable building rules and regulations.

(Paragraph deleted)

§ 3.17.1.2 Dust control shall be effectively maintained at all times whether or not specifically ordered by the Owner Representative or Owner. The Contractor shall provide and apply continuous internal and external dust control, including holidays and weekends, as required, to prevent the spread of dust and to avoid the creation of a nuisance at the work site or in the surrounding areas as a result of construction activities. Internal dust control shall be accomplished by barrier, vacuum, filters or other approved methods and equipment. External dust control shall be by sprinkler water or other approved means, except that no chemicals or oil shall be used. Quantities and equipment shall be sufficient to control dust effectively. When weather conditions warrant, external sprinkling equipment shall be on hand and immediately available at all times. Owner Representative and Owner shall have the authority to order dust control Work whenever required in its opinion; however, dust control shall be effectively maintained at all times whether or not specifically ordered by the Owner Representative and Owner. Contractor shall also take proper measures at no additional cost to Owner to prevent tracking mud into the interior of buildings or onto public streets or roads or property of third persons. Such measures shall include but are not limited to covering muddy areas on the Site with clean dry sand. All ingress/egress from the Site shall be maintained in a dry condition, and any mud tracked off site including streets or roads or any other areas of the building or property of third persons shall be immediately removed and the affected area cleaned. Owner Representative or Owner may order such work at any time that conditions warrant.

(Paragraph deleted)

§ 3.17.1.3 Contractor shall be ultimately responsible for all daily cleanup of construction materials and debris and building dust control. Cleanup shall include removal of materials and debris from the building and placement in a debris box or other disposal. Special consideration is required for the immediate removal and/or protection of material or debris which pose a hazard to Owner's students, employees, invitees, fixtures and floor coverings (i.e. particularly hazardous materials, broken glass, sawdust, materials that pose a tripping hazard, etc.), including utilization of protective coverings for newly installed floor covering and fixtures. Certain construction activities, including but not limited to drywall sanding, spray painting, sawing, etc., create dust which must be controlled to protect Owner's students, employees, invitees, equipment, facilities and property. Contractor shall take steps as necessary to control the dust created by these operations, including but not limited to Visquine, ventilation, or a solid construction barrier. In addition to the requirements identified in this Section, Contractor shall comply with the requirements regarding airborne contaminants set forth in the Project Specifications and Division 00 and 01.

(Paragraph deleted)

§ 3.17.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

(Paragraph deleted)

§ 3.18 Access to Work

(Paragraph deleted)

§ 3.18.1 The Contractor shall provide the Owner and Owner Representative with access to the Work in preparation and in progress wherever located.

(Paragraphs deleted)

§ 3.18.2 Contractor is responsible for its site access. Contractor shall keep roads, walks, ramps, etc. on and adjacent to the Project site in good working order and condition and free from obstructions which might present a hazard to or interference with traffic. When construction operations necessitate the closing of traffic lanes, Contractor shall be responsible for arranging such closings in advance with the authorities having jurisdiction, Owner, and adjacent property owners. Contractor shall prepare and submit a maintenance of traffic plan to the Owner and Owner's Representative for approval.

(Paragraphs deleted)

§ 3.19 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Owner Representative harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Owner Representative. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Owner Representative.

(Paragraph deleted)

§ 3.20 Indemnification

(Paragraph deleted)

§ 3.20.1 To the fullest extent permitted by law, Contractor shall indemnify, hold harmless and defend Owner, Owner Representative and all of their officers, directors, partners, agents, employees, consultants, attorneys and any other person or entity for whom any of them may be legally responsible, of and from and against all claims, suits, demands, causes of action, damages, losses, costs and expenses, including reasonable attorney's and consultant's fees and expenses, of any nature whatsoever which arise out of, or are alleged to arise out of, result from, or are in connection with or incidental to the performance of Contractor's Work under this Contract, or occasioned by any breach or nonperformance of its terms and obligations, or by any labor, services, materials or equipment furnished hereunder, provided that any such claim, suit, demand, cause of action, damage, loss, cost, fees or expense: (a) is attributable to, or alleged to arise out of or be attributable to, bodily injury, sickness, disease or death, or actual or alleged infringements of any patent, trademark, copyright or other intellectual property or proprietary right, or the breach of or failure to comply with any term, condition or obligation under the Contract, or to injury or damage to or destruction of tangible property or real property, including the loss of use thereof and consequential damages resulting therefrom, or is attributable to damages from economic harm or loss, or is attributable to damages to any party indemnified hereunder or its employees, servants and agents, and whether such claim, suit, demand, cause of action, damage, loss, cost, fees or expense, is based upon, or claimed to be based upon, statutory, contractual, tort or other liability of any indemnified party hereunder; and (b) is caused in whole or in part by any negligent act or omission, breach of contract, breach of warranty, strict liability, or other breach of any duty or obligation of Contractor, Owner Representative, a Consultant, a Contractor, or anyone directly or indirectly employed by them or anyone for whose acts they may be liable, or is caused by or arises out of the use of any products, materials, machinery or equipment furnished by Contractor, regardless of whether such claim, suit, damage, loss, cost or expense is caused in part by any joint, several or comparative, but not sole, negligent act or omission, breach of contract, breach of warranty, strict liability, or other breach of duty or obligation by any party indemnified hereunder.

(Paragraphs deleted)

§ 3.20.2 Without limiting the generality of the foregoing under §3.18 and in addition thereto, the indemnification, hold harmless and defense duties and obligations of Contractor shall apply to any claims, suits, demands, causes of action, damages, losses, costs and expenses, including attorney and expert fees and expenses and court costs, of whatsoever kind, nature and type, whether based in contract, tort or otherwise, of Contractor and its employees against Architect, or any other Consultant, Contractor, material supplier or third party and to the claims of whatsoever kind, nature and type, whether based in contract, tort or otherwise, of Owner Representative, or any other Consultant, Contractor, material supplier or third party, or its employees, against Contractor or Owner or any other party indemnified hereunder, consistent with the provisions of the Indiana Anti-Indemnity Statute, as codified at Indiana Code.

§ 3.20.3 In any and all claims against Owner or any of its officers, directors, partners, agents, employees, consultants, attorneys and any other person or entity for whom any of them may be legally responsible, by any employee of Contractor or anyone directly or indirectly employed by Contractor, or anyone for whose acts Contractor may be liable, the indemnification obligations under this §3.18 shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for Contractor under worker's compensation acts, disability benefit acts or other employee benefit acts.

§ 3.20.4 The indemnification, hold harmless and defense duties and obligations of Contractor arising under the Contract and this 3.20 shall extend to any and all claims, suits, demands, causes of action, damages, losses, costs and expenses, including attorney and expert fees and expenses, occurring after the Work under this Contract is completed and the

performance obligations of Contractor hereunder are concluded as well as while the Contract remains in full force and effect, and such indemnification, hold harmless and defense duties and obligations shall continue until there is a final adjudication or determination that any and all such claims, suits, demands and causes of action against the parties indemnified hereunder are fully and finally barred by applicable statutes of limitation or operation of law.

§ 3.20.5 Contractor shall assume all liability, financial or otherwise, in connection with its Contract and the Work and shall protect and hold harmless Owner and Owner Representative from any and all damages or claims that may arise because of inconvenience, delay, or loss experienced by Contractor and caused directly or indirectly by the acts or omissions of other contractors or third parties. Contractor shall make no claim for damages against Owner or Owner Representative by reason of any act or omission to act by any other contractor or third party or in connection with Owner Representative's or Owner's acts or failures to act in connection with such other contractor or third party, but Contractor shall have a direct right to recover such damages from other contractors.

§ 3.20.6 Upon receipt of a progress payment, Contractor shall pay promptly all valid bills and charges for materials, equipment, labor or other costs in connection with or arising out of the Work, and will hold Owner free and harmless from and against all liens and claims of liens for such materials, equipment, labor and other costs, or any of them, filed against the Project or the site, or any part thereof, and from and against all expense and liability in connection therewith including, but not limited to, the court costs and attorney fees resulting or arising therefrom. Should any liens or claims of liens be filed of record against the Project or the Site, or should Owner receive notice of any retainage claim or of any unpaid bill of charge in connection with the Work, Contractor shall forthwith either pay or discharge the same and cause the same to be released of record, or shall furnish Owner with appropriate indemnity in form and amount satisfactory to Owner.

§ 3.20.7 If any part of the indemnity provisions of this Section 3.18 is adjudged to be contrary to law, the remaining parts of the provisions shall in all other respects be and remain legally effective and binding. Moreover, such indemnity obligation shall not be construed to negate, abridge, or otherwise reduce any other right which would otherwise exist or obligation of indemnity as to any party or person described in this Article.

§ 3.21 LINES AND GRADES

§ 3.21.1 All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as otherwise given by Owner Representative, and Contractor shall retain the full and exclusive responsibility for maintaining specified alignments and grades throughout the course of the Work. Control points and reference marks for lines and grades shall be set by Contractor as the Work progresses and shall be located to avoid any undue inconvenience to the prosecution of the Work. Contractor shall place excavation and other materials so as to cause no inconvenience in the use of the reference marks provided. Contractor shall remove any obstructions placed by Contractor contrary to this Section at no cost to Owner.

§ 3.21.2 Contractor shall safeguard all points, stakes, grade marks, monuments and bench-marks made or established on the Work, bear the cost of reestablishing them if disturbed, and bear the entire expense of rectifying work improperly installed due to not maintaining or protecting or to removing without authorization such established points, stakes and marks. Contractor shall safeguard all existing and known property corners, monuments and marks adjacent to but not related to the Work and, if required, shall bear the cost of reestablishing them if disturbed or destroyed.

ARTICLE 4 OWNER'S REPRESENTATIVE

§ 4.1 General

(Paragraphs deleted)

§ 4.1.1 The Owner shall retain an architect or engineer lawfully licensed to practice architecture or engineering or an entity lawfully practicing architecture or engineering in the jurisdiction where the Project is located. That person or entity is identified as the Owner's Representative in the Agreement and is referred to throughout the Contract Documents as if singular in number. To the extent that the Project does not involve the practice of architecture or engineering but instead involves the practice of another licensed profession, the term 'Owner's Representative,' as used herein, shall refer to such other licensed design professional.

(Paragraph deleted)

§ 4.1.2 Duties, responsibilities and limitations of authority of the Owner's Representative as set forth in the Contract Documents shall not be restricted, modified or extended without written consent of the Owner, Contractor and Owner's Representative. Consent shall not be unreasonably withheld.

(Paragraph deleted)

§ 4.1.3 If the employment of the Owner's Representative is terminated, the Owner shall employ a successor Owner's Representative, as defined above in Section 4.1.1, whose status under the Contract Documents shall be that of the Owner's Representative.

(Paragraphs deleted)

§ 4.2 ADMINISTRATION OF THE CONTRACT

(Paragraph deleted)

§ 4.2.1 The Owner's Representative will provide administration of the Contract as described in the Contract Documents during construction until the date the Owner's Representative issues the final Certificate for Payment, and, with the Owner's concurrence, from time to time during the two-year period for correction of the Work. The Owner's Representative will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

(Paragraph deleted)

§ 4.2.2 The Owner's Representative will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Owner's Representative will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Owner's Representative will not have control over, charge of, or responsibility for, the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents, except as provided in Section 3.3.1.

(Paragraph deleted)

§ 4.2.3 On the basis of the site visits, the Owner's Representative will keep the Owner informed about the progress and quality of the portion of the Work completed, and report to the Owner (1) known deviations from the Contract Documents and from the most recent construction schedule submitted by the Contractor, and (2) defects and deficiencies observed in the Work. The Owner's Representative will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Owner's Representative will not have control over or charge of and will not be responsible for acts or omissions of the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.3 COMMUNICATIONS FACILITATING CONTRACT ADMINISTRATION

Except as otherwise provided in the Contract Documents or when direct communications have been specially authorized, the Owner and Contractor shall endeavor to communicate with each other through the Owner's Representative about matters arising out of or relating to the Contract. Communications by and with the Owner's Representative's consultants shall be through the Owner's Representative. Communications by and with Subcontractors and material suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner.

(Paragraphs deleted)

§ 4.3.1 Based on the Owner's Representative's evaluations of the Contractor's Applications for Payment, the Owner's Representative will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

(Paragraph deleted)

§ 4.3.2 The Owner's Representative has authority to reject Work that does not conform to the Contract Documents. Whenever the Owner's Representative considers it necessary or advisable, the Owner's Representative will have authority to require inspection or testing of the Work in accordance with Sections 13.5.2 and 13.5.3, whether or not such Work is fabricated, installed or completed. However, neither this authority of the Owner's Representative nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Owner's Representative to the Contractor, Subcontractors, material and equipment suppliers, their agents or employees, or other persons or entities performing portions of the Work.

(Paragraphs deleted)

§ 4.3.3 The Owner's Representative will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Owner's Representative's action will be taken in accordance with the submittal schedule approved by the Owner's Representative or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Owner's Representative's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Owner's Representative's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5 and 3.12. The Owner's Representative's review shall not constitute approval of safety precautions or, unless otherwise specifically stated by the Owner's Representative, of any construction means, methods, techniques, sequences or procedures. The Owner's Representative's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

(Paragraphs deleted)

§ 4.3.4 The Owner's Representative will prepare Construction Change Directives and may authorize minor changes in the Work as provided in Section 7.2. The Owner's Representative will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Owner's Representative will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion, issue Certificates of Substantial Completion pursuant to Section 9.8, receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor; and issue a final Certificate for Payment pursuant to Section 9.9.

§ 4.3.5 If the Owner and Owner's Representative agree, the Owner's Representative will provide one or more project representatives to assist in carrying out the Owner's Representative's responsibilities at the site. The duties, responsibilities and limitations of authority of such project representatives shall be as set forth in an exhibit to be incorporated in the Contract Documents.

§ 4.3.6 The Owner's Representative will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Owner's Representative's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.3.7 Interpretations and decisions of the Owner's Representative shall be made in writing or in the form of drawings and will be consistent with the intent of and reasonably inferable from the Contract Documents. When making such interpretations and decisions, the Owner's Representative will endeavor to secure faithful performance by both Owner and Contractor and will show partiality to neither.

§ 4.3.8 The Owner's Representative's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.3.9 The Owner's Representative will review and respond to requests for information about the Contract Documents. The Owner's Representative's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Owner's Representative will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

(Paragraphs deleted)

§ 5.2 AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK

§ 5.2.1 As part of its bid documents and where required by the bid form, Contractor shall furnish to the Owner and Owner's Representative in writing the name and trade for each proposed Subcontractor of all persons or entities proposed as manufacturers of the products identified in the Specifications (including those who are to furnish materials or equipment fabricated to a special design) and, where applicable, the name of the installing Subcontractor. If this information is not required to be provided on the bid date, then it shall be furnished to Owner as otherwise required by the Contract Documents. Contractor shall not propose or utilize a Subcontractor who has been disqualified under existing federal laws and regulations from participating in federally-assisted construction projects. The Contractor shall contract only with a Subcontractor approved in writing by the Owner and, after bid opening, substitution of any Subcontractor identified in the bid shall be made only by way of the Construction Change Directive process set forth in Article 7 of this Agreement. Additionally, the Contractor may not adjust its bid price, and may not seek a refund of its bid bond, based upon Owner's rejection of any Subcontractor or of a proposed substitution. . The Construction Manager may reply within 14 days to the Contractor in writing stating (1) whether the Owner, the Construction Manager or the Owner's Representative has reasonable objection to any such proposed person or entity or, (2) that the Construction Manager, Owner's Representative or Owner requires additional time for review. Failure of the Construction Manager, Owner, or Owner's Representative to reply within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 Contractor shall not contract with any Subcontractor without the Owner's and Owner's Representative's prior written approval, which shall not be granted until Contractor submits a written statement concerning the proposed award to the Subcontractor that contains such information as the Owner may require. The Owner shall issue a written approval or rejection of each proposed award within fourteen (14) days of the Bid Opening. The Contractor shall not contract with a proposed person or entity whom the Owner and/or Owner's Representative has timely rejected.

§ 5.2.3 If the Owner or Owner's Representative has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Owner's Representative has no reasonable objection. In the event that the Contractor is required to substitute a Subcontractor during the course of the Work, such substitution shall be made only by way of the Construction Change Directive process set forth in Article 7 of this Agreement. The Contractor may not adjust its price based upon such a substitution or upon Owner's rejection of any proposed substitute Subcontractor.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person or entity previously selected if the Owner or Owner's Representative makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Owner Representative. Each subcontract agreement shall preserve and protect the rights of the Owner and Owner Representative under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

Init.

- .1 assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- .2 assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension except to the extent that the terms of the subcontract agreement prohibits such adjustment, in which case the terms of such contract agreement shall take precedence over this Section 5.4.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

§ 5.4.4 Contractor must disclose all their affiliates, subsidiaries and vendors, regardless of other reporting requirements.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 When Owner performs construction or operations with Owner's own forces including persons or entities under separate contracts, Contractor shall cooperate with the activities of Owner's own forces and of each separate contractor and coordinate the Work of Contractor with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement. These Separate Contractors may also be referred to in the Contract Documents as "Multiple Prime Contractor".

§ 6.1.5 The Contractor accepts assignment of, and liability for, all purchase orders and other agreements for procurement of materials and equipment that are identified as part of the Contract Documents. The Contractor shall be responsible for any such purchased items as if the Contractor were the original purchaser. The Contract sum includes, without limitation, all costs and expenses in connection with delivery, storage, insurance, installation, and testing of items covered in any assigned purchase orders or agreements. Unless the Contract Documents specifically provide otherwise, all warranty and correction of the Work obligations included in the Contract Documents shall apply to any pre-purchased items. Refer to Division 00 and 01 for additional requirements.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends on proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Owner Representative of apparent delays, discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Owner Representative of apparent delays, discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for delays, discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 Contractor shall be liable for costs incurred or damages sustained by Owner or a separate contractor because of delays, improperly timed activities, defective construction or any other failure of performance by Contractor. Owner shall not be responsible to Contractor for costs incurred by Contractor because of delays, improperly timed activities, damage to the Work or defective construction of such Separate Contractors. Each Contractor agrees that all other Separate Contractors are intended additional beneficiaries of such Contractor's obligations insofar as they pertain to the Work of Separate Contractors. Accordingly, if the Contractor is delayed, hindered, or otherwise damaged by the act, omission, or delay by any separate contractor, Contractor's sole right and recourse shall be against such separate contractor except as to the conditional right to an extension of time as provided in Article 8 hereof.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.2.6 If such separate contractor or other contractors initiate any dispute proceedings against Owner on account of any damage alleged to have been caused by Contractor, Owner shall notify Contractor who shall indemnify Owner and hold Owner harmless and shall defend such proceedings at Contractor's expense.

§ 6.3 Owner's Right to Clean Up

Upon written notice by the Owner, the Contractor, Separate Contractors, and other entities are responsible for their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Owner Representative will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after the Notice to Proceed is issued without notice to any surety and without invalidating the Contract, by Construction Change Directive for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

(Paragraphs deleted)

§ 7.1.2 When a contemplated change in the Work may affect the Contract Sum or the Contract Time, the Owner's Representative will issue a Construction Change Directive detailing the work involved in such proposed change. The Contractor shall promptly, but in no case longer than five (5) working days after receipt of such Construction Change Directive, issue a written reply or Change Quotation itemizing the cost of such Construction Change Directive and any projected enlargement of the Contract Time or modification of the Project Schedule. Authorization to proceed with the Work shall be in accordance with 7.2.3.

§ 7.1.3 To expedite the review and evaluation of Contractor's Change Quotations, all Change Quotations (except those so minor that their propriety is obvious on their face) shall include a complete itemization of costs showing quantities, with unit prices of labor and materials for each such quantity, including items furnished by Subcontractors. Where major cost items are provided by Subcontractors, such items also shall be itemized and a copy of the Subcontractor's quotations, itemized as indicated above, shall be included in the Construction Change Directive.

§ 7.1.4 A Construction Change Directive requires agreement among the Owner, Contractor and Owner's Representative.

§ 7.1.5 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly, unless otherwise provided in the Construction Change Directive or order for a minor change in the Work. A change in the Contract Sum or Contract Time shall be accomplished only by Construction Change Directive. No course of conduct or dealing between the parties, no expressed or implied acceptance of alterations or additions to the Work, and no claim that Owner has been unjustly enriched by any alteration of or addition to the Work, whether or not there is any unjust enrichment to the Work, shall be the basis of any claim for an increase in the Contract Sum or for a change in the Contract Time in the absence of a Construction Change Directive.

§ 7.1.6 No action, conduct omission, prior failure or course of dealing by Owner shall be effective to waive, modify, change or alter the requirement that Changes in the Work by Construction Change Directive must be in writing and signed by the Owner. As such, Construction Change Directives are the exclusive methods of affecting any change in the Contract Sum or Contract Time. Contractor acknowledges that the Contract Sum and Contract Time cannot be changed by implication, oral agreement, actions, inactions, or course of conduct other than the methods prescribed by the Construction Documents.

§ 7.2 Construction Change Directives

§ 7.2.1 A

(Paragraphs deleted)

Construction Change Directive is a written order prepared by the Owner's Representative and signed by the Owner and Owner's Representative, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

(Paragraphs deleted)

§ 7.2.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

(Paragraphs deleted)

§ 7.2.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

- .1 Mutual acceptance of a lump sum properly itemized with breakdown, labor and material, and supported by sufficient substantiating data to permit evaluation;
- .2 Unit prices stated in the Contract Documents or subsequently agreed upon;
- .3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
- .4 As provided in Section 7.2.4.

§ 7.2.4 The cost of Contractor's overhead and profit combined, to be included on any Change Order or Construction Change Directive, shall be based on the following schedule:

- .1 For extra Work performed by the Contractor's own forces, ten percent (10%) of the cost.
- .2 For extra Work performed by a Subcontractor of Contractor, five percent (5%) of the amount due the Subcontractor, except that Contractor shall receive two (2%) of the cost for overhead and profit for Subcontractors affiliated with the Contractor
- .3 For each Subcontractor or Sub-Subcontractor involved, for extra Work performed by its own forces, ten percent (10%) of the cost.
- .4 For each Subcontractor, for extra Work performed by its Sub-Subcontractors, five percent (5%) of the amount due the Sub-Subcontractor, except that Subcontractor shall receive two (2%) of the cost for overhead and profit for Sub-Subcontractors affiliated with the Subcontractor.
- .5 For Work deleted which would have been completed by Contractor, ten (10%) of the cost shall be credited to the Owner; work deleted which would have been completed by Subcontractors of Contractor, five percent (5%) shall be credited to the Owner as the allowance for overhead and profit.
- .6 When specifically authorized by the Owner, overtime shall be paid by Owner on the base rate payroll and taxes only. Overhead, profit and markup will not be paid by the Owner for overtime.

§ 7.2.5 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Owner's Representative shall determine the adjustment on the basis of reasonable expenditures and savings of

those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, a fixed percentage for 7.2.4 of the overhead and profit as set forth in Subparagraph Agreement. In such case, and also under Section 7.2.6, the Contractor shall keep and present, in such form as the Owner's Representative may prescribe, an itemized accounting together with appropriate supporting data to verify any and all costs and expenditures or savings, if any, directly attributable to the change as described in the Constructive Change Directive. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.2.5 shall be limited to the following:

- .1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement, workers' compensation insurance, and other employee costs approved by the Owner's Representative;
- .2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;
- .3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;
- .4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and
- .5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.2.6 In order to facilitate checking of quotations for extras or credits, all proposals, except those so minor that their propriety can be seen by inspection, shall be accompanied by a complete itemization of costs showing quantities, with unit price of labor and materials for each quantity, including those items furnished by Subcontractors. Where major cost items are subcontracts, they shall be itemized also and a copy of their quotations, itemized as indicated above, shall be included in the proposal. In no case shall a change involving over One Thousand Dollars (\$1,000.00) be approved without such itemization. The Contractor shall submit the cost itemization to Owner's Representative within fourteen (14) days after receipt of the proposal request. All proposed contract changes must be processed as a condition for release of Final Payment per section 9.8.1.

§ 7.2.7 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.2.8 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Owner's Representative of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.2.9 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.2.10 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Owner's Representative. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.2.11 No action, conduct, omission, prior failure or course of dealing by Owner or Owner's Representative shall act to waive, modify, change or alter the requirements that Construction Change Directives must be in writing and signed by the parties as provided herein, and that such written Construction Change Directives are the exclusive method of effecting any change to the Contract Sum or Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the construction Work is the date of the Notice to Proceed.

§ 8.1.3 The date of Substantial Completion is the date identified in the Notice to Proceed.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly commence the site work prior to the effective date of insurance required to be furnished by the Contractor to the Owner and is to be kept current through the 2-year warranty period.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.2.4 The number of days for Project duration as stated in the Contractor's bid shall be noted in the Notice to Proceed and shall be used to calculate the Completion Date on the initial Project Schedule. The Completion Date shall not thereafter be changed except by way of a Construction Change Directive in accordance with Article 7. If Contractor shall fail to adhere to the approved original or revised progress schedule, Contractor shall adopt such other or additional means and methods of construction and commit such additional manpower, equipment and other resources as necessary to make up for the time lost and to assure completion of the Work.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by a wrongful act or neglect of the Owner or Owner's Representative, or an employee of either, or of a separate contractor employed by the Owner, or by changes ordered in the Work or by labor disputes not caused by wrongful or unlawful acts of Contractor, fire, unusual delay in deliveries, unavoidable casualties or other causes beyond the Contractor's reasonable control, or by delay authorized by the Owner, or by such other causes which Owner's Representative determines may justify delay ("Excusable Delay"), then the Contract Time shall be extended for a number of days equal to the duration of the Excusable Delay, provided the Work is not, was not, or would not have been delayed by a cause for which the Contractor is responsible ("Concurrent Delay"). Extensions of the Contract Time will be permitted only to the extent that the duration of the Excusable Delay could not have been limited, avoided or mitigated.

§ 8.3.2 Except as provided in Sections 3.7.4 and 10.3.3., an extension of time for Excusable Delay, as defined above, shall be the Contractor's exclusive remedy in the event of such a delay, no matter how or by whom caused. Contractor further specifically acknowledges that it shall have no claim for increase in contract price or damages because of any delays whatsoever to all or any part of the Work whether foreseen or unforeseen, and whether caused by any person's hindrance or active interference.

§ 8.3.3 It is a condition precedent to the consideration or prosecution of claims relating to any delays, interferences, hindrances, disruptions, accelerations, suspensions or causes which justify an extension of the Contract Time, that such claims be made and furnished in strict accordance with all applicable time limits provided in this Article. Otherwise, if the Contractor fails to comply, such claims shall be waived, invalid and unenforceable as against Owner and Owner Representative.

§ 8.3.4 Acceleration: In the event of an Excusable Delay which extends Schedule Completion Dates, the Owner, in its sole discretion, in lieu of granting an enlargement of the Contract Time, may direct Contractor to accelerate its performance to meet the Construction Schedule, in which case the Owner shall direct the Owner Representative to issue a Construction Change Directive to increase the Contract Sum to include the additional costs of the Work, if any, reasonably incurred by Contractor to meet the Construction Schedule. Upon request, Contractor shall provide Owner with the options available for acceleration, including the costs and impact on the Construction Schedule. In presenting such costs, Contractor shall credit Owner for those costs which would not be incurred as the result of the Owner's willingness to invest extra funds to compress the Construction Schedule. Owner shall be responsible only for the actual premium costs of acceleration specifically authorized in advance for critical activity in order to offset an Excused Delay. Owner shall not be responsible for premium costs which do not accelerate critical path activities.

§ 8.4 BENEFICIAL OCCUPANCY

§ 8.4.1 The Owner shall have the privilege of Beneficial Occupancy and the use and benefit of designated areas, subdivisions or portions of the Work prior to completion and acceptance of the entire Work, provided that, in the opinion of the Owner's Representative, such occupancy shall not unduly interfere with the Contractor's operations or unduly delay it in completing the entire Work or such occupancy is a cure for delays caused by the contractor in achieving Substantial Completion. Such occupancy and use shall be further subject to the provisions as set forth herein.

§ 8.4.2 In the event that the Owner desires to exercise the privilege of Beneficial Occupancy, it shall give written notice to the Owner's Representative and Contractor. If the Owner's Representative determines that such proposed Beneficial Occupancy is reasonable and proper, the Contractor shall cooperate with the Owner in providing basic services and facilities reasonably required for the health, safety and comfort of the occupants and other parties lawfully present and/or entering or leaving the premises. Mutually acceptable arrangements shall be made between the Owner and the Contractor with regard to procedures, terms and conditions governing the operation and maintenance of such services and facilities, except that the Contractor is obligated to operate and maintain the services and facilities if the Operation and Maintenance manuals are not completed and approved by the Owner's Representative, as may be utilized for the benefit of the Owner, including but not limited to the provision of Operation and Maintenance manuals. The Owner will not assume proportionate and reasonable responsibility for operation of systems, equipment and/or utilities required to provide such services, in part or in total, including proportionate and reasonable expenses of operation incidental thereto. All responsibility for conditioning systems, utilities and monitored systems/equipment is still the contractors' responsibility until S.C. is achieved and 2 year warranty starts. See 8.4.3 and 8.4.4.

§ 8.4.3 The Owner's occupancy or use of such designated areas, subdivisions, or portions of the Work shall not constitute acceptance of systems, materials, or elements of the Work which are not in accordance with the requirements of the Contract Documents; nor relieve the Contractor from its obligations to complete the Work; nor for responsibility for loss or damage due to or arising out of defects in, or malfunctioning of, systems, materials, equipment, or elements of the Work; nor from other unfulfilled obligations or responsibilities of the Contractor under the Contract. If, however damage results from any act of the Owner, the Owner will assume its proportionate responsibility for such damage.

§ 8.4.4 Notwithstanding the Owner's occupancy or use of such designated areas, subdivisions, or portions of the Work pursuant to this Article, the warranty period(s) referenced in Section 3.5 shall not begin to run until Substantial Completion. The Owner will continue to hold retainage in accordance with Section 9.4.4 until Substantial Completion.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed by 10% so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

§ 9.2.1 Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Owner Representative and Owner before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work as detailed in the specifications by Division 00 and 01. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Owner Representative and Owner. This schedule, unless objected to by the Owner Representative and Owner, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Owner Representative and supported by such data to substantiate its accuracy as the Owner Representative may require, and unless objected to by the Owner Representative, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.2.2 When O&M and As Built Drawings are required, they shall be listed as a separate item in the Schedule of Values with a value of 3% of Contract Sum.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Owner Representative an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work as detailed in the specifications by Division. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Owner Representative require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 Progress payment requests shall be submitted on AIA Document G702, Application and Certificate for Payment, supported by AIA Document G703, Continuation Sheet. The Continuation Sheet G703 shall be prepared the same as in the Schedule of Values submitted by Contractor. These requests shall detail the value of the various materials installed and accepted in the Work, and the value of the various types of labor performed during the period of time since the previous payment request. Contractor shall attach to each payment request a statement certifying that all payments due Contractor from previously issued Certificates for Payment have been paid. Contractor shall furnish such additional supporting documents and data substantiating Contractor's right to payment as Owner and Owner's Representative may require, including but not limited to waivers of lien and verified lists of Subcontractors and suppliers on forms approved by Owner Representative and Owner.

§ 9.3.1.2 Contractor's Application for Payment shall, if requested by Owner or Owner Representative, be accompanied by a payroll report by Contractor and each of its Subcontractors for the pay period covered by the application. The report shall state as to each employee his/her name, address and work classification, hours worked, rate of pay, itemized deductions, gross amount earned, net pay and fringe benefit information.

§ 9.3.1.3 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay. In such case, the Contractor shall obtain Owner's written approval prior to adding new subcontractors or shall provide written notice to the Owner prior to an existing subcontractor performing the Work.

§ 9.3.2 Unless otherwise provided in the Contract Documents, partial payments may be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, partial payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Partial payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's unencumbered title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, handling, loading/unloading and transportation to the site. Approval for stored materials require storage and maintenance of the materials per the manufacturer's requirements and approval by the Owner's Representative.

§ 9.3.3 The Contractor warrants that unencumbered title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor shall include with each pay application, a signed and notarized Partial Waiver as attached to Contract Documents. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.3.4 The Contractor's Application for Payment shall include Tier II Reporting on diversity participation as required by Division 00 and 01.

§ 9.3.5 Final Payment, including any remaining retainage, shall not be made until Contractor provides Owner with complete and legally effective releases or full unconditional waivers of all claims or liens arising out of or filed in connection with the Work. In lieu thereof and as approved by Owner, Contractor shall furnish receipts or releases in full; an affidavit of Contractor that the releases and receipts include all labor, services, material, and equipment for which a claim or lien could be filed, and that all payrolls, material work equipment bills, and other indebtedness connected with the Work for which Owner or his property might in any way be responsible have been paid or otherwise satisfied; and consent of the Surety, if any, to final payment. If any Subcontractor, manufacturer, fabricator,

supplier or distributor fails to furnish a release or receipt in full, Contractor shall furnish a Bond or other collateral satisfactory to Owner to indemnify Owner against any claim or lien.

§ 9.4 Certificates for Payment

§ 9.4.1 The Owner's Representative will, within seven days after receipt of the Contractor's correct and complete Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Owner Representative recommends is properly due, and notify the Contractor and Owner reasons for withholding certification in part as provided in Section 9.5.1; or (3) recommend that Owner withhold certification of the entire Application for Payment, and notify the Contractor and Owner of reason for recommending withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Owner Representative to the Owner, based on the Owner Representative's evaluation of the Work and the data in the Application for Payment, that, to the best of the Owner Representative's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Owner Representative. However, the issuance of a Certificate for Payment will not be a representation that the Owner Representative has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.4.3 Certificate for Payment shall be issued monthly provided the work is processed diligently and to the satisfaction of the Owner Representative and Owner, with the Owner entitled to withhold retainage in the amount of 3% less the value than the value of work completed and materials stored on-site, or off-site with approval by the Owner, to the date of application of the certificate. If, upon Substantial Completion of the Work, there are any remaining uncompleted minor items and/or Punch List items, the Owner shall be entitled to retain up to two hundred percent (200%) of the dollar value of such items until those items are completed. In addition, Owner shall be entitled to retain up to one hundred percent (100%) of any unresolved claims against the Project until Owner has received written notification that all claims have been resolved. Owner shall release all retainage after all items are complete and all claims are resolved.

§ 9.4.4 At the time that the Owner withholds retainage, it shall place such retainage in an escrow account, with a bank, savings and loan institution, or the State of Indiana or an instrumentality thereof to be selected by mutual agreement between the Owner and the Contractor, as escrow agent, pursuant to a written agreement which shall provide that: (1) the escrow agent shall promptly invest all escrowed principal in such obligations as shall be selected by the escrow agent in its discretion; (2) the escrow agent shall hold the escrowed principal and income until receipt of notice from the Owner, specifying the portion or portions of the escrowed principal to be released from the escrow account, and the person or persons to whom such portion or portions are to be released and, upon receipt of such notice, the escrow agent shall promptly remit the designated portion of escrowed principal and the same proportion of then escrowed income to such person or persons; and (3) the escrow agent shall be compensated for its services as the parties may agree upon a commercially reasonable fee commensurate with fees then being charged for the handling of escrow accounts of like size and duration, which fee shall be paid from the escrowed income of the escrow account.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Owner Representative may recommend withholding a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Owner's Representative opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Owner Representative is unable to certify payment in the amount of the Application, the Owner Representative will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Owner Representative cannot agree on a revised amount, the Owner Representative will promptly issue a Certificate for Payment for the amount for which the Owner Representative is able to make such representations to the Owner. The Owner Representative may also recommend withholding a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a

Certificate for Payment previously issued, to such extent as may be necessary in the Owner's Representative opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- .1 defective Work not remedied;
- .2 third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- .3 failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;
- .4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
- .5 damage to the Owner or a Separate Contractor;
- .6 reasonable evidence that the Work will not be completed within the Contract Time
- .7 failure to carry out the Work in accordance with the Contract Documents.
- .8 failure or refusal to perform or prosecute the Work or any separate part or element thereof in accordance with the Contract Documents and with such diligence as will insure its completion within the Contract Time,
- .9 failure to adhere to the original and any revised progress schedules established under the Contract Documents;
- .10 performs defective work or failure or refusal to correct any such Work
- .11 fails in the performance of any agreement or obligation on its part herein contained or provided by the Contract Documents;
- .12 delays the work of Owner, other contractors or other third parties;
- .13 rejection of the Work or any part thereof by any governmental authority having jurisdiction over the Project
- .14 failure to defend, indemnify or hold harmless the Owner, the Owner's Representative and other required indemnitees as required by the Contract Documents.

§ 9.5.2 When either party disputes the Owner Representative decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15. The Owner shall not be in default by reason of withholding payment while any of the grounds set forth in §9.5.1 remain uncured.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Owner Representative recommends withholding certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Owner Representative and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.5.5 If Contractor disputes a determination and/or recommendation to Owner by Owner Representative with regard to a Certificate of Payment, and during any related dispute resolution, arbitration, litigation or other proceeding, Contractor nevertheless shall continue to execute the Work as described in the Contract Documents.

§ 9.6 Progress Payments

§ 9.6.1 After Owner Representative has issued its recommendation to Owner concerning Contractor's Application for Payment, Owner shall make payment in accordance with such recommendation, subject to the terms of the Contract Documents which permit other action to be taken, in which case, Owner shall notify Contractor and Owner Representative of any payment action taken by Owner at variance with Owner's Representative recommendation.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Owner Representative will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Owner Representative and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. In the event that Owner determines that Subcontractors and suppliers have not been paid, Owner shall have the right to issue direct checks and/or joint checks to such Subcontractors and suppliers and deduct such amounts from Contractor in accordance with Contract Documents and adjust the Contract Price accordingly. Notwithstanding these rights, neither the Owner nor Owner Representative shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law. Owner's decision to issue any direct or joint check is elective, and no Subcontractor or supplier shall have any third-party beneficiary rights or expectations in connection with Owner's rights under this Subparagraph to issue a direct or joint check.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Payments received by Contractor for Work properly performed by Subcontractors and suppliers shall be held by Contractor in trust for the benefit of Owner and for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with Contractor for which payment was made by Owner. Contractor shall disburse such funds held in trust appropriately to pay subcontractors, suppliers and employees for all labor incurred and materials utilized in connection with the performance of the Work and the construction of the Project. Contractor will ensure that funds provided by Owner to Contractor for Work properly performed by subcontractors will be held in trust in a separate account and shall not be commingled with any Contractor's accounts or monies.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents and/or the Owner has exercised its rights to withhold payment pursuant to Paragraph 9.5 or elsewhere in the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Owner Representative does not issue a Certificate of Payment, through no fault of the Contractor, within fourteen (14) calendar days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within fourteen (14) calendar days after the date established in the Contract Documents, the amount certified by the Owner Representative or awarded by binding dispute resolution, and provided Owner does not have a right to withhold payment under Paragraph 9.5, then the Contractor may, upon seven additional days' written notice to the Owner and Owner's Representative, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable and verified direct costs of shutdown, delay and start-up the Work.

§ 9.7.1 A final Certificate of Payment shall not be issued until all labor and materials required in the Contract Documents have been furnished, installed and completed, all claims have been disposed of and all claims for extra work materials and allowances for omissions have been rendered, considered, and, if agreed to, made a part of such Certificate of Payment.

§ 9.7.2 If, pursuant to the Contract Documents, the Owner is entitled to any reimbursement or payment from the Contractor, Contractor shall make such payment within ten (10) days of demand by the Owner. Notwithstanding anything in the Contract Documents to the contrary, if Contractor fails to timely make any payment due the Owner, or if the Owner incurs any costs and expenses to cure any default of Contractor or to correct defective Work, the Owner shall have the right to either (i) deduct an amount equal to that which the Owner is entitled from any payment then or thereafter due Contractor from the Owner, or (ii) issue a written notice to the Contractor reducing the Contract Sum by an amount equal to that which the Owner is entitled

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work: (i) when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use, (ii) the Owner has received from any governmental authority having jurisdiction thereof all certificates of occupancy and all other permits, approvals, licenses, or other documents necessary for Owner's beneficial occupancy of the Project, (iii) Contractor submits Operating and Maintenance Manuals, Lock Out/Tag Out Roadmaps, As-Built Field Data Set Scans and other documents required in the Contract Documents, and (iv) all construction change directives have been submitted and processed within the fourteen (14) day timeframe per Section 7.2.6 and is a condition for release of Final Payment.

(Paragraphs deleted)

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Owner's Representative a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. Additional precondition requirements for the Substantial Completion inspection are set forth in Division 00 and 01.

§ 9.8.3 Upon receipt of the Contractor's list and the other documentation required by Division 00 and 01, the Owner Representative will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Owner's Representative inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Owner Representative. In such case, the Contractor shall then submit a request for another inspection by the Owner Representative to determine Substantial Completion. Test and Balance (TAB) and monitored control systems must be 100% complete. If the Owner has engaged a third-party Commissioning agent then the TAB and monitored control systems must be complete before the commencement of Substantial Completion.

§ 9.8.3.1 At the time Owner Representative commences the Substantial Completion Inspection, if Owner Representative discovers excessive additional items requiring completion or correction, Owner Representative may decline to continue the inspection, instructing Contractor as to the general classification of deficiencies which must be corrected before Owner Representative will resume the Substantial Completion Inspection. If Contractor fails to pursue the Work so as to make it ready for Substantial Completion Inspection in a timely fashion, Owner Representative shall, after notifying Contractor, conduct inspections and develop a list of items, Punch List, to be completed or corrected. This list of items shall be furnished to Contractor who shall proceed to correct such items within the time period noted on the AIA Form G-704. Owner Representative will conduct additional inspections. Contractor shall reimburse Owner for the costs of such additional inspections, and Owner may offset the amounts payable to Owner Representative for such services from the amounts due to the Contractor under the Contract Documents.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Owner Representative will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat and cooling, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work for a period of two years or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.4.1 The time fixed by Owner Representative for the completion of all Punch List items on the list accompanying the Certificate of Substantial Completion shall not be greater than 60 days. Contractor shall complete items on the list within such 60 day period unless a reasonably longer time is needed, in which event Contractor shall make a request in writing for a longer time to complete the remaining items identified in the request, which request shall not be unreasonably denied. If Contractor fails to do so, Owner in its discretion may perform the Work by itself or others and the cost thereof shall be charged against Contractor. Failure to do so may serve as cause for Owner to declare Contractor in default and terminate the Contractor pursuant to Article 14 of the General Conditions, as modified.

§ 9.8.4.2 If more than one inspection by Owner Representative for the purpose of evaluating corrected work is required by the Punch List of items to be completed or corrected, it will be performed at Contractor's expense unless Contractor has requested additional time and Owner has consented thereto, in accordance with Paragraph 9.8.4.1. In such an event an additional inspection shall not be performed at Contractor's expense, unless and until an additional reinspection of corrected work is required and Owner Representative has charged Owner for such reinspection.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.8.6 Contractor, through qualified individuals, shall adequately coordinate with designated employees of Owner in the operation and care of all equipment installed hereunder. Contractor shall also furnish and deliver to Owner Representative within forty-five (45) days of the shop drawing approval date, ONE (1) complete set for permanent files, electronic file as identified in accordance with Division 00 and 01 for technical bulletins and any other printed matter, such as diagrams, prints or drawings, containing full information required for the proper operation, maintenance and repair of the equipment installed and the ordering of spare parts, except for equipment that may be furnished by Owner. Additional requirements are set forth in the Division 1.

§ 9.9 Final Completion and Final Payment

§ 9.9.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Owner Representative will promptly make such inspection. When the Owner Representative finds the Work acceptable under the Contract Documents and the Contract fully performed, the Owner Representative will promptly issue a final Certificate for Payment stating that to the best of the Owner's Representative knowledge, information and belief, and on the basis of the Owner's Representative on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Owner's Representative final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled. Owner's Representative Final Certificate for Payment will serve as a recommendation to Owner concerning final payment.

(Paragraphs deleted)

§ 9.9.2 Final payment and release of retainage shall not become due to Contractor until and unless (1) all Work for the Project is fully completed and performed in accordance with the Contract Documents and is satisfactory to and approved and accepted by Owner and Owner Representative. Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Owner Representative:

1. an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied,
2. a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect,
3. a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents,
4. consent of surety, if any, to final payment,
5. documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties,
6. Contractor has delivered to Owner all operating and maintenance manuals, as-built, guarantees, and warranties for material, machinery and equipment furnished by Contractor, and all testing and/or inspection results or reports,
7. if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner; and
8. Contractor has fulfilled all other requirements and furnished all other documentation, required for Project closeout which are prescribed in the Contract or the Contract Documents as conditions to final payment, including but not limited to those set forth in Division 00 and 01. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the

Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

9. COBIE to the extent and in such form as may be designated by the Owner
10. Lock-Out/Tag-Out Roadmaps as required in the Project Specifications at time of Substantial Completion, Division 00 and 01 and OSHA regulation must be created and reviewed.

§ 9.9.3 In addition to the foregoing, as a condition to final payment and release of retainage, Contractor shall submit to Owner: (1) Contractor's affidavit that payrolls, including wages and fringe benefits, union dues, payroll taxes, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied; (2) Contractor's affidavit of payment in the form of AIA Document G706 – Contractor's Affidavit of Payment of Debt and Claims or equal; (3) Contractor's release of liens in the form of AIA Document G706A – Contractor's Affidavit of Release of Liens, or as may otherwise be reasonably requested or required to comply with Indiana law; (4) releases and final unconditional waivers of lien from all subcontractors and suppliers; (5) Consent of Surety in the form of AIA Document G707 – Consent of Surety Company to Final Payment or equal; and (6), if required by Owner, other data establishing payment or satisfaction of obligations, such as receipts, releases and waivers of liens, claims, security interests or encumbrances arising out of the Contract, to the extent and in such form as may be designated by Owner.

§ 9.9.4 In addition to the above requirements for final payment and release of retainage, the following items also must be submitted by Contractor to Owner: (1) Contractor's certification stating that no materials containing asbestos were incorporated into the Work; (2) Contractor's certification that all final punch list items have been completed; (3) Contractor's certificate of code compliance from the mechanical, electrical and plumbing subcontractors, if applicable; (4) Contractor's certification from its plumbing subcontractor, if any, that no lead was used in any fittings and connections; (5) Contractor's charts, graphs and locations of concealed work required under the Contract Documents; (6) any and all extra or spare parts, equipment and materials required under the Contract Documents; (7) Contractor's evidence that all startup, testing and/or commissioning requirements under the Contract Documents have been met; and (8) Contractor's maintenance agreements or maintenance bonds required under the Contract Documents.

§ 9.9.5 Contractor shall furnish such evidence as may be necessary to show that any "Non-Resident Contractor" subcontractor or supplier has fully met the requirements of payment of taxes as established in any law of the State or local subdivision thereof which may be in effect at the time of final payment. Owner will require the submission of such proof or evidence before final payment will be approved or made.

§ 9.9.6 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Owner Representative so confirms, the Owner shall, upon application by the Contractor and certification by the Owner Representative, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Owner's Representative prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.9.7 The making and acceptance of Final Payment shall constitute a waiver of all claims by Owner against Contractor and by Contractor against Owner except (i) liens, security interests or encumbrances arising out of the Contract unsettled; (ii) claims previously made in writing by either party and remaining unsettled as of the date of final payment; (iii) claims by Owner duties or responsibilities in accordance with the Contract Documents; (iv) Owner claims and other rights arising under the terms of any general or special warranties or guarantees specified by the Contract Documents or arising thereunder, (v) Owner claims and other rights in respect of Contractor's and its surety's continuing obligations under Laws and Regulations or the Contract Documents, and (vi) unresolved claims that remain from those claims designated on the Contractor and Owner claim lists required above. The date of Final Payment shall be regarded as the date of acceptance of the Work, and payment of the retained percentage shall be due no later than ninety (90) days from the date of acceptance, provided that all claims filed with the Owner by Subcontractors, Sub-subcontractors, suppliers or others, if any, have been resolved, as confirmed by written documentation submitted by the Contractor and the claimant, and subject to and consistent with Indiana Code as applicable.

§ 9.9.8 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

(Paragraphs deleted)

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the as required by Federal, State, OSHA and ANSI guidelines. Contractor acknowledges that safety is of prime importance to Owner and agrees to utilize all reasonable efforts to prevent injuries to personnel. Contractor shall be solely responsible for the safety of its employees and those of other contractors and Subcontractors working at the Project site that may be affected by its Work. Lock Out/Tag Out and LOTO Roadmaps for all equipment are required per Contract Documents, Division 00 and 01 and as required in the Project Specifications at time of Substantial Completion.

(Paragraphs deleted)

§ 10.1.1 By executing the Contract, each Prime Contractor represents that it is knowledgeable with respect to such regulations and will take all necessary measures to comply therewith. It is acknowledged that Owner does not possess expertise as to construction-related safety matters and programs and, therefore, Owner does not assume any duty to the Contractor, its Subcontractors or Suppliers, Separate Contractors or others involved with the Project as to the applicable safety standards or procedures with respect to their work or services.

(Paragraph deleted)

§ 10.2 Safety of Persons and Property

(Paragraph deleted)

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

- .1 employees on the Work and other persons who may be affected thereby;
- .2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
- .3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

(Paragraph deleted)

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss including but not limited to, State and Federal Occupational Safety and Health Acts ("OSHA"), in accordance with the requirements of the Contract Documents and shall conform to the safety and health standards and regulations for construction issued by the Secretary of Labor pursuant to Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 333), entitled "Safety and Health Regulations for Construction" (29 CFR Part 1926). In the event of any conflict among the Contract Documents and any federal, state or local authorities, laws, rules, regulations or requirements, the most stringent requirement shall govern the Work.

(Paragraph deleted)

§ 10.2.2.1 In the event that any action is taken against Contractor, including but not limited to assessments of fines or penalties, whether by State or Federal OSHA agencies or otherwise, due to any actual or alleged violation, act or omission of the duties, responsibilities and obligations set out herein that are caused or created by Contractor or any of its contractors or Subcontractors, or any other party for whom Contractor is responsible, whether also caused in part by Owner or Owner Representative, Contractor shall defend, indemnify and hold Owner and Owner Representative harmless therefrom, and Contractor shall be liable for all costs and damages sustained by Owner and Owner Representative as a result thereof, including, but not limited to, fines, penalties and attorney fees incurred in the defense of or appeal from any such action, and any OSHA proceeding or hearing which may occur or be related thereto. The failure of Contractor to comply with these requirements may be treated by Owner as a default under the Agreement.

(Paragraph deleted)

§ 10.2.2.2 Contractor shall immediately report in writing any safety-related injury, loss, damage or accident arising from the Work at the Project to Owner and Owner Representative and, to the extent mandated by applicable laws, ordinances, codes, rules and regulations, including those relating to health and safety matters, relating to the Project or Site or their performance of the Work, to all government or quasi-government authorities having jurisdiction over safety-related matters involving the Project or the Work. Refer to Contract Documents and Division 00 and 01 for more information on Reporting of Construction Losses and Accidents.

(Paragraph deleted)

§ 10.2.2.3 Contractor shall make frequent and regular inspections of the jobsite by a competent onsite safety representative designated by Contractor. Unsafe acts and/or conditions noted during inspections shall be corrected immediately and reported to Owner and Owner Representative. The name of the Contractor's onsite safety representative will be kept at the jobsite and furnished to Owner and Owner Representative prior to Contractor commencing its Work on the Project.

(Paragraphs deleted)

§ 10.2.2.4 Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, cause other damage or create an unsafe condition, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

§ 10.2.2.5 Contractor shall develop and implement an electronic and site copy for site specific safety program with Safety contact 24/7 contact. OSHA standards will serve as the minimum safety requirements for performance of the Work. A copy of Contractor's site safety program shall be available at the Site prior to the commencement of Contractor's Work at the Project and shall be furnished to each of Contractor's other contractors and Subcontractors utilized on the Project.

§ 10.2.2.6 Contractor shall comply with all applicable safety recommendations of Federal and State OSHA and National Fire Protection Association.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards. The Contractor also shall be responsible, at the Contractor's sole cost and expense, for all measures necessary to protect any property adjacent to the Project and improvements thereon or therein. Any damage to such property or improvements shall be promptly and properly repaired by the Contractor.

§ 10.2.4 When use or storage of explosives or other particularly hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel as per Division 00 and 01.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Owner's Representative or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a member of the Contractor's organization who is knowledgeable in the management of environmental health and safety at the site whose duty shall be the prevention of accidents and health-related risks.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition. Weather related precautions such as high wind, freezing temperatures, high volume rain or snow events shall be anticipated and preventative measures shall be enacted until such conditions have subsided as it relates to loading the Work.

§ 10.2.8 Injury or Damage to Person or Property

If any party suffers injury or damage to person or property because of an act or omission of others, notice of the injury or damage, whether or not insured, shall be given to the Owner promptly upon discovery. The notice shall provide sufficient detail to enable the Owner to investigate the matter.

§ 10.2.9 When all or a portion of the Work is suspended for any reason, Contractor shall securely fasten down all coverings and protect the Work from injury by any cause.

§ 10.2.10 The Contractor shall promptly report in writing to the Owner and Owner's Representative all accidents arising out of or in connection with the Work that caused personal injury or property damage, giving full details and statements of any witnesses. Accidents causing death, serious reportable personal injuries or serious property damage shall also be immediately reported by telephone for Emergency response, if necessary, and then the Owner and Owner's Representative. Owner shall have the right, but not the duty, to investigate all accident reports.

§ 10.3 Hazardous Materials and Substances

§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding particularly hazardous materials or substances as defined by OSHA and DOT. If the Contractor encounters a particularly hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Owner Representative of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Owner Representative the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Owner Representative will promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Owner Representative has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Owner Representative have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site. If the Contract Documents permit the use of a Regulated Substance of a type which by law an employer must notify its employees is to be used on the Project, then prior to exposure of any person on the Site to such Substance, Contractor shall notify the Owner's Representative in writing of the chemical composition thereof in sufficient detail and time, including, but not limited to providing a material safety data sheet for such Substance, to permit the Owner and other persons and entities to comply with any applicable laws per Division 00 and 01. Contractor's activities regarding the use of any such Regulated Substance are to be coordinated with the activities of Owner and other persons or entities to avoid any cost or impact to the Owner or any other person or entity as the result of the use of such Regulated Substance.

§ 10.3.4 Contractor shall not dispose of a Regulated Substance on the Project Site. Contractor shall not commingle Regulated Substances with materials or waste of the Owner, another Prime Contractor (in the event that the Project is a multi-prime Project) or any other person or entity performing Work on the Project Site. Contractor shall provide separate disposal receptacles approved by law for the particular regulated substance(s) which will be placed in them. Such receptacles shall be used exclusively for the storage or temporary disposal of Regulated Substances for which they are approved. When storing, working with, treating or disposing of regulated substances, Contractor and its waste hauler shall strictly comply with all applicable laws. Contractor shall identify its waste haulers and provide the Owner with a copy of each manifest or other document relating to the storage, transportation or disposal of any Regulated Substance taken from the Project Site.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1,

§ 10.3.6 In addition to the requirements identified in this Section, Contractor shall comply with the requirements set forth in Division 00 and 01.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

§ 10.4.1 In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, Contractor, without special instruction or authorization from Owner Representative or Owner, shall act to prevent threatened damage, injury or loss. Contractor shall give Owner Representative and Owner immediate written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents are caused thereby as provided in Article 15 and 7.

§ 10.4.2 Contractor shall provide the Owner and Owner Representative a list of names and telephone numbers of the designated employees for each Subcontractor to be contacted in case of emergency during non-working hours. A copy of the list will also be displayed on the job site.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in Division 00 Appendix C - Insurance Requirements. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. Through the 2-year warranty period, the Owner shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents and specifically as set forth in Division 00 Appendix C - Insurance Requirements. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance

The Owner shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage. Any time delay or cost impact caused by the stop work order will be the Contractor's liability and will not obligate the Owner to change the substantial completion date or contract sum.

(Paragraphs deleted)

§ 11.2 BUILDER'S RISK INSURANCE

The Owner's obligation to provide Builder's Risk Insurance is identified in Division 00 and 01.

§ 11.2.1 Beneficial Occupancy or use in accordance with Section 8.4 herein shall not commence until the insurance company or companies providing property insurance have consented to such Beneficial Occupancy or use by endorsement or otherwise. The Owner and the Contractor shall take reasonable steps to obtain consent of the insurance company or companies and shall not, without mutual written consent, take any action with respect to Beneficial Occupancy or use that would cause cancellation, lapse or reduction of insurance.

§ 11.2.2 A loss insured under Owner's property insurance shall be adjusted by the Owner in good faith and made payable to the Owner as fiduciary in good faith for the insured, as their interest may appear, subject to requirements of bonding obligations associated with the Project. The Contractor shall pay subcontractors their just share of insurance proceeds received by the Contractor, and by appropriate agreements, written where legally required for validity, shall require subcontractors to make payments to their Sub-subcontractors in similar manner.

§ 11.2.3 The Owner in good faith shall have power to adjust and settle a loss with insurers, unless one of the parties in interest shall object in writing within five (5) days after occurrence of loss to the Owners exercise of this power.

§ 11.3 PERFORMANCE AND PAYMENT BOND

§ 11.3.1 The Owner shall have the right to require the Contractor to furnish bonds covering faithful performance of the Contract and payment of obligations arising thereunder as stipulated in bidding requirements or specifically required in the Contract documents on the date of execution of the Contract, or as required by applicable law. This bond shall be furnished using the form provided to Contractor by the Owner.

§ 11.4 Waivers of Subrogation

§ 11.4.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.4.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

(Paragraphs deleted)

§ 11.5 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Owner's Representative for loss of use of the Owner's property, due to fire or other hazards however caused.

§ 11.6 Adjustment and Settlement of Insured Loss

§ 11.6.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Owner Representative and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Owner Representative and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.6.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor in writing of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object in writing to the proposed settlement or allocation of the proceeds. If the Contractor does not object in writing, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the

appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects in writing to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

§ 11.6.3 Nothing contained in these insurance requirements is to be construed as limiting the extent of Contractor's responsibility for payment of damages resulting from its failure to perform the Work in accordance with the Contract Documents.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Owner's Representative request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Owner Representative, be uncovered for the Owner's Representative examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Owner's Representative has not specifically requested to examine prior to its being covered, the Owner's Representative may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, costs of uncovering and replacement shall, by appropriate Construction Change Directive, be at the Owner's expense. If such Work is not in accordance with the Contract Documents, such costs and the cost of correction shall be at the Contractor's expense.

(Paragraphs deleted)

§ 12.1.3 Owner, Owner Representative and all governmental agencies with jurisdictional interests in respect of the Work or the activities of Contractor or its subcontractors shall be afforded complete and unhindered access to the Work for their observation, inspecting and testing. Contractor shall provide proper and safe conditions for such access and advise them of Contractor's site safety procedures and programs so that they may comply therewith as applicable.

§ 12.1.4 Contractor shall give Owner Representative timely notice of readiness of the Work for all required inspections, tests, commissioning or approvals. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) to specifically be inspected, tested or approved, Contractor shall assume full responsibility therefore, pay all costs in connection therewith and furnish Owner Representative the required certificates of inspection, testing or approval, subject to any provisions on quality control to the contrary set forth and contained in the Specifications. The cost of all other inspections, tests and approvals which are required by Contract Documents shall be paid by Contractors except as otherwise specified. All inspections, tests or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to Owner and Contractor or by Owner's Representative if so specified. Neither observations by Owner's Representative nor inspections, tests or approvals by others shall relieve Contractor from Contractor's obligations to perform the Work in accordance with the Contract Documents.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Owner Representative or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Owner's Representative services and expenses made necessary thereby, shall be at the Contractor's expense. If, prior to the date of final payment, the Contractor, a Subcontractor, or anyone for whom either is responsible, uses or damages any portion of the Work, including, without limitation, mechanical, electrical, plumbing, or other building systems, machinery, equipment, or other mechanical device, Contractor shall cause such item to be restored to "like new" condition at no expense to the Owner and shall not assert a claim for delay or request a Construction Change Directive on this basis.

§ 12.2.1.2 Owner, Owner Representative and all governmental agencies with jurisdictional interests in respect of the

Work or the activities of Contractor or its subcontractors shall be afforded complete and unhindered access to the Work for their observation, inspecting and testing. Contractor shall provide proper and safe conditions for such access and advise them of Contractor's site safety procedures and programs so that they may comply therewith as applicable.

§ 12.2.1.3 Contractor shall give Owner Representative timely notice of readiness of the Work for all required inspections, tests or approvals. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) to specifically be inspected, tested or approved, Contractor shall assume full responsibility therefore, pay all costs in connection therewith and furnish Owner Representative the required certificates of inspection, testing or approval, subject to any provisions on quality control to the contrary set forth and contained in the Specifications. The cost of all other inspections, tests and approvals which are required by Contract Documents shall be paid by Contractor except as otherwise specified. All inspections, tests or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to Owner and Contractor or by Owner Representative if so specified. Neither observations by Owner Representative nor inspections, tests or approvals by others shall relieve Contractor from Contractor's obligations to perform the Work in accordance with the Contract Documents.

§ 12.2.1.4 Neither observations by Owner Representative nor inspections, tests or approvals by others shall relieve Contractor from Contractor's obligations to perform the Work in accordance with the Contract Documents.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within two year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice within a reasonable time after discovery of the condition. During the two-year period for correction of Work, if the Owner is unaware of a defect and fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner does not waive the right to require correction by the Contractor. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Owner's Representative, the Owner may correct it in accordance with Section 2.5. The Contractor's responsibility to correct such work within two years of Substantial Completion shall not be affected, diminished or restricted by the limitations, restrictions or conditions of a subcontractor, manufacturer, supplier, or installer's warranty, including the expiration of any Uniform Commercial Code statute of limitations. The inability or refusal of a subcontractor, manufacturer, supplier or installer responsible for defective Work to correct or warrant such Work shall not relieve the Contractor from its obligation to correct such Work within two years of Substantial Completion.

§ 12.2.2.2 The two-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 Upon completion of any work under or pursuant to this Section 12.2, the two-year correction period in connection with the Work requiring correction shall be renewed and recommenced. The obligations under Paragraph 12.2 shall cover any repairs and replacements to any part of the Work or other property that is damaged by the defective Work at its own cost, to include repair of all interior and exterior masonry or drywall cracks and provide new control joints as required.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the two-year period for

correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If, instead of requiring correction or removal and replacement of nonconforming Work, Owner elects to accept such Work in the condition as provided, Owner may do so. Contractor shall bear all direct, indirect and consequential costs attributable to Owner's evaluation of and determination to accept such Defective Work, to include but not be limited to fees and charges of engineers, architects, attorneys and other professionals. If any such acceptance occurs prior to Owner's Representative recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price to account for such costs and damages. If the acceptance occurs after such recommendation of final payment, such costs and damages shall be paid by Contractor and its surety to Owner. The acceptance of nonconforming Work by the Owner shall be by written Change Order, signed by the Owner's authorized representative. No person has authority to accept nonconforming work except pursuant to such written Change Order.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the laws of the State of Indiana and the sole and exclusive venue of any claims or disputes arising out of this Agreement (including counterclaims, cross-claims, third party claims and claims for indemnity) shall be Monroe County, Indiana.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partner, successors, assigns and legal representatives to the other party hereto and to partners, successors, assigns and legal representatives of such other party in respect to covenants, agreements and obligations contained in the Contract Documents. Except as provided elsewhere in the Contract Documents, the Contractor shall not assign the Contract in whole or in part, or any rights whatsoever (including the right to payment or to present or assert claims arising out of the Project) without prior written consent of the Owner. If the Contractor attempts to make such an assignment without prior written consent it shall be void and of no effect.

(Paragraph deleted)

§ 13.3 Written Notice

Written notice shall be deemed to have been duly served if delivered in person to an officer of the corporation for which it was intended; or if delivered by registered or certified mail or express carrier to persons designated in the Agreement. Email shall constitute valid notification only in those circumstances identified in Section 7.2.3.

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Owner's Representative, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.3.3 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights and remedies otherwise imposed or available by law. Every provision of the Contract is intended to be severable such that, if any term or provision thereof is illegal or invalid for any reason whatsoever, such provision shall be severed from the Contract and shall not affect the validity of the remainder of the Contract. A waiver of any breach or default under the Contract shall not constitute a waiver of any other breach or default of any provision hereunder.

§ 13.3.4 The waiver by the Owner of any breach or default of the Contract by the Contractor shall not be construed as a waiver of any other breach or default of the same or any other terms or conditions of the Contract. Forbearance from demanding strict compliance with any term or provision of the Contract shall not operate as a waiver and shall not prevent the Owner from subsequently demanding strict compliance therewith. In any instance whereby Owner is

entitled, under the terms of this Contract, to be indemnified by or recover any moneys from Contractor, or Owner is required to enforce any term or condition of this Contract, Owner shall be entitled, in addition, to recover from Contractor (i) interest on any sums due from Contractor at the rate of ten percent (10%) per annum to accrue from the date due until paid.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Owner's Representative timely notice of when and where tests and inspections are to be made so that the Owner Representative may be present for such procedures. The Contractor shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations are concluded.

§ 13.4.2 If the Owner Representative, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Owner Representative will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Owner's Representative of when and where tests and inspections are to be made so that the Owner Representative may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Contractor's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Owner's Representative services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Owner's Representative.

§ 13.4.5 If the Owner's Representative is to observe tests, inspections, or approvals required by the Contract Documents, the Owner's Representative will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

§ 13.6 Interpretation

All personal pronouns used in the Contract Documents, whether used in the masculine, feminine or neuter gender shall include all other genders; and the singular shall include the plural and vice versa. Titles of articles, paragraphs, and subparagraphs are for convenience only and neither limit nor amplify the provisions of such articles, paragraphs and subparagraphs.

§ 13.7 CLOSEOUT

§ 13.7.1 See Article 9 with additional requirements set forth in the Contract Documents and Division 00 and 01.

§ 13.7.2 The Contract Sum shall include the costs of furnishing competent and experienced engineers, superintendents or other technically qualified representatives who shall represent equipment manufacturers and shall assist Contractor, when required, to install, adjust, test, commission and place in operation equipment in conformity with the Contract Documents. When equipment is ready for permanent operation, such engineers, superintendents or representatives shall make all adjustments and tests required by Owner Representative to prove that such equipment is in proper and satisfactory operating condition, and shall coordinate with such personnel as may be designated by Owner in the proper operation and maintenance of such equipment. See Article 9.

§ 13.8 OWNER AUDIT

§ 13.8.1 Contractor shall maintain all pertinent accounting records of its Project costs on a generally recognized accounting basis, including all supporting vouchers, canceled checks, subcontracts, purchase orders, time records, project cost reports and similar data as required to substantiate an expenditure, including but not limited to the following items: (a) costs incurred and payments for labor and material, including supervision and equipment (whether rented or owned); (b) costs incurred and payments to Subcontractors and suppliers and vendors; (c) changes in the Work; (d) Claims submitted by Contractor; (e) suspension of the Work and Contractor operations; (f) Project closeout; (g) termination of the Contract; and (h) whenever Contractor's costs and expenses are subject to audit under the Contract Documents. Said accounting records shall be subject to review by the Owner, and said records shall be available to Owner or his authorized representative at mutually convenient times.

§ 13.9 FUTURE COOPERATION

Each party hereto agrees to do all acts and things and to make, execute and deliver such written instruments, as from time to time shall be reasonably required to carry out the terms and provisions of the Contract Documents.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 90 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- .1 Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- .2 An act of government, such as a declaration of national emergency, that requires all Work to be stopped;
- .3 Because the Owner Representative has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Owner's Representative, terminate the Contract if the Owner is not able to cure issue within 30 days upon receipt of notification. Contractor is entitled to reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination. In lieu of terminating Contract, if Owner has failed to make payment as aforesaid, Contractor may, upon twenty days written notice to Owner and Owner Representative, stop the Work until payment is made of all amounts then due.

(Paragraph deleted)

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may declare Contractor to be in default and/or terminate the Contract if the Contractor

- .1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials to perform Work in accordance with the approved schedule;
- .2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;
- .3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or
- .4 otherwise has breached a provision of the Contract Documents.
- .5 Is adjudged bankrupt or insolvent, or makes a general assignment for the benefit of creditors, or Contractor or a third party files a petition to take advantage of any debtor's act or to reorganize under the bankruptcy or similar laws, or a trustee or receiver is appointed for Contractor or for any of

- Contractor's property on account of the Contractor's insolvency, and Contractor or its successor in interest does not provide adequate assurance of future performance in accordance with the Contract Documents within ten (10) days of receipt of a written request by Owner for such assurance;
- .6 Fails or refuses to perform or prosecute the Work or any separate part or element thereof in accordance with the Contract Documents and with such diligence as will ensure its completion within the Contract Time,
 - .7 Fails to adhere to the original and any revised progress schedules established under the Contract Documents;
 - .8 Performs any Work which is rejected as defective and fails or neglects to correct any such Work;
 - .9 Abandons or suspends performance of any of the Work, or removes from the site materials or equipment reasonably required to perform and complete the Work, without Owner's written consent, directive or approval.
 - .10 Fails in the performance of any agreement or obligation on its part herein contained or provided by the Contract Documents;
 - .11 Delays the work of Owner, other contractors or other third parties
 - .12 Rejection of the Work or any part thereof by any governmental authority having jurisdiction over the Project; or
 - .13 Failure to defend, indemnify or hold harmless the Owner, the Owner's Representative and other required indemnitees as required by the Contract Documents.

If any of the above-stated events or conditions of default shall exist under any uncompleted separate or additional Contract between Contractor and Owner, whether for this Project or any other project.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and after consultation with the Owner Representative, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' written notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

- .1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;
- .2 Accept assignment of subcontracts pursuant to Section 5.4; and
- .3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished. At that time, if the unpaid balance of the amount to be paid under the Contract shall exceed the expenses incurred by Owner in completing and correcting Contractor's Work, plus any costs and damages sustained by Owner by reason of such failure or lack of performance by Contractor, including but not limited to delay damages, attorney's fees, costs of administration, and a reasonable allowance for overhead and profit, such excess Contract balance shall be paid by Owner to Contractor, or to Contractor's surety if Owner proceeds to complete the work under Section 14 herein. However, if Owner's expenses, costs and damages shall exceed such unpaid balance, Contractor and Surety shall be liable to Owner for such deficiency. Contractor or its surety shall pay Owner such excess expenses, costs and damages within thirty (30) days after submission to Contractor or surety of Owner's invoice.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Owner's Representative's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.2.5 Upon termination of the Contract and Owner's right to proceed thereunder, which termination shall become effective without further notice upon the expiration of such seven (7) day period unless otherwise rescinded or modified by Owner in writing, the following shall govern:

- .1 Owner may exclude Contractor from the site and take possession of the Work and of all Contractor's

- tools, appliances, scaffolding, construction equipment and machinery at the site and use or authorize third party contractors to use the same for completing or correcting the Work, and incorporate in the Work all materials and equipment stored at the site or for which Owner has paid Contractor but which are stored elsewhere. Owner and completion contractors shall not be liable to Contractor for the cost or value of any such property used or incorporated in the course of such completion or correction.
- .2 Owner may, by any means it may deem expedient and appropriate under the circumstances, complete and correct or contract with one or more Separate Contractors for completion and correction of the Work. Owner shall not be required to accept the lowest price or the shortest duration proposed for such completion or corrective Work. In the event that Owner takes bids for completion or corrective Work, Contractor shall not be eligible for the award of any contracts resulting therefrom.
 - .3 As used in this Paragraph 14.2, the term "costs of finishing the Work" shall mean any and all direct, indirect and consequential costs and expenses paid or incurred by Owner for or incidental to completion of the Work or correction of previous Work performed by Contractor, whether by Owner's own forces or by one or more Separate Contractors engaged by Owner for such purposes, and shall include but not be limited to all fees and charges of engineers, architects, consultants, attorneys and other professionals, plus court costs, arbitration and arbitrator fees and charges.

§ 14.2.6 The occurrence of any labor dispute, work stoppage, strike (including sympathetic strike), slow down, picketing, or any other activity directly or indirectly attributable to Contractor's employees, either caused by them or resulting from their employment on the Project which interrupts, interferes with or delays the Work of Contractor or other Separate Contractors shall constitute a breach of the Contract. In such event, Owner shall have the right, in addition to any other rights and remedies provided by this Contract or the Contract Documents, or by law, following three days' written notice to Contractor, to terminate this Contract or any part thereof for all or any portion of the Work, and for purpose of completing the Work, to enter upon the premises and take possession in the same manner, to the same extent, and upon the same terms and conditions as set forth elsewhere herein.

§ 14.2.7 If Owner terminates the Contract for cause pursuant to this Paragraph 14.2 and it subsequently is determined for any reason that Contractor was not in default, or that such termination was wrongful as against Contractor, or that adequate grounds did not exist to support the termination, the termination shall be deemed a termination for the convenience of Owner, whereupon the rights and obligations of the parties shall be determined and governed in accordance with the provisions of Paragraph 14.4.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine. In its written notice to Contractor, Owner may fix either the date or requisite events for resumption of the Work. Contractor shall resume the Work on the date so fixed. Contractor may make a claim for an extension of the Contract Time on account of such suspension, as provided by and subject to the limitations of Article 8.

(Paragraphs deleted)

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of written notice from the Owner of such termination for the Owner's convenience, the Contractor shall

- .1 cease operations as directed by the Owner in the notice;
- .2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and
- .3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; verified direct costs incurred by reason of the termination, including costs attributable to termination of Subcontracts; and the termination fee of four (4)% of the Work completed to date, less any general condition costs..

§ 14.4.4 Upon receipt of written notice of Owner's termination for convenience, Contractor shall immediately discontinue Work and follow all other instructions of Owner as stated in such notice, and shall take all other action as may be required or appropriate to minimize costs, damages and expenses in consequence of the termination. Furthermore, Contractor shall deliver to Owner all survey notes, drawings, specifications and estimates completed or partially completed and these shall become the property of Owner. Contractor shall not be entitled to payment on account of loss of anticipated profits or revenue or other economic loss associated with any terminated Work.

§ 14.5 SURVIVAL OF WARRANTIES

All warranties made to the Owner by Contractor, and all obligations of Contractor to defend, indemnify, and hold harmless the Owner, shall survive any termination of the employment of Contractor for any reason.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, adjustment or interpretation of the Contract terms, payment of money, extension of time or other relief with respect to the terms of the Contract. The term 'Claim' also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the binding dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

The failure to give such written notice by Contractor shall constitute an irrevocable waiver of the Claim.

§ 15.1.3 Notice of Claims

Claims by either the Owner or Contractor must be initiated by written notice to the other party and to the Initial Decision Maker with a copy sent to the Owner's Representative. Claims by either party must be initiated within 7 days after occurrence of the event giving rise to such Claim or within 7 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later. Claims must be initiated by written notice to the Owner's Representative and the other party. Once a Claim is recognized, the claimant shall use its best efforts to give the Owner's Representative and the other party notice of any such Claim as expeditiously as possible, including, without limitation, Claims in connection with concealed or unknown conditions. Claimant shall cooperate with the Owner's Representative and the party against whom the Claim is made in any reasonable effort to mitigate alleged or potential damages, delays or other adverse consequences arising out of the condition that is the subject of such Claim. Unless the other party objects, Claims may be reserved in writing within the time limits set forth in Section 15.1.2. If a claim is reserved, procedures for the resolution of claims and disputes shall not commence until a written notice from the claimant is received by the Owner's Representative. Any notice of Claim or reservation of Claim must clearly identify the alleged cause and the nature of the Claim and include data and information not available to the claimant that will facilitate prompt verification and evaluation of the Claim. Contractor's timely written notice of Claim is a condition precedent to its entitlement to an adjustment of the Contract Sum, Contract Time or Contract Schedule.

(Paragraphs deleted)

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Owner Representative decision, subject to the right of either party to proceed in accordance with this Article 15. The Owner's Representative will issue Certificates for Payment in accordance with the decision of the Owner Representative.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4. Contractor shall have the burden of substantiating the basis for the Claim and shall furnish Owner and Owner's Representative with documentation relating thereto as Owner may reasonably require. The failure to give such written notice by Contractor shall constitute an irrevocable waiver of the Claim for Additional Cost.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary. Contractor shall have the burden of substantiating the basis for the Claim and demonstrating the effect of the claimed delay on the Contract Time, and shall furnish Owner and Owner's Representative with documentation relating thereto as Owner may reasonably require. The failure to give such written notice by Contractor shall constitute an irrevocable waiver of the Claim for Additional Time.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

Contractor waives Claims against Owner for all consequential damages arising out of or relating to
(Paragraphs deleted)

the Contract for principal office expenses, including the compensation of personnel stationed there, extended or unabsorbed home office overhead, losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

§ 15.2 RESOLUTION OF CLAIMS AND DISPUTES

§ 15.2.1 Claims, including those alleging an error or omission by the Owner's Representative but excluding those arising under Sections 10.3 and 10.4, shall be referred initially to the Owner's Representative for decision. An initial decision by the Owner's Representative shall be required as a condition precedent to litigation of all Claims between the Contractor and Owner arising prior to the date final payment is due, unless 30 days have passed after the Claim has been referred to the Owner's Representative with no decision having been rendered by the Owner's Representative. The Owner's Representative will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Owner's Representative will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Owner's Representative is unable to resolve the Claim if the Owner's Representative lacks sufficient information to evaluate the merits of the Claim or if the Owner's Representative concludes that, in the Owner's Representative's sole discretion, it would be inappropriate for the Owner's Representative to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Owner's Representative may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Owner's Representative in rendering a decision. The Owner's Representative may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Owner's Representative requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of such request, and shall either (1) provide a response on the requested supporting data, (2) advise the Owner's Representative when the response or supporting data will be furnished or (3) advise the Owner's Representative that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Owner's Representative will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Owner's Representative will render an initial decision approving or rejecting the Claim, or indicating that the Owner's Representative is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefore; and (3) notify the parties and the Owner's Representative of any change in the Contract Sum or Contract Time or both.

§ 15.2.6 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.7 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

ARTICLE 16 ADDITIONAL CONTRACTOR RESPONSIBILITIES

§ 16.1 Substitute or "equal" items

§ 16.1.1 Neither the approval of alternate material or equipment as being equivalent to that specified nor the furnishing of the material or equipment specified, shall in any way relieve Contractor of responsibility for failure of the material or equipment, due to faulty design, material, or workmanship, to perform the functions required by the Contract and Contract Documents.

§ 16.1.2 The Contract Sum shall be based on the exact materials specified in the Contract Documents. The Contract Sum shall not be contingent upon the approval of any substitute or "equal" product, material equipment or system. If the Contractor wants to propose a substitute product, material, equipment or system different from what is identified in the Contract Documents, it shall submit its recommendation, in writing, to the Architect with a copy to the Owner. The proposal shall be submitted by the Contractor, reviewed by the Architect and either approved or rejected by the Owner in accordance with the terms, conditions and procedures set forth below:

- .1 The product, material, equipment or system called for in the Contract Documents is intended to establish the standard of quality, performance and design; however, a proposed substitute product, material, equipment or system may be used if the Architect determines that it is "equal" and the Owner approves of the substitution, in writing, by signing a Construction Change Directive.
- .2 The term "or approved equal" is deemed to be included after all products, materials, equipment or systems described in the Contract Documents.
- .3 When submitting proposed substitutions the Contractor shall provide appropriate certifications or other materials necessary for the review and evaluation of the proposed substitution, including, but not limited to:
 - Name and description of the product, material, equipment or system which is proposed to be substituted, including cut sheets, drawings, performance and test data and other information necessary for an evaluation;
 - Identification of any change in other materials, equipment or portions of the Work that would be required if the substitution is approved;
 - Explanation as to why the Contractor believes the proposed substitution meets or exceeds, in all respects, the standard of quality, performance and design of the specified item, including supporting documentation;
 - Confirmation that the Contractor, if the substitution is approved, will provide a warranty for the substituted items which equals or exceeds the warranty for the specified item;
 - Confirmation that if the proposed substitution is approved, the Contractor will coordinate the installation so that the Work will be timely completed in accordance with the Contract Documents; and
 - Confirmation that the Contractor, if the substitution is approved, waives all claims for additional costs or time that may subsequently be incurred as a result of using the substituted item.

The materials submitted by the Contractor shall also identify the cost of the proposed substitute item as compared to the specified items and other costs savings, if any, that will be achieved if the proposed substitution is approved. Such cost information shall be verified by the Contractor, if requested by the Owner, and shall be subject to audit. If the substitution is being considered for approval, the resulting cost savings, if any, shall be addressed and confirmed in the Construction Change Directive issued by the Owner. All costs associated with the evaluation of a proposed

- substitution (including but not limited to the cost of Additional Services rendered by the Architect) shall be borne by the Contractor.
- .4 After review and analysis of the information submitted by the Contractor, the Architect shall advise the Owner, in writing, whether it finds the proposed substitution to be of equivalent and comparable quality, performance and design to what was specified and the Owner shall then determine whether or not to approve the proposed substitution. To be effective and binding, the Owner's approval must be in the form of a Construction Change Directive signed by the Owner.
- .5 Approval of a proposed substitution shall not relieve the Contractor from responsibility for compliance with all the requirements of the Contract Documents. The Contractor shall be completely responsible for the cost of any changes to other parts of its Work or the work of other Contractors caused by such substitution, including the cost of all necessary design or redesign services.
- .6 The Contract Time shall not be extended and the Contract Price shall not be increased as the result of any substitution.

§ 16.2 Indiana Buy American Steel

In addition to meeting the Buy America Requirements of the FTA at 49 USC 5323(j) and 49 CFR Part 661, as set out in 16.2 below, Contractor agrees to comply with Indiana Code § 5-16-8 *et seq.*, relating to steel procurement on public works projects in Indiana, which requires that only steel or foundry products made in the United States shall be used or supplied in the performance of the Contract or any subcontracts unless the head of the public agency determines, in writing, that the cost of steel or foundry products is considered to be unreasonable or that the steel or foundry products are not produced in sufficient quantities in the United States.

§ 16.3 E-Verify Compliance

This Project and Contract is subject to the requirements of Indiana Code § 22-5-1.7 *et seq.* and Contractor shall enroll in and verify the work eligibility status of all newly hired employees of Contractor through the E-Verify Program ("Program") as defined therein.

§ 16.4 Drug Free Work Site

Contractor and its employees shall comply with all provisions of the Drug Free Workplace Act of 1988 as amended. The unlawful manufacture, distribution, dispensation, possession or use of a controlled substance in the workplace is prohibited. Contractor is responsible for the development implementation, administration and enforcement of a formal substance abuse policy ("Substance Abuse Policy") which, as, a minimum, meets the standards set forth by the Owner. In all cases where Contractor is permitted to employ a subcontractor, Contractor is responsible for insuring that the subcontractor and subcontractor's employees are in compliance with the Substance Abuse Policy. Contracts between Contractor and its subcontractor must stipulate that Owner reserves the right to audit the subcontractor's substance programs for compliance with the requirements of this provision.

§ 16.5 Equal Employment Opportunity And Non-Discrimination

§ 16.5.1 The Contractor shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability. The Contractor shall take affirmative action to ensure that applicants are employed and that employees are treated during employment without regard to their race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability. Such action shall include, but not be limited to the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to all employees and applicants for employment, notices to be provided by an appropriate agency of the federal government setting forth the requirements of these non-discrimination provisions.

§ 16.5.2 The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, religion, color, sex, national origin, marital status, age, sexual orientation, veteran status or disability.

§ 16.5.3 The Contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the labor union or workers representative of the Contractors' commitments under Section 202 of Executive Order No. 11246 dated September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

§ 16.5.4 The Contractor shall comply with all provisions of Executive Order No. 11246 dated September 24, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor.

§ 16.5.5 The Contractor shall furnish all information and reports required by Executive Order No. 11246 dated September 24, 1965, and by the rules, regulations and order of the Secretary of Labor. or pursuant thereto, and will permit access to its books, records, and accounts by an appropriate agency of the federal government and by the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulation and others.

§ 16.6 Performance Specifications

(Paragraph deleted)

§ 16.6.1 If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner's Representative will specify in the Contract Documents all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Owner shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications and approvals performed or provided by such design professionals. Owner's Representative will review, approve or take other appropriate action on such submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

(Paragraph deleted)

§ 16.7 Damage Survey and Correction

Contractor, accompanied by a representative of Owner and Owner's Representative, shall make a damage survey of the Project site and adjacent properties prior to commencing the Work and before making application for final payment for the Work. Contractor shall provide Owner's Representative a written inventory of damage observed during each survey. Contractor shall replace or repair all existing construction and facilities (both surface and subsurface) including, but not limited to, sidewalks, fences, yards, plantings, mechanical services and electrical services which may be damaged in the performance of the Work. All damage shall be corrected and such facilities shall be restored to their original condition. Materials and construction shall be new and equal in quality, design, workmanship, and installation to the existing material and construction.

(Paragraph deleted)

§ 16.7.1 Contractor shall notify Owner's Representative immediately upon observing damage to the site regardless of whether or not the damage is the result of Contractor's operations.

(Paragraph deleted)

§ 16.8 Water, Lights and Power

Unless otherwise specified in the Contract and Contract Documents, Contractor shall provide, at its expense, the necessary water supply for Contractor's activities, and shall, if necessary, provide and lay necessary water lines from existing mains to the place where such water service is required, and shall secure all necessary permits and pay for all hookups, meters, and taps to water mains or hydrants and for all water used at the established rates.

(Paragraph deleted)

§ 16.8.1 Contractor shall provide, at its own expense, temporary lighting and power facilities required for the proper prosecution and inspection of the Work, unless specified otherwise in the Contract Documents. Owner shall furnish electrical power to the Site to which Contractor shall be responsible to secure hook-ups and any electrical connections for temporary lighting and power service, as needed, to perform the Work. Contractor shall meter and pay for Contractor's share of all power utilized.

(Paragraph deleted)

§ 16.9 Prevention, Control and Abatement of Erosion and Water Pollution

Contractor shall be responsible for prevention, control and abatement of erosion, siltation and water pollution resulting from construction of the project until Final Acceptance of the Project and per the IDEM permit and reporting requirements.

(Paragraph deleted)

§ 16.9.1 Contractor shall provide, install, construct, and maintain coverings, mulching, sodding, sand bagging, berms, slope drains, sedimentation structures, or other devices necessary to meet Owner, State and Federal regulatory agency codes, rules and laws.

(Paragraph deleted)

§ 16.9.2 Contractor shall take sufficient precautions to prevent pollution of adjacent rivers and streams with fuels, oils, bitumens, or other harmful materials. Also, Contractor shall conduct and schedule Contractor's operations so as to avoid or otherwise minimize pollution or siltation of the waters.

(Paragraph deleted)

§ 16.9.3 Storm drainage facilities, both open and closed conduit, serving the construction area shall be protected by Contractor from pollutants and contaminants. If it is determined that siltation of drainage facilities has resulted due to the project, Owner's Representative will advise Contractor to remove and properly dispose of the deposited material. Should Contractor fail to or elect not to remove the deposits, Owner will provide maintenance cleaning as needed and will charge all costs of such service against the amount of money due or to become due Contractor.

(Paragraph deleted)

§ 16.9.4 Excavated material shall not be deposited in streams, ditches or impoundments, or in a position close enough thereto to be washed away by high water or runoff.

(Paragraphs deleted)

§ 16.9.5 Contractor shall not disturb lands or waters outside the limits of construction and public rights of way. The location of and methods of operation in all detention areas, borrow pits, material supply pits and disposal areas furnished by Contractor shall meet the approval of Owner's Representative as being such that erosion during and after completion of the Work will not likely result in detrimental siltation or water pollution.

(Paragraphs deleted)

§ 16.9.6 Contractor shall schedule operations such that the area of unprotected erodible earth exposed at any one time is not larger than the minimum area necessary for efficient construction operations; and the duration of exposed, uncompleted construction to the elements shall be as short as practicable.

(Paragraphs deleted)

§ 16.9.7 Clearing and grubbing shall be so scheduled and performed that grading operations can follow immediately thereafter; and grading operations shall be so scheduled and performed that permanent erosion control features can follow immediately thereafter if conditions on the project permit.

(Paragraph deleted)

§ 16.9.8 The surface areas of unprotected erodible earth exposed by clearing and grubbing, excavation or filling operations shall be kept to a minimum. Immediate erosion or pollution control measures to prevent siltation or contamination of any stream, ditch or other impoundment or to prevent damage to the project or property outside the project limits shall be provided when necessary.

(Paragraphs deleted)

§ 16.10 Patents, Copyrights and Infringement Claims

All inventions, ideas, designs and methods contained in the Instruments of Service and the Contract Documents in which Owner has, or acquires patent, copyright or other intellectual property rights ("Intellectual Property") shall remain reserved for the exclusive use of Owner and may not be utilized, reproduced or distributed by or on behalf of Contractor, or any employee, Third Party or agent of Contractor without the prior written consent of Owner except to the extent that the Intellectual Property are necessarily required in connection with performance of the Work.

(Paragraphs deleted)

§ 16.10.1 If, pursuant to performance of the Work, Contractor or any of its agents, officers, employees or Third Parties shall produce any patentable or copyrightable subject matter as to which Owner does not gain ownership rights, Owner shall thereupon have, without cost or expense, an irrevocable, non-exclusive, royalty-free license to make, have made or use, either itself or by another contractor or other party on its behalf, such subject matter in connection

with the Work or any activity now or hereafter undertaken by or on behalf of Owner. The license herein granted shall not be transferable and shall not extend to contractors or other parties except to the extent of their work or activity on behalf of Owner.

§ 16.10.2 Except to the extent that rights are held by Contractor or others under existing valid patents or copyrights and are not given to Owner, Owner shall have the right to use or permit the use of all such Instruments of Service and Contract Documents, and also any oral information of any nature whatsoever received by Owner, and any ideas or methods represented by such Intellectual Property, for any purposes and at any time without other compensation than that specifically provided herein, and no such Intellectual Property shall be deemed to have been given in confidence and any statement or legend to the contrary on any of said Instruments of Service and Contract Documents shall be void and of no effect.

§ 16.10.3 Contractor warrants that the Work performed shall be free from any claims made against Owner or indemnified parties of Intellectual Property from any other person or entity. Contractor shall save harmless and indemnify the indemnified parties from and against all costs, expenses and damages, including attorney fees and legal costs, which any of them shall incur or be obligated to pay by reason of any such infringement or claim of infringement, and shall, at the election of Owner, defend at the Contractor's sole expense all such claims in connection with any alleged infringement.

§ 16.10.4 If Owner is enjoined from using any portion of the Instruments of Service and Contract Documents as to which the Contractor is to indemnify Owner against Intellectual Property claims, Owner may at its option and without thereby limiting any other right it may have hereunder or at law or in equity, require the Contractor to supply at its own expense, temporarily or permanently, facilities not subject to such injunction and not infringing any Intellectual Property. If the Contractor shall fail to do so, the Contractor shall, at its expense, remove such offending facilities and refund the cost thereof to Owner or take such steps as may be necessary to ensure compliance by Owner with such injunction, to the satisfaction of Owner.

§ 16.10.5 Contractor is responsible to determine whether a prospective Third Party is a party to any litigation involving Intellectual Property infringement claims, including antitrust or other trade regulation claims, or is subject to any injunction which may prohibit it under certain circumstances from providing Work or using any Instruments of Service to be used or furnished under this Contract. Contractor enters into any agreement with a party to such litigation at its own risk and Owner will not undertake to determine the merits of such litigation. Owner, however, reserves the right to reject any article which is the subject of such litigation or injunction, or in its judgment use of such article as a result of such circumstances, would delay the Work or be unlawful.

Appendix C –

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Insurance Requirements

VPCPF Support Resources - Construction Procurement
2901 East Discovery Parkway
Bloomington, IN 47408
812-855-5294
bidtab@iu.edu

9. INSURANCE REQUIREMENTS

Cross-Reference General Conditions, Article 11

INDIANA UNIVERSITY MINIMUM INSURANCE REQUIREMENTS FOR CONSTRUCTION, NON-CONSTRUCTION AND PROFESSIONAL DESIGN CONTRACTS

Obligations of Contractors and Consultants

Contractors and Consultants (whether corporation, sole proprietorship or partnership) shall procure and maintain during the term of the contract, until final acceptance of the completed work under the contract and during any extended period to the extent required and described in the Contract Documents, insurance of the types of coverages and minimum limits as identified herein and shall provide the Owner with Certificate(s) of Insurance evidencing that these coverages are in place prior to beginning work. Except as expressly stated otherwise in specific provisions below, Contractors and Consultants shall collectively be referred to herein as “Contractor,” irrespective of their area of expertise, and references to “work” herein shall refer to either providing labor, equipment and materials as part of physically constructing a Project or providing professional design or construction management services with respect to a Project.

- ◆ It is the responsibility of the Contractor and Subcontractors to become familiar with Owner’s insurance requirements and to ensure that they can meet these requirements prior to submitting a bid or proposal to perform work. This Article 9 is to be read in conjunction with insurance requirements set forth in other Contract Documents, including the applicable Agreement between the Owner and Contractor and the General Conditions. To the extent other Contract Documents require a Contractor to procure and maintain any insurance coverage in addition to those set forth below, at higher limits than those set forth below or to provide other terms of insurance not specified herein, Contractor shall adhere to such requirements in order to comply with the insurance requirements as set forth both in this Article 9 and in other Contract Documents. **Please provide all Contract Documents to your insurance agent so the correct certificate can be issued without delay.**
- ◆ No Contractor or Subcontractor of any tier shall be on the jobsite, proceed with work or be paid for any work performed, until proper certificate(s) of insurance have been submitted to and approved by the Owner. The Owner shall not be liable to any person for the failure of the Contractor or any Subcontractor to carry specified insurance.
- ◆ It is the responsibility of all Contractors to ensure that all of its Subcontractors also meet these insurance requirements.
- ◆ If any part of any coverage includes a deductible, self-insurance, a captive insurance company or a fronting arrangement, the amount so covered must be disclosed on the certificate or in a

separate letter from the Contractor. Owner reserves the right to approve of this coverage.

- ◆ NOTE: Contractor is required to meet the insurance specifications during the time of construction, during the correction of Work period, usually two years after the project is accepted by Owner, and during any Extended Coverage Periods as required herein or in other Contract Documents.
- ◆ Copies of subsequent, renewal certificates must be emailed to:

kudavis@iu.edu
Indiana University
Office of Insurance, Loss Control & Claims
Smith Research Center 110
2805 E. 10th St.
Bloomington, IN 47408

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Insurance Requirements

1. Commercial General Liability

- **Construction Contracts**

- Required Limits
 - General Aggregate \$2,000,000
 - Products/Completed Operations Aggregate \$2,000,000
 - Personal Injury (with Employment Exclusion Deleted) and Advertising Injury \$1,000,000
 - Each Occurrence Limits \$1,000,000
 - Damages to Rented Premises \$100,000
- The "COMMERCIAL GENERAL LIABILITY" box must be checked
- The "OCCUR" box must be checked
- Per Project box must be checked
- Coverage provided by this policy shall include contractual coverage for liability assumed by contract. Products/Completed Operations Coverage shall be maintained for five (5) years following Substantial Completion of the Project ("Extended Coverage Period").

- **Design/Consultant Contracts**

- Required Limits
 - General Aggregate \$2,000,000
 - Products/Completed Operations Aggregate \$2,000,000
 - Personal Injury and Advertising Injury \$1,000,000
 - Each Occurrence Limits \$1,000,000
 - Damages to Rented Premises \$100,000
- The "COMMERCIAL GENERAL LIABILITY" box must be checked
- The "OCCUR" box must be checked

2. Automobile Liability

- Required Coverages
 - Combined Single Limit coverage \$1,000,000
 - If separate Bodily Injury and Property Damage limits are purchased, each must be \$1,000,000
- Either the Any Auto -or- All Owned, Hired and Non-Owned Autos box(es) must be checked

3. Excess/Umbrella

- **Construction Contracts:** Separate Umbrella policy written in excess of the commercial General Liability, Employers Liability and Auto policies on a follow form basis. The limits of the Umbrella/Excess coverage to be carried by a construction

Contractor or Construction Manager, shall correspond to the category set forth below in which the Contract Sum or the Construction Budget for the applicable Project falls:

- Contract Sum/Construction Budget up to \$25,000,000
 - Per Claim Limit \$5,000,000
 - Aggregate Limit \$5,000,000
- Contract Sum/Construction Budget Between \$25,000,001 and \$50,000,000
 - Per Claim Limit \$10,000,000
 - Aggregate Limit \$10,000,000
- Contract Sum/Construction Budget Over \$50,000,000
 - Per Claim Limit \$20,000,000
 - Aggregate Limit \$20,000,000
- **Design/Consultant Contracts:** Separate Umbrella policy written in excess of the Commercial General Liability, Employers Liability and Auto policies on a follow form basis.
 - Per Claim Limit \$3,000,000
 - Aggregate Limit \$3,000,000

4. Professional Liability

Any type of design or professional services contract requires Professional Liability coverage of at least \$1 million per occurrence, \$2 million in the aggregate and a deductible or self-insured retention not to exceed \$25,000. If written on a “claims made” basis the coverage shall be maintained not only throughout the term of the Agreement, but also for a minimum of three (3) years following Substantial Completion of the Project (“Extended Coverage Period”).

Owner reserves the right to require increased limits of coverage on a Project-by-Project basis, to the extent set forth in the Agreement or other Contract Documents.

5. Worker’s Compensation

The Contractor shall procure and maintain a Workers’ Compensation policy to cover its obligation under the applicable laws of any state or federal government to its employees employed on the jobsite or elsewhere on this project, including its liability as an employer under common law (commonly known as Employer’s Liability Coverage “B”) with limits of not less than that listed below. Before commencing work, Contractor shall submit to the Owner a valid State Form 41321 (Certificate of Compliance – Worker’s Compensation and Occupational Diseases) or a facsimile thereof at Owner’s option. **If the Contractor has no employees** (i.e., a one-person shop) then a Certificate of Exception must be obtained from the State.

Worker’s Compensation:

Statutory

<u>Employer's Liability:</u>	\$ 1,000,000 each accident or disease
	\$ 1,000,000 policy limit
	\$ 1,000,000 each employee

6. Contractor's Pollution Liability – Construction Contracts

All General Contractors, Prime Contractors or Construction Managers At Risk, shall procure Contractor's pollution liability insurance with the following limits:

- For projects of \$1 million or less: \$1 million incident, aggregate \$1 million.
- For projects over \$1 million to \$5 million: minimum limit (per incident and aggregate) equal to cost of project, rounded up to the next million. (E.g., a \$2.3 million project requires \$3 million pollution liability.)
- For projects over \$5 million to \$10 million: \$5 million minimum limit (per incident and aggregate).
- For projects over \$10 million to \$25 million: \$5 million minimum limit per incident, \$10 million aggregate.
- For projects over \$25 million: \$10 million minimum limit (per incident and aggregate).

Subcontractors do not have to procure this insurance unless otherwise expressly required in the Contract Documents. The policy shall contain or shall be endorsed to contain a provision extending coverage for completed operations hazard losses for as long as there is exposure to claims under the Indiana Statute of Repose, Ind. Code 32-30-1.

The policy shall cover sums that the insured becomes legally obligated to pay to a third party or for the investigation, removal, remediation (including associated monitoring) or disposal of soil, surface water, groundwater or other contamination to the extent required by environmental laws (together "clean-up costs") caused by pollution conditions resulting from covered operations, subject to the policy terms and conditions, including bodily injury, property damage (including natural resource damages), clean-up costs, and legal defense costs. Such policy shall cover claims related to pollution conditions to the extent such are caused (i) by the performance of Work; (ii) by transportation, including loading and unloading, by owned and non-owned vehicles and/or (iii) by other activities performed by or on behalf of the Contractor, Prime Contractor or Construction Manager At Risk that occur on the Project. The policy shall have no exclusions or limitations for loss occurring over water including but not limited to a navigable waterway. Coverage shall apply to sudden and non-sudden pollution conditions resulting from the escape or release of smoke, vapors, fumes, acids, alkalis, toxic chemicals, liquids, or gases, waste materials, or other irritants, contaminants, or pollutants. The policy

shall contain a severability provision.

7. Builder's Risk Insurance

The Owner shall purchase and maintain during the course of construction Builder's Risk Insurance, on an "all risk" or equivalent policy form, providing coverage for the scope of the Project (as defined in the Contract Documents) in an amount of not less than one hundred percent (100%) of the insurable value of the Work (as defined in the Contract Documents) performed by the Contractor and the work of separate contractors on the Project, if any, including materials, equipment, and supplies to become a part of the completed Work which have been delivered to the site, which are stored temporarily off the Project site and while in transit, subject to a \$25,000 deductible. The Contractor shall bear responsibility for that deductible.

This insurance shall include the interests of the Owner, the Contractor(s) (whether General Contractor, Prime Contractors or Construction Managers At Risk) and Subcontractors (whether First Tier Subcontractors, or Sub-subcontractors), as their respective interests may appear. A loss insured by the Builder's Risk coverage shall be adjusted by the Owner and made payable to the Owner for the insureds, as their interests may appear. Contractor shall pay Subcontractors their just share of Builder's Risk insurance proceeds received by the Contractor and, by appropriate agreements written where legally required, shall require Subcontractors to make payment to their Sub-subcontractors in similar manner. The Contractor shall be responsible for and shall insure all Contractor's equipment, tools, scaffolding, staging, towers, forms and temporary buildings, and other materials, equipment and supplies not intended to become a part of the completed Work.

The Owner and Contractor waive all rights of subrogation against each other and any of their Subcontractors, Sub-subcontractors, agents and employees, each of the other, and against the Architect, Architect's consultants, separate contractors, if any, and any of their subcontractors, sub-subcontractors, agents and employees, for damages to the Work (as defined in the Contract Documents) caused by fire or other causes of loss to the extent covered by the Builder's Risk coverage obtained by the Owner pursuant to this Section, except such rights as they have to proceeds of such insurance held by the Owner. The Owner or Contractor, as appropriate, shall require of the Architect, Architect's consultants, separate contractors, if any, and the subcontractors, sub-subcontractors, agents and employees of any of them, by appropriate agreements written where legally required for validity, similar waivers of subrogation each in favor of other parties enumerated herein. The Builder's Risk coverage shall provide such waivers of subrogation by endorsement or otherwise.

The waiver of subrogation as to damaged Work set forth herein, shall be effective as to a person or entity even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, did not pay the Builder's Risk insurance premium directly or indirectly, and whether or not the person or entity had an insurable interest in the damaged Work. For the avoidance of doubt, the waiver of subrogation set forth above applies only to damage or loss to the Work (as

defined in the Contract Documents) performed as part of the Project and which is included within the Builder's Risk coverage procured by the Owner. The waiver of subrogation does not extend to damage or loss of other property beyond the scope of the Work performed as part of the Project, regardless of whether such other damaged property is part of an existing facility on which the Work is being performed, or is adjacent to the Work being performed, and regardless of whether the Owner has obtained property coverage for the other property in addition to the Builder's Risk coverage procured by the Owner to cover the Work. Indemnification obligations and additional insured requirements set forth in the Contract Documents shall apply to their full extent with respect to any damage or loss to other property which is not covered by the Builder's Risk coverage procured by the Owner.

This provision shall not release the Contractor from its obligation to complete, according to plans, specifications and other requirements of the Contract Documents, the Work covered by the Contract and the Contractor and its Surety shall be obligated to the full performance of the Contractor's undertaking.

NOTE: Prompt notice of potential claims is required. In the event of an occurrence that might be covered by Builders Risk insurance, notice must be given to the Owner within two (2) business days of the occurrence. Except for emergency repairs, no changes to damaged property will be made until an inspection is made.

Insurance Policy Endorsements

All insurance policies must provide the following endorsements to the policy and must be noted on the certificate(s):¹

1. Additional Insured Endorsement (CG2010 10 01 and CG2037) or equivalent form required on General Liability, Automobile Liability and Excess/Umbrella Liability policies naming the Owner and/or Other Parties as defined in Owner's Contract and including coverage for completed operations. Owner shall be identified as: "The Trustees of Indiana University, its officers, agents and employees." *If additional insured status is automatically granted by the insurance form "where required by written contract" then it is sufficient to note that on the certificate with a reference to the form number. This must include information confirming that under the Excess/Umbrella coverage -- "Excess coverage is following form."*

¹ An addendum to the COI can be used if additional space is needed.

2. Aggregate Per-Project Endorsement (CG2503) to the Commercial General Liability Policy, indicating that the general aggregate applies separately to each project.
3. Waiver of Subrogation under the Contractor's Commercial General Liability, Automobile Liability, Employer's Liability/Workers' Compensation and Umbrella/Excess Policies, in favor of the Owner.

4. All insurance policies required of the Contractor shall be primary and non-contributory (including Contractor's Umbrella/Excess policy to be exhausted vertically above Contractor's Commercial General Liability, Employer's Liability and Automobile policies), with any and all insurance maintained by the Owner to be excess of Contractor's insurance as specified and required above. Contractors' policies shall contain a severability of interests clause in respect to liability, protecting each insured as though a separate policy had been issued to each.
5. Unless expressly waived by the Owner in writing, all policies shall contain a covenant requiring (30) days written notice by the insurer to the Indiana University Office of Insurance, Loss Control & Claims before cancellation, reduction or other modifications of coverage, except ten (10) days prior notice will be required in the event coverage is being terminated for failure to pay the applicable premium.

Certificates of Insurance/Insurance Policies

Before commencing its work, Contractor shall deliver to the Owner a Certificate or Certificates of Insurance evidencing that the required coverages, limits and terms of insurance are in effect. If requested by the Owner during the period in which insurance is required to be maintained per the terms of the Contract Documents, Contractor shall provide certified copies of one or more of the required policies for review by the Owner. If one or more of the policies providing the required coverages, limits and terms of insurance expire or renew during the period in which coverage is required to be maintained (including the Extended Coverage Periods for Products/Completed Operations and Professional Liability coverages), an updated Certificate of Insurance shall be provided by the Contractor to the Owner at least fifteen (15) days before the expiration or renewal of the existing policy, confirming that the required coverages, limits and terms of insurance will remain in place under either a renewal of the existing policy or the procurement of a new policy.

Copies of subsequent, renewal certificates must be emailed to:

kudavis@iu.edu

Indiana University

Office of Insurance, Loss Control & Claims

Smith Research Center 110

2805 E. 10th St.

Bloomington, IN 47408

Owner shall also have the right during the term that insurance is required to be maintained (including Extended Coverage Periods) to periodically request that an updated Certificate or Certificates of Insurance be provided to confirm that the required coverages, limits and terms of insurance remain in effect. Contractor shall provide such updated Certificate or Certificates within five (5) business days of receiving such request. If Contractor fails to timely provide a Certificate or

Certificates of Insurance or certified copies of policies as required herein, the Owner may suspend all further work by the Contractor and/or payments due to the Contractor until the required evidence of insurance is provided.

On all Certificates of Insurance, the "Certificate Holder" shall be as follows:

The Trustees of Indiana University
2901 East Discovery Parkway
Bloomington, IN 47408

The Description of Operations section on all Certificates of Insurance must include the Indiana University Project Name and Project Number to which the Certificate applies.

Insurance Companies

All required insurance shall be procured from companies licensed to do business in the State of Indiana (unless this requirement is waived by the Owner, in writing) and having an A.M. Best Rating of A-, VII (or better).

Hold Harmless Agreement

In addition to and not in limitation of any indemnity obligations of the Contractor as otherwise included in the Contract Documents, Contractor shall indemnify and save harmless the Owner from any and all losses, costs, damages, liability and expenses, including reasonable attorney fees, arising out of or in conjunction with claims or suits for damage to any property not included in the scope of Work and/or injury to persons, including Contractor's employees and all Subcontractor's employees of any tier, including death, alleged or claimed to have been caused by or through the performance of the Work or operations incidental to the Work by the Contractor, its agents or employees, or by its Subcontractors of any tier, their agents or employees, whether through negligence or willful act; and Contractor shall, at the request of Owner, undertake to investigate and defend any and all such claims or suits against Owner.

Hold Harmless Agreement—Consultants

In addition to and not in limitation of any other indemnity obligations of the Consultant as otherwise set forth in the Agreement between Owner and Consultant or in other terms and conditions of the Contract Documents, with regard to losses, costs, damages, liability and expenses, including reasonable attorney fees (“Losses”) that may be covered by Consultant’s professional liability insurance, Consultant shall indemnify and save harmless the Owner from any and all Losses arising out of or in conjunction with claims or suits for damage to any property not included in the scope of work and/or injury to persons, including Consultant’s employees and all employees of a Sub-Consultant, if any, of any tier, including death, caused by or through the performance of the work or operations incidental to the work by the Consultant, its agents or employees, or by its Sub-Consultants, if any, of any tier, their agents or employees, whether through negligence or willful act and Consultant.

In addition to and not in limitation of any other indemnity obligations of the Consultant as otherwise set forth in the Agreement between Owner and Consultant or in other terms and conditions of the Contract Documents, with regard to losses, costs, damages, liability and expenses, including reasonable attorney fees (“Losses”) that may be covered by Consultant’s other liability insurance programs, Consultant shall indemnify and save harmless the Owner from any and all losses, costs, damages, liability and expenses, including reasonable attorney fees (“Losses”), arising out of or in conjunction with claims or suits for damage to any property not included in the scope of work and/or injury to persons, including Consultant’s employees and all employees of a Sub-Consultant, if any, of any tier, including death, alleged or claimed to have been caused by or through the performance of the work or operations incidental to the work by the Consultant, its agents or employees, or by its Sub-Consultants, if any, of any tier, their agents or employees, whether through negligence or willful act and Consultant shall, at the request of Owner, undertake to investigate and defend any and all such claims or suits against Owner.

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SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section summarizes the Work covered in detail in the complete Contract Documents.
- B. Owner: Indiana University is contracting for Work described in the Contract Documents.
 - 1. Contract Identification: Central Chilled Water Plant Chiller 3 & 4 Replacement
 - 2. Work Site Location: BL411, Chilled Water Plant, 920 E. 13th Street, Bloomington, IN 47405.
- C. Engineer: The Contract Documents were prepared by Burns & McDonnell Engineering Company, Inc., 25 Fenton Main Street, Suite 400, Cary, NC 27511.

1.02 PROJECT DESCRIPTION:

- A. Indiana University Central Chilled Water Plant supplies chilled water to campus users. The plant has eight (8) chillers and twelve (12) cooling tower cells. Indiana University desires to increase the capacity of the plant by replacing and upsizing Chiller 3 and Chiller 4, replacing and upsizing Cooling Tower 1B, and associated pumps, piping and control equipment.
- B. Mechanical System Upgrade
 - a. The existing chilled water system is a variable primary variable secondary system consisting of:
 - (1) Eight (8) variable speed chillers.
 - (2) Eight (8) chilled water production pumps.
 - (3) Five (5) chilled water distribution pumps.
 - (4) Eight (8) condenser water pumps.
 - (5) Four (4) tower water supply pumps.
 - (6) Twelve (12) cooling tower cells.
 - (7) The total rated load of the existing system is 14,596 tons.
 - b. Contractor shall modify the system by installing the following equipment (supply as noted):
 - (1) Two (2) variable speed chillers, furnished by Owner.
 - (2) Two (2) chilled water production pumps, supplied by Contractor.
 - (3) Two (2) condenser water pumps, supplied by Contractor.
 - (4) One (1) tower water supply pump, supplied by Contractor.
 - (5) Three (3) cooling tower cells, supplied by Contractor.
 - (6) The rated load of the new system will be 15,934 tons.
- C. Work Covered by Contract Documents: Furnish all supervision, equipment, labor, tools, material, supplies, transportation, and services required for construction of all piping, insulation, foundations, structural steel, controls, electrical, and final alignment and erection of Owner furnished as well as Contractor supplied equipment. Furnish all personnel and services required to place all equipment, piping systems, and materials into satisfactory operation. The Work includes site preparation, equipment procurement, foundations, slabs, steel procurement and erection, finishes, concrete, electrical, HVAC, controls, piping, mechanical, equipment and material installation, and integration to existing chiller plant shall be performed by Contractor according to the Contract Documents for the following:
 - 1. Variable Speed Chillers CH-3 and CH-4: Contractor shall install the owner-furnished variable-speed chillers, CH-3 and CH-4, per the Contract documents and manufacturer

- recommendations. The installation shall also include the chiller foundation, piping, valves, pipe supports, and other equipment necessary for the tie-in to the existing system.
2. Cooling Tower, Chilled Water Production Pump, Chilled Water Distribution Pump, Tower Water Supply Pump, and Condenser Well Pump Installation: Contractor shall procure, install, and integrate into the existing system three (3) cooling tower cells (Tower 1B Cells 5, 6, and 7) with platform, two (2) chilled water production pumps (PE-3 and PE-4), one (1) tower water supply pump (PT-2), and two (2) condenser water pumps (PC-3 and PC-4), per the Contract Documents. This shall include all necessary foundations, structural steel, piping, valves, and other equipment and material necessary for tying into the existing system.
 - a. Contractor shall also procure and install new platforms and stair tower for new Tower 1B as specified in the Contract Documents.
 - b. Contractor shall purchase cooling tower equipment with platforms and necessary grating to be installed with new Tower 1B. Contractor shall demolish the existing platforms on the east and west sides of Tower 1B. Details of this new platform arrangement can be viewed in the Contract Documents.
 3. Contractor shall relabel impacted existing VFD's, Fans, and Power distribution due to new tower fan numbering / identification scheme (Fans 5 through 13) per the Contract Documents.
 - a. New microprocessor to continue monitoring existing refrigerant and an unused channel will be used to sense for levels of R-514a.
 - b. Install and program per manufacturers' recommendations.
 - c. Contractor shall verify the monitor responds to all refrigerant detection setpoints correctly. Verify response to Owner's sequence of operations.
 4. Contractor shall field route vent piping, supplied with CH-3 and CH-4, from rupture disk located on the chiller through roof. See CH-1 and CH-2 vent piping routing for reference.
 5. Contractor shall request chiller and cooling tower suppliers provide one (1) week of technical field assistance (TFA) for each piece of equipment during start-up. Contractor shall coordinate start-up activities with Owner prior to scheduling TFA arrival.
 6. Contractor shall provide all labor, materials, equipment, accessories, and incidentals required for the complete installation and commissioning of the Owner-furnished 480V Unit Substation (USS2), ship date 01/04/2027, including the integral transformer, low-voltage switchboard, and PLC, in accordance with the Contract Documents, manufacturer's recommendations, and applicable NEC requirements. The new 480V USS shall replace existing MCC-2 and MCC-2R, and selected existing loads currently served from MCC-2 and MCC-2R shall be re-fed from the new low-voltage switchboard as indicated on the Drawings. Work shall include, but not be limited to, installation of the remote breaker control panel, associated PLC control wiring, VFDs with lockout/tagout (LOTO) provisions, conduits, conductors, power wiring, control wiring, terminations, fuses, housekeeping pad/foundation, supports, unistrut, anchors, mounting hardware, and all miscellaneous materials and equipment required for a complete and operational installation. Contractor shall furnish and install all conduits and cables required for the complete project scope unless specifically noted otherwise. Contractor shall provide temporary power as required to maintain operation of Makeup Pump PM-1, Lighting Panels LP-1 and L-1, and other loads indicated in the Contract Documents during demolition, outage, and equipment transition activities. Contractor shall review and coordinate all Drawings, specifications, schedules, details, and notes associated with the

project and shall provide all components, materials, and installation requirements necessary for a complete, code-compliant, and fully operational system, whether specifically indicated or reasonably inferred from the Contract Documents.

7. This Contract includes, but is not limited to, the following items which are listed for the convenience of Contractor in understanding the scope of work intended:
 - a. Pipe, valves, fittings, fabrication, welding, testing, installation, erection, hangers, supports, and anchors required and not specified to be furnished by others.
 - b. Special items of material and equipment including electrical, instrumentation, and controls as specified.
 - c. Receiving, checking, unloading, hauling, storing, removal from storage, erection, and installation of Owner furnished equipment and material.
 - d. Insulation, covering, and lagging.
 - e. Removing and replacing to original condition any building girts or siding as required to permit entry of equipment or piping furnished and/or installed under this Contract. Removal shall be approved by Engineer.
 - f. All other Work included in the Contract Documents including all piping connections, drains, vents, and control piping required to completely pipe up all equipment furnished, installed, or connected to, whether or not such piping was specified or shown but is required to make a complete installation.
 8. The purpose and intent of the Contract Documents is to require that all piping and related material necessary shall be furnished and installed to provide complete and workable piping systems. No wording or intention of the Contract Documents is contrary to this statement except where specific mention is made that material will be furnished under other contracts or by Owner.
- D. Protections:
1. Ensure the safe passage of persons around the area of construction/demolition. Conduct operations to prevent damage to adjacent buildings, structures, other facilities, and/or injury to persons. Erect temporary covered passageways as required by authorities having jurisdiction.
 2. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structures to be demolished and adjacent facilities to remain.
 3. Protect from damage existing facilities that are to remain in place and become exposed during demolition operations.
 4. Protect floors with suitable coverings when necessary.
 5. All piping wall penetrations shall include a Link-Seal to provide closure of the opening and infiltration of water and the exterior environment from within the plant. Link-Seal shall be installed per manufacturer's recommendations. In the event of an underground piping penetration, the exterior side of the Link-Seal shall be grouted in to seal the opening and provide a secondary layer of protection. Contractor shall flash above grade penetrations like in kind to existing above grade penetrations after the installation of the Link-Seal.
 6. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- E. Traffic:
1. Conduct demolition operations and the removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

2. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without permission from the Owner.
3. Promptly repair damages caused to adjacent facilities, pavement, and/or underground utilities by demolition operations at no cost to Owner.

1.03 WORK BY OTHERS:

A. Work Under Other Contracts:

1. Controls and Low Voltage Wiring
 - a. IU EMS shall demo all existing low voltage connections to chillers, sensors, VFD's, and valves to building automation field panels.
 - b. IU EMS shall terminate all low voltage control wiring from chillers, sensors, VFD's, and valves to building automation field panels.
 - c. IU EMS shall extend / re-add the refrigerant lines / monitoring for R514A to the refrigerant detector system.
2. Refrigerant Monitoring Modifications by IU
 - a. Microprocessor to continue monitoring existing refrigerant and an unused channel will be used to sense for levels of R-514a.
 - b. Install and program per manufacturers' recommendations.
3. Commissioning and Startup
 - a. Contractor shall provide craft labor support during commissioning and startup to make adjustments as needed.

1.04 CONTRACTOR'S USE OF PREMISES:

A. Limited Use:

1. Limit use of the premises for storage and execution of the Work to allow Owner occupancy.
2. Coordinate with other separate contractors and Owner to avoid interference of operations.
3. Conduct operations so as to ensure the least inconvenience to Owner and the general public.

1.05 OWNER'S USE OF PREMISES:

- A. Full Owner Occupancy: The Owner will occupy the Site and existing building during the entire construction period. Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations. Unplanned outages of Owner's existing equipment are not acceptable. Contractor shall provide two weeks advanced notice for equipment outage needs.
- B. General: Construction sequence shall be determined by Contractor subject to Owner's need for continuous operation of existing facilities.
 1. Contractor shall submit a construction schedule for owner approval.
- C. Continuous Service of Existing Facilities: Exercise caution and schedule operations to ensure that functioning of present facilities will not be disrupted. Shutdown of Owner's operating facilities to perform the Work shall be held to a minimum length of time and shall be coordinated with Owner who shall have control over the timing and schedules of such shutdowns.

1.06 MEASUREMENT AND PAYMENT:

- A. Lump Sum Contracts: All Work indicated and specified in the Contract Documents shall be included in the Lump Sum Contract Price.

1.07 COPIES OF DOCUMENTS:

- A. Furnished Copies: After execution of Agreement, Contractor will be furnished at no cost, an electronic set of Contract Documents consisting of full-size Contract Drawings including revised Drawings (and schedules), and the Project Manual, in addition to those used in execution of the Agreement.

1.08 LIST OF DRAWINGS (AND SCHEDULES):

- A. Contract Drawings:
1. Each sheet of the Contract Drawings bears the following general title: BL411 – CHILLER 3 & 4 REPLACEMENT #20240165.

1.09 INTENT OF DOCUMENTS

- A. The drawings and specifications are complementary, one to the other. That which is shown on the drawings or called for in the specifications shall be as binding as if it were called for and shown on both. The intent of the drawings and specifications is to establish the scope of all labor, material, transportation, equipment, and any and all other things necessary to provide a complete job. In case of discrepancy or disagreement in the Contract Documents, the order of precedence shall be:
1. Specifications
 2. Process and instrumentation drawings
 3. Contract drawings and schedules.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION – NOT APPLICABLE.

END OF SECTION 01 11 00

SECTION 01 23 00 – ALTERNATES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section specifies administrative and procedural requirements for Alternates.
- B. Definition: An Alternate is an amount proposed by Bidders and stated on the Bid Form for certain construction activities defined in the Bidding Requirements that may be added to or deducted from Base Bid amount if Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the Equipment and Materials, or installation methods described in Contract Documents.
- C. Coordination: Coordinate related Work and modify or adjust adjacent Work as necessary to ensure that Work affected by each accepted Alternate is complete and fully integrated into the Project. Costs listed for each Alternate shall include costs of related coordination, modification, or adjustment.
- D. Notification: Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected, or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.
- E. Schedule: A "Schedule of Alternates" is included at the end of this Section. Specification Sections and/or Drawings referenced in the Schedule, if any, contain requirements for Equipment and Materials and methods necessary to achieve the Work described under each Alternate.
 - 1. Each Alternate is defined by abbreviated language, recognizing that Drawings and Specifications document the requirements.
 - 2. Include as part of each Alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not mentioned as part of the Alternate.

PART 2 - PRODUCTS – NOT APPLICABLE.

PART 3 - EXECUTION

3.01 SCHEDULE OF ALTERNATES:

- A. Alternate No. 1: Contractor to provide cost for replacement and installation of chilled water distribution pump PS-4 including but not limited to the removal of existing pump PS-4, branch piping and accessories, installation of new pump PS-4, piping and supports, valves and instrumentation and connections to existing piping and equipment.

END OF SECTION 01 23 00

SECTION 01 31 00 – PROJECT COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. Project meetings.
 - 2. Requests for information (RFIs).

1.02 RELATED REQUIREMENTS:

- A. For Submittal Requirements: Section 01 33 00.
- B. For coordinating closeout of the Contract: Section 01 78 00.

1.03 DEFINITIONS:

- A. RFI: Request for information prepared by Contractor and submitted to Engineer seeking interpretation or clarification of the Contract Documents.

1.04 COORDINATION:

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to allow optimum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Where availability of space is limited, coordinate installation of different components to allow optimum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of others to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of construction progress schedule.
 - 2. Installation and removal of temporary facilities and controls.
 - 3. Delivery and processing of Submittals.
 - 4. Progress meetings.
 - 5. Project closeout activities.
 - 6. Startup and adjustment of systems.

1.05 SUBMITTALS:

- A. Submit as specified in Section 01 33 00.

1.06 PROJECT MEETINGS:

- A. Preconstruction Conference:
 - 1. Engineer will conduct a meeting within 10 days after the Effective Date of the Agreement, to review items stated in the following agenda and to establish a working

understanding between the parties as to their relationships during performance of the Work.

2. Meeting Agenda:
 - a. Construction schedules.
 - b. Phasing.
 - c. Critical Work sequencing and long-lead items.
 - d. Designation of key personnel and their duties; lines of communication.
 - e. Project coordination.
 - f. Procedures and Processing of:
 - (1) RFIs.
 - (2) Field decisions.
 - (3) Substitutions.
 - (4) Submittals.
 - (5) Change Orders.
 - (6) Applications for Payment.
 - g. Procedures for testing.
 - h. Procedures for preparing and maintaining record documents.
 - i. Use of Premises:
 - (1) Office, work, storage, laydown, and parking areas.
 - (2) Owner's requirements.
 - (3) Work restrictions and hours.
 - j. Construction facilities, controls, and construction aids.
 - k. Temporary utilities.
 - l. Safety and first-aid.
 - m. Security.
 - n. Deliveries of Equipment and Materials.
 3. Location of Meeting: At the Project Site.
- B. Construction Progress Meetings:
1. Engineer will schedule and conduct a meeting at least weekly and at other times requested by Owner. Representatives of the Owner, Engineer, and Contractor shall be present at each meeting. With Owner's concurrence, Contractor may request attendance by representatives of Subcontractors, Suppliers, or other entities concerned with current program or involved with planning, coordination, or performance of future activities. All participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
 2. Contractor and each Subcontractor represented shall be prepared to discuss the current construction progress report and any anticipated future changes to the schedule. Each Subcontractor shall comment on the schedules of Contractor and other Subcontractors and advise if their current progress or anticipated activities are compatible with that Subcontractor's Work.
 3. Meeting Agenda:
 - a. Review of construction progress since previous meeting.
 - b. Field observations, interface requirements, conflicts.
 - c. Issues which may impede construction schedule.
 - d. Off-Site fabrication.
 - e. Delivery schedules.
 - f. Submittal schedules and status.
 - g. Site use; coordination with other contractors.
 - h. Temporary facilities, controls, and services.
 - i. Hours of Work.

- j. Hazards and risks.
- k. Housekeeping.
- l. Quality and Work standards.
- m. RFIs.
- n. Status of Change Orders.
- o. Documentation of information for payment requests.
- p. Corrective measures and procedures to regain construction schedule if necessary.
- q. Revisions to construction schedule.
- r. Review of proposed activities for succeeding Work period.
- s. Review proposed Contract modifications for:
 - (1) Effect on construction schedule and on completion date.
- 4. Location of Meetings: At Project Site.
- C. Startup Coordination Meetings:
 - 1. Owner will conduct daily startup coordination meetings at the Site with Contractor. Regular meetings will be held starting when Contractor's Work can permit the commencement of commissioning and startup activities and will continue until startup of the installed equipment is achieved. Contractor and its major Subcontractors shall attend and participate in the meetings.
 - 2. Agenda:
 - a. Review of commissioning progress.
 - b. Safety, hazard, and risk consideration.
 - c. Startup observations and deviations from procedures.
 - d. Coordination among multiple prime contractors as applicable.
 - e. Issues that may impede startup.
 - f. Construction interfaces affecting startup.
 - g. Delivery schedules.
 - h. Performance and acceptance testing.
 - i. Quality assurance and quality control issues.
 - j. Corrective and/or warranty issues.
 - k. Other items as appropriate.

1.07 REQUESTS FOR INFORMATION (RFI):

- A. Procedure: Promptly on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI with the content specified.
 - 1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
 - 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's Work or work of Subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
 - 1. Project name.
 - 2. Date.
 - 3. Name of Contractor.
 - 4. Contract number and title.
 - 5. Name of Engineer.
 - 6. RFI number, numbered sequentially.
 - 7. Specification Section number and title and related paragraphs, as appropriate.
 - 8. Drawing number and detail references, as appropriate.
 - 9. Field dimensions and conditions, as appropriate.

10. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Times or the Contract Price, Contractor shall state impact in the RFI.
11. Contractor's signature.
12. Attachments: Include drawings, descriptions, measurements, photos, product data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
- C. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
 1. Attachments shall be electronic files in Adobe Acrobat PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and return it. Allow seven (7) working days for Engineer's response for each RFI. RFIs received after 1:00 p.m. Engineer's local time (CST) will be considered as received the following working day.
 1. The following RFIs will be returned without action:
 - a. Requests for approval of Submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for coordination information already indicated in the Contract Documents.
 - d. Requests for adjustments in the Contract Times or the Contract Price.
 - e. Requests for interpretation of Engineer's actions on Submittals.
 - f. Incomplete RFIs or RFIs with numerous errors.
 2. Multiple RFIs addressing similar or identical issues may be addressed by Engineer with a single broad response.
 3. Engineer's action may include a request for additional information, in which case Engineer's time for response will start again upon Contractor's response and resubmittal.
 4. If Contractor believes the RFI response warrants change in the Contract Times or the Contract Price, notify Engineer in writing within tendays of receipt of the RFI response.
- E. On receipt of Engineer's action, update the RFI log and promptly distribute the RFI response to affected parties. Review response and notify Engineer within seven (7) days if Contractor disagrees with response.
- F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly at construction progress meetings.
 1. Project name.
 2. Name and address of Contractor.
 3. Contractor representative name and telephone number.
 4. Name and address of Engineer.
 5. RFI number including RFIs that were dropped and not submitted.
 6. RFI description.
 7. Date the RFI was submitted.
 8. Date Engineer's response was received.
 9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 01 31 00

SECTION 01 32 00 – CONSTRUCTION PROGRESS SCHEDULES AND REPORTS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preliminary construction progress schedule.
 - 2. Construction progress schedule.
 - 3. Schedule of Submittals.

1.02 RELATED REQUIREMENTS:

- A. For submitting and distributing meeting and conference minutes: Section 01 31 00 – "Project Coordination and Meetings."
- B. For submitting schedules and reports: Section 01 33 01 – "Submittals."

1.03 REFERENCE STANDARDS:

- A. Associated General Contractor's of America (AGC):
 - 1. Construction Planning and Scheduling.

1.04 DEFINITIONS:

- A. Activity: A discrete part of a contract that can be identified for planning, scheduling, monitoring, and controlling the construction Work. Activities included in a construction schedule consume time and resources, but shall not include planned work stoppages. Activities shall not normally reflect the Work of more than one trade.
 - 1. Critical activities are activities on the critical path and have zero or negative float. Critical activities must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. "Baseline" schedule: The schedule submitted and accepted by Engineer for the Work.
- C. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Price, unless otherwise approved by Engineer.
- D. CPM: Critical path method (CPM), which is a method of planning and scheduling a construction contract where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Contract.
- E. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Contract duration and contains no float.
- F. Event: The starting or ending point of an activity. An event has no duration.
- G. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time [belongs to Owner] [is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date].
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting an intermediate deadline or the planned Contract completion date.
- H. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

- I. Milestone: A key or critical point in time for reference or measurement. A milestone has no duration.
 - J. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.
 - K. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.
- 1.05 SUBMITTALS:
- A. Submit as specified in Section 01 33 00.
- 1.06 COORDINATION:
- A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors, Owner, and Engineer.
 - B. Coordinate construction progress schedule with the schedule of values, list of subcontracts, schedule of Submittals, Material and Equipment procurement, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from parties involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

- 2.01 CONTRACTOR'S CONSTRUCTION PROGRESS SCHEDULE, GENERAL:
- A. Time Frame: Extend schedule from date established in the Notice to Proceed to date of Final Completion.
 - 1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.
 - B. Activities: Treat each building floor or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities so no activity is longer than 30 calendar days, unless specifically allowed by Engineer.
 - 2. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 – "Submittals" in schedule. Coordinate Submittal review times in Contractor's construction progress schedule with schedule of Submittals.
 - 3. Startup and Testing Time: Include not less than 20 working days for startup and testing.
 - 4. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.
 - C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
 - 1. Phasing: Arrange list of activities on schedule by phase.
 - 2. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 01 11 00 – "Summary of Work". Delivery dates indicated stipulate the earliest possible delivery date.
 - 3. Owner-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 01 11 00 – "Summary of Work". Delivery dates indicated stipulate the earliest possible delivery date.

4. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Uninterruptible services.
 - b. Partial occupancy before Substantial Completion.
 - c. Use of premises restrictions.
 - d. Provisions for future construction.
 - e. Seasonal and Holiday variations for weather and dips in available labor.
 - f. Environmental control.
 5. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Subcontract awards.
 - b. Submittals.
 - c. Sample testing.
 - d. Deliveries.
 - e. Installation.
 - f. Tests and inspections.
 - g. Curing.
 - h. Startup and initial operation.
 - i. Performance, guarantee, and acceptance testing.
 - j. Placement into final use and operation.
- D. Submittals: Include submittals in the schedule by showing submittal issue review dates, review periods, and final submittal dates.
- E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.
- F. Contract Modifications: For each proposed Contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall schedule.
- G. Computer Software: Prepare schedules using a program that has been developed specifically to manage construction schedules and is acceptable to Engineer:
 1. Microsoft Project
 2. Engineer-approved equal.
- 2.02 PRELIMINARY CONSTRUCTION PROGRESS SCHEDULE:
- A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established in the Notice to Proceed.
 1. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60days of construction. Include skeleton diagram for the remainder of the Work.
- B. Preliminary Schedule of Values:
 1. Initiate a preliminary value assigned to each significant construction activity.
 2. Values shall give an indication of cash requirement prediction, with total equal to Contract Price.
 3. Submit within ten days of Effective Date of Contract to Owner for review.
- 2.03 CONSTRUCTION PROGRESS SCHEDULE (GANTT CHART):
- A. Gantt-Chart Schedule: After submittal of preliminary construction progress schedule as stated above, submit a detailed construction progress schedule within 30days after the Notice to Proceed. Base the schedule on the preliminary construction progress schedule and incorporate review comments and other feedback.

- B. The schedule shall show the Work in a horizontal bar chart or other graphic format suitable for displaying scheduled and actual progress.
 - 1. The schedule shall indicate phases of the Work, starting date, interim milestones, and dates of Substantial Completion and Final Completion.
 - 2. Breakdown Work phases into separate time bar for each significant construction activity entry, with dates Work is expected to begin and be completed. Within each time bar, indicate estimated completion percentage in 10% increments.
 - 3. Scale and spacing shall allow room for notation and revisions.
 - 4. Sheet Size: Minimum 11 x 17 inches.
- C. Provide subschedules to define in more detail critical portions of schedules, including inspections and tests.
- D. Coordinate construction progress schedule with schedule of values, schedule of Submittals schedule, procurement schedule, progress reports, and payment requests.
- E. Engineer will review and comment on construction progress schedule and, upon agreement between Engineer and Contractor on necessary changes:
 - 1. Contractor shall distribute copies as specified of the accepted "baseline" schedule to Engineer. Contractor shall provide additional copies to Subcontractors and other parties required to comply with scheduled dates, one copy to each party.
- F. Revise the construction progress schedule after each meeting, event, or activity where revisions have been recognized and accepted to reflect impacts of new developments on the schedule.
- G. Update and submit electronic copy to Engineer, in Adobe PDF format, of the revised schedule at least once each month to show actual progress compared to the originally accepted "baseline" schedule and any proposed changes in the schedule of remaining Work. Include with construction progress report.
- H. Schedule shall show Contractor critical path.

PART 3 - EXECUTION

3.01 CONSTRUCTION PROGRESS SCHEDULE:

- A. Construction Progress Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before the last regularly scheduled construction progress meeting of the month.
 - 1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 - 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 - 3. As the Work progresses, indicate actual completion percentage for each activity.
- B. Distribution: Distribute copies of accepted schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
 - 1. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 33 00 – SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes definitions, descriptions, transmittal, and review of Submittals.

1.02 RELATED REQUIREMENTS:

- A. Section 01 31 00 – Project Coordination and Meetings.
- B. Section 01 78 00 – Contract Closeout.

1.03 GENERAL INFORMATION:

A. Definitions:

1. Shop Drawings, product data, and Samples are technical Submittals prepared by Contractor, Subcontractor, manufacturer, or Supplier and submitted by Contractor to Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties, as specified in each Division of the Specifications.
 - a. Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.
 - b. Product data includes standard printed information on materials, products, and systems; not custom-prepared for this Project, other than the designation of selections from available choices.
 - c. Samples include both fabricated and unfabricated physical examples of Materials, products, and Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or [where indicated] for more detailed testing and analysis. Mockups are a special form of Samples which are too large to be handled in the specified manner for transmittal of Sample Submittals.
2. Informational Submittals are those technical reports, administrative Submittals, certificates and guarantees not defined as Shop Drawings, product data, or Samples.
 - a. Technical reports include laboratory reports, tests, technical procedures, technical records, and Contractor's design analysis.
 - b. Administrative Submittals are those nontechnical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, Bonds, Project photographs, physical work records, statements of applicability, copies of industry standards, Project record data, schedules, security/protection/safety data, and similar type Submittals.
 - c. Certificates and guarantees are those Submittals on Equipment and Materials where a written certificate or guarantee from the manufacturer or Supplier is called for in the Specifications.
3. Refer to ARTICLES 1.03 and 1.04 of this Part for detailed lists of Submittals and specific requirements.

B. Quality Requirements:

1. Submittals such as drawings and data submitted to Engineer shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings such as reproducibles shall be useable for further reproduction to yield legible hard copy.

2. Documents submitted to Engineer that do not conform to specified requirements shall be subject to rejection by Engineer, and upon request, Contractor shall resubmit conforming documents. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. Contractor's or its Subcontractor's failure to initially satisfy the legibility quality requirements will not relieve Contractor or its Subcontractors from meeting the required schedule for Submittals.
- C. Language and Dimensions:
 1. All words and dimensional units shall be in the English language.
 2. Metric dimensional unit equivalents may be stated in addition to English units. However, English units of measurement shall prevail.
- D. Submittal Completeness:
 1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Engineer to review the information effectively.
 2. Where standard drawings are furnished which cover a number of variations of the general class of Equipment, each drawing shall be annotated to indicate exactly which parts of the drawing apply to the Equipment being furnished. Use hatch marks to indicate variations which do not apply to the Submittal. The use of "highlighting markers" will not be an acceptable means of annotating Submittals. Such annotation shall also include proper identification of the Submittal permanently attached to the drawing.
 3. Reproduction or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings, but will be acceptable when used by Contractor as a drawing upon which to indicate information on erection or to identify detail drawing references.
- E. Form of Submittals:
 1. Submittals and other Project documents shall be transmitted in electronic format as specified.
 - a. Selected Submittals may be provided in paper ("hardcopy") copies only with advance approval of Engineer, and using the procedures specified herein.
 - b. Equipment instruction books and operating manuals shall be provided in paper copies in addition to specified electronic format.
 2. Electronic Format:
 - a. Scanned Submittals and documents are not acceptable. Transmit Submittals and Project documents in:
 - (1) Nonproprietary, native electronic format, incorporating any necessary reference files, or Adobe *PDF files created directly from native electronic format, or Engineer-approved equal.
 - (2) Each file will be right reading and oriented the same for all consecutive resubmissions.
 - (3) For any given Submittal, the filename and format shall be consistent for initial submission and subsequent revisions of the same. Use consistent naming convention throughout. Reference to revision or dates shall not be included in a filename.
 - (4) Nonconforming Submittals are subject to rejection by Engineer.
 - b. Provide "as-constructed" Submittals, record documents, Equipment instruction books and operating manuals, and other documents via email in Adobe *PDF generated from native file format as required and approved by Owner.

1.04 TECHNICAL SUBMITTALS:

- A. Items shall include but not be limited to, the following:
1. Manufacturer's specifications.
 2. Catalogs, or parts thereof, of manufactured Equipment.
 3. Shop fabrication and erection drawings.
 4. General outline drawings of Equipment showing overall dimensions, location of major components, weights, and location of required building openings and floor plates.
 5. Detailed Equipment installation drawings, showing foundation details, anchor bolt sizes and locations, base plate sizes, location of Owner's connections, and all clearances required for erection, operation, and disassembly for maintenance.
 6. Schematic diagrams for electrical items, showing external connections, terminal block numbers, internal wiring diagrams, and one-line diagrams.
 7. Bills of material and spare parts list.
 8. Instruction books and operating manuals.
 9. Material lists or schedules.
 10. Performance tests on Equipment by manufacturers.
 11. Concrete mix design information.
 12. Samples and color charts.
 13. All drawings, catalogs, or parts thereof, manufacturer's specifications and data, samples, instructions, and other information specified or necessary:
 - a. For Engineer to determine that Equipment and Materials conform with the design concept and comply with intent of the Contract Documents.
 - b. For proper erection, installation, operation, and maintenance of Equipment and Materials which Engineer will review for general content but not for basic details.
 - c. For Engineer to determine what supports, anchorages, structural details, connections, and services are required for Equipment and Materials, and effects on contiguous or related structures, Equipment, and Materials.
 14. Manufacturer's catalog cuts on piping being supplied annotated with the PMS (pipe material specification) number to which it applies.
 15. Complete details of pipe, fittings, connections, mechanical connections, gaskets, bolting materials, and fabrication procedures.
 16. Pipe Fabrication Drawings with layout with spool piece numbers and spool piece details sheets with bill of material.
 17. Color code for random-length pipe shipped to the jobsite.
 18. Certificates of completion of piping factory tests.
 19. Piping Factory test reports.
 20. Rigging and Lifting Plan
 21. Below Grade Utility Protection from Heavy Equipment Plan
 22. Existing Owner Equipment/System Outage Request Plan
 23. SWPPP Plan
- B. Prepare and submit the following:
1. See Submittal list for required submittals. Note that Contractor shall only submit on submittals applicable to the Work.
- C. Schedule of Submittals:
1. Prepare for Engineer's concurrence a schedule for submission of all Submittals specified or necessary for Engineer's approval of the use of Equipment and Materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. Submit the schedule with the Work progress schedule. Schedule submission of all Submittals to permit review, fabrication, and delivery in time so as to not cause delay in the Work of Contractor or its Subcontractors or any other contractors as described herein.

2. In establishing schedule for Submittals, allow five (5) working days in Engineer's office for reviewing original Submittals and five (5) working days in Engineer's office for reviewing resubmittals.
 3. Submittals requiring revisions shall be resubmitted within five (5) working days after receipt of Engineer's review notations.
 4. The schedule shall indicate anticipated dates of original submission for each item and Engineer's approval thereof and shall be based upon at least one resubmission of each item.
 5. Resubmit Submittals the number of times required for Engineer's "Submittal Approved." However, any need for resubmittals in excess of the number set forth in the accepted schedule, or any other delay in obtaining approval of Submittals, will not be grounds for extension of the Contract Time provided Engineer completes his reviews within the times specified.
 6. Where a Submittal is required by the Specifications or the accepted Submittal Schedule, Contractor shall not commence production of any part of the Equipment and Materials affected thereby until such Submittal has been reviewed and approved by Engineer.
- D. Transmittal of Submittals:
1. All Submittals, Shop Drawings, product data, and Samples for Equipment and Materials furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor.
 2. After checking and verifying all field measurements, transmit all Submittals to Engineer for approval as follows:
 - a. Submittal Information Block:
 - (1) Affix to all paper copies whether Submittal is prepared by Contractor, Subcontractor, or Supplier. Use transparent decal type Submittal Information Blocks for Shop Drawings and use gummed paper type for product data and Sample Submittals. All Submittal Information Blocks needed for this Contract will be furnished to Contractor at no charge at the initial coordination conference.
 - b. Mark each Submittal by Project name and number, Contract title and number, and applicable Specification Section and Article numbers. Include in the letter of transmittal the drawing number and title, sheet number (if applicable), revision number, and electronic file name (if applicable). Unidentifiable Submittals will be returned for proper identification.
 - c. Check and approve Submittals of Subcontractors, Suppliers, and manufacturers prior to transmitting them to Engineer. Contractor's submission shall constitute a representation to Owner and Engineer that Contractor approves Submittals and has determined and verified all design criteria, quantities, dimensions, materials, catalog numbers, compliance with Laws and Regulations, and similar data, and Contractor assumes full responsibility for doing so; and Contractor has coordinated each Submittal with requirements of the Work and the Contract Documents.
 - d. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from requirements of the Contract Documents.
 - e. Make all modifications noted or indicated by Engineer and return the required number of revised Submittals until approved. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by Engineer on previous Submittals. After paper copy Submittals have been approved, submit copies thereof for final distribution. Previously approved Submittals transmitted for final distribution will not be further reviewed and are not to be

- revised. If errors are discovered during manufacture or fabrication, correct the Submittal and resubmit for review.
- f. Following completion of the Work and prior to final payment, furnish record documents and approved Samples and Shop Drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in Equipment instruction books and operating manuals as required. All such copies shall be clearly marked "PROJECT RECORD."
 - (1) Submit a final record copy of the Master Field Drawing list which shall indicate the final revision status of each drawing on the list.
3. Quantity Requirements:
- a. Except as otherwise specified, transmit all Shop Drawings electronically to Engineer.
 - b. Transmit Submittals of product data electronically to Engineer.
 - c. Transmit Submittals of Material Samples, color charts, and similar items as follows:
 - (1) Initial Submittal – One to Owner.
 - (2) Resubmittal – One to Owner.
 - (3) Upon approval, Sample(s) will be returned to Contractor.
 - d. When all Submittals have been updated to "as-constructed" conditions, transmit to Engineer and to Owner in electronic format.
 - e. Owner may copy and use for internal operations and staff training purposes any and all document Submittals required by this Contract and approved for final distribution, whether or not such documents are copyrighted, at no additional cost to Owner. If permission to copy any such Submittal for the purposes stated is unreasonably withheld from Owner by Contractor or any Subcontractor, manufacturer, or Supplier, Contractor shall provide to Engineer 50 copies plus the number of copies required by Contractor at each final distribution issue.
4. Equipment erection drawings and other Submittals required for installation of Equipment furnished by others under separate contract for installation under this Contract will be transmitted to Contractor by Engineer in the final distribution of such Submittals.
- E. Engineer's Review:
- 1. Engineer will review and take appropriate action on Submittals in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if items of Equipment and Materials covered by the Submittals are compatible with the design concept and conform to information given in the Contract Documents.
 - 2. Such review and approval will not extend to design data reflected in Submittals which is peculiarly within the special expertise of Contractor or Contractor's Subcontractors or Suppliers. Review and approval of a component item as such will not indicate approval of the assembly in which the item functions.
 - 3. Engineer's review and approval of Shop Drawings, product data, or Samples will not relieve Contractor of responsibility for any deviation from requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission, and Engineer has given written concurrence in and approval of the specific deviation. Approval by Engineer shall not relieve Contractor from responsibility for errors or omissions in Submittals.

F. Submittal Action Stamp:

1. Engineer's review action stamp, appropriately completed, will appear on all Submittals of Contractor when returned by Engineer. Review status designations listed on Engineer's action stamp are defined as follows:

A - SUBMITTAL APPROVED Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work. Contractor is to proceed with fabrication or procurement of the items and with related Work. Copies of the Submittal are to be transmitted to Engineer for final distribution.

B - SUBMITTAL APPROVED AS NOTED (RESUBMIT) Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work in accordance with Engineer's notations. Contractor is to proceed with fabrication or procurement of the items and with related Work in accordance with Engineer's notations and is to submit a revised Submittal responsive to notations marked on the returned Submittal or written in the letter of transmittal.

C - SUBMITTAL RETURNED FOR REVISION (RESUBMIT) Signifies Equipment or Material represented by the Submittal appears to conform with the design concept and comply with the intent of the Contract Documents but information is either insufficient in detail or contains discrepancies which prevent Engineer from completing his review. Contractor is to resubmit revised information responsive to Engineer's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related Work is not to proceed until the Submittal is approved.

D - SUBMITTAL NOT APPROVED (SUBMIT ANEW) Signifies Equipment or Material represented by the Submittal does not conform with the design concept or comply with the intent of the Contract Documents and is disapproved for use in the Work. Contractor is to provide Submittals responsive to the Contract Documents.

E - PRELIMINARY SUBMITTAL Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. Contractor is to submit such additional information to permit layout and related activities to proceed.

F - FOR REFERENCE, NO APPROVAL REQUIRED Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to Engineer or Owner in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the intent of the Contract Documents. Engineer reviews such Submittals for general content but not for basic details.

G - DISTRIBUTION COPY (PREVIOUSLY APPROVED) Signifies Submittals which have been previously approved and are being distributed to Contractor, Owner, Resident Project Representative, and others for coordination and construction purposes.

1.05 INFORMATIONAL SUBMITTALS:

- A. Informational Submittals are comprised of technical reports, administrative Submittals, and guarantees which relate to the Work, but do not require Engineer approval prior to proceeding with the Work. Informational Submittals include:
 - 1. Welder qualification tests.
 - 2. Welding procedure qualification tests.
 - 3. X-ray and radiographic reports.
 - 4. Field test reports.
 - 5. Concrete cylinder test reports.
 - 6. Certification on Materials:
 - a. Steel mill tests.
 - b. Paint laboratory tests.
 - c. Metal paneling laboratory tests.
 - d. Cement tests.
 - 7. Shipping or packing lists.
 - 8. Job progress schedules.
 - 9. Equipment and Material delivery schedules.
 - 10. Progress photographs.
 - 11. Warranties and guarantees.
- B. Transmittal of Informational Submittals:
 - 1. All Informational Submittals furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor unless otherwise specified.
 - a. Identify each Informational Submittal by Project name and number, Contract title and number, and the Specification Section and Article numbers marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
 - b. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from the requirements of the Contract Documents.
 - 2. Quantity Requirements:
 - a. Technical reports and administrative Submittals except as otherwise specified:
 - (1) Electronic: One (1) to Engineer.
 - b. Written certificates and guarantees:
 - (1) Engineer: One (1) copy.
 - (2) Owner: Two (2) copies.
 - 3. Test Reports:
 - a. Responsibilities of Contractor, Owner, and Engineer regarding tests and inspections of Equipment, Materials, and completed Work are set forth elsewhere in these Contract Documents.
 - b. The party specified responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports as follows:
 - (1) Owner: One (1) electronic copy, Adobe PDF generated from native file.
 - (2) Engineer: One (1) electronic copy, Adobe PDF generated from native file.
 - (3) Contractor: One (1) copy, Adobe PDF generated from native file.
 - (4) Manufacturer or Supplier: One (1) copy, Adobe PDF generated from native file.

- C. Engineer's Review:
1. Engineer will review informational Submittals for indications of Work or Material deficiencies.
 2. Engineer will respond to Contractor on those informational Submittals which indicate Work or Material deficiency.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 01 33 00

013300 - APPENDIX A

Submittal Description – As applicable to the Scope of Work of this Contract

System I/O list

- Tabulation of all inputs and outputs associated with a PLC or DCS to be used to control the supplied system.

Electrical Schematic

- Detailed schematics showing each and every light, switch, controller, relay, timer, etc., associated with a systems control circuit
- All voltage and current ratings
- Special wiring requirements (coax, high temp., etc.)

Control Panel Front View & Internal Wiring Diagram

- Physical diagrams of all supplied control panels (internal and external)
- All light and switches including color
- All wiring internal to the panel
- All Tagging/Labeling
- Panel NEMA rating

Electrical Load List

- Tabulation of all motors (load in hp)
- Tabulation of all variable speed drives (load in kW)
- Tabulation of all 120V vital ac loads (load in kW)
- Tabulation including hp, voltage, and number of phases

Electrical Equipment Layout

- Physical drawing showing the location of each of the electrical interface points and elevation of equipment in respect to the plant elevation
- Location of each device that requires Owner's cable to be run to it

Equipment Installation Details

- Drawings showing how to install all devices that require field installation
- Details including support/mounting devices
- Instrument installation details including tubing installation from root valve to the instrument including tubing size, slope, valve manifold, etc.

Interconnection Wiring Diagrams

- Overall system diagram showing 100% of the field wiring required
- Interface of each device or panel being supplied in the system
- Voltage and current ratings

Control Logic Diagrams

- Normal start/stop sequence
- Alarm development
- Identification of all time delays
- Auto stop/start sequence
- Identification of digital control
- Identification of analog control

P&IDs

- System diagrams of all system piping
- Identification of all instruments, pressure switches, limit switches, temperature elements, etc.
- Identification of interface (PLC, DCS, or hard wired interlocks) for each device
- Identification of valves, pumps, etc.
- Identification of all pipe size, materials, and schedule

General Arrangement Drawings

- Dimension and location (plan and elevation) of all equipment including locating dimensions in respect to the plant columns and elevation of equipment in respect to the plant elevation
- Identification of all pull space requirements
- Identification of all access/maintenance requirements

Foundation Details

- Foundation details/outlines depicting overall dimensions, pad and blockout requirements, anchor bolt locations and details, and any additional information necessary to establish the foundation arrangement
- Either actual or "not-to-exceed" foundation design loads, and their points of application, for all applicable load cases and/or combinations (i.e., dead load, live load, wind, seismic, dynamic, etc.)
- Identification of loading directions, magnitudes, and any other permanent data required for the foundation design

Structural and Miscellaneous Steel

- Certified shop drawings and erection diagrams for all structural steel and miscellaneous steel
- Documents prepared in accordance with the AISC specification for the design, fabrication, and erection of structural steel for buildings

Outline Drawings

- Outline dimensional drawing
- Location of all interface connections (plan and elevation)
- Recommended/required mounting details clearly depicting bolting location, size, material, and projection requirements, or sufficient data such that the Engineer can establish such requirements (for dynamic equipment or machinery data include operating speeds, rotating masses, centers-of-gravity, eccentricities, etc.)
- Weight and center of gravity
- Type of interface connection (e.g., 150 lb. RF flange, welded, weld end preparation, wall thickness or schedule, etc.)
- Allowable loads for all nozzles
- Removal space/maintenance requirements
- Special rigging requirements
- Thermal movements of all nozzles (if applicable)

Piping Information

- Physical drawing showing the routing of all vendor supplied pipe
- Location of pumps, valves, traps, strainers, instrument connections, etc. on the piping drawing
- Location of all Owner/Vendor interface points (plan and elevation) for large and small pipe
- Drawing including locating dimensions in respect to the plant columns and elevation or centerline of equipment
- Allowable loads and movements for all interface points
- Support locations and details
- Identification of pipe sizes, materials, valves, pumps, insulation, etc.
- Field weld locations
- Wall/floor penetration requirements
- Pipe movements in excess of 1 inch
- Design/service conditions (temperature/pressure)

O & M Manuals

- Description of equipment
- Theory of operation
- Troubleshooting
- Equipment drawings
- Installation instructions
- Maintenance instructions
- Sub-supplier component list

Customer Interface Point List

- Interface Point Number and Description
- Interface Point Connection Size, Type, Rating, and Material
- Design Fluid/Gas Conditions at Interface Connection including Flow, Temperature, and Pressure
- Allowable Forces and Moments on Interface Connection
- Reference P&ID and Outline Drawing Showing Interface Connection

APPENDIX 013300-B

Typical Instruction Book or Operating Manual Cover and Spine Layout

< enter contract name>	IU CCWP Chiller 3 & 4 Replacement	22
	(Instruction Book) (Operating Manual)	16
IU Woodlawn Chiller Addition	for	16
Contract Number	<enter contract name>	
	Volume Number* _____	22
< enter contract number>		16
	Contract Number	
	<enter contract number>	16
Volume Number* _____	<Enter Manufacturer's Name>	22
	<Enter Manufacturer's Address>	18

(Spine)

(Cover)

NOTES:

1. Choose either "Instruction Book" or "Operating Manual."
2. All lettering shall be a block style font, imprinting color to contrast with binder color specified.
3. Contract Name shall be assigned by the equipment the manual includes.
4. Contract Number shall be the Owner's Contract Number with Installing Contractor.
5. Cover lettering shall be point sizes indicated in column to right of cover illustration.
6. Spine letter shall be 14-point minimum.
7. *Volume number required only if instructions are contained in more than one volume.

SECTION 01 51 00 – TEMPORARY UTILITIES AND FACILITIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes requirements of a temporary nature not normally incorporated into final Work. It includes the following:
 - 1. Utility services.
 - 2. Construction and support facilities.
 - 3. Construction aids.
 - 4. Safety and health.
 - 5. Fire protection.

1.02 RELATED REQUIREMENTS:

1.03 REFERENCE STANDARDS:

- A. American National Standards Association (ANSI):
 - 1. A10 Series - Safety Requirements for Construction and Demolition.
- B. National Electrical Contractors Association (NECA):
 - 1. Electrical Design Library - Temporary Electrical Facilities.
- C. National Fire Protection Association (NFPA):
 - 1. 10 - Portable Fire Extinguishers.
 - 2. 70 - National Electrical Code.
 - 3. 241 - Safeguarding Construction, Alterations, and Demolition Operations.
- D. National Electrical Manufacturers Association (NEMA).
- E. Underwriters Laboratories (UL).

1.04 SUBMITTALS:

- A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
- B. Implementation and Termination Schedule: Submit a schedule indicating implementation and termination of each temporary utility within 15 days of the date established for commencement of the Work.

1.05 QUALITY ASSURANCE:

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
 - 1. Building Code requirements.
 - 2. Health and safety regulations.
 - 3. Utility company regulations.
 - 4. Police, Fire Department, and rescue squad rules.
 - 5. Environmental protection regulations.
 - 6. Excavation of waste and material
- B. Standards:
 - 1. Comply with NFPA 10 and 241, and ANSI A10 Series standards "Temporary Electrical Facilities."
 - 2. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70.
- C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.06 PROJECT CONDITIONS:

- A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of the permanent service.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous, unsanitary conditions, or public nuisances to develop or persist on the Site.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

- A. Water: Provide potable water approved by local health authorities.
- B. Water Hoses: Provide 3/4-inch (19-mm), heavy-duty, abrasion-resistant, flexible rubber hoses 100 feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.
- C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.
- D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
- E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.
- F. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.
- G. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.01 TEMPORARY UTILITIES:

- A. General:
 - 1. Engage the appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
 - 2. Provide adequate utility capacity at each stage of construction. Prior to availability of temporary utilities at the Site, provide trucked-in services as required for start-up of construction operations.
 - 3. Furnish, install, and maintain temporary utilities required for adequate construction, safety, and security. Modify, relocate, and extend systems as Work progresses. Repair damage caused by installation or use of temporary facilities. Grade the areas of Site affected by temporary installations to required elevations and grades, and clean the area.

Remove on completion of Work or until service or facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

4. The types of temporary construction utilities and facilities required include, but not by way of limitation, water distribution, drainage, dewatering equipment, enclosure of Work, heat, ventilation, electrical power distribution, lighting, hoisting facilities, stairs, ladders, and roads.
5. Inspect and test each service before placing temporary utilities in use. Arrange for required inspections and tests by governing authorities, and obtain required certifications and permits for use.
6. Materials used for temporary service shall not be used in the permanent system unless so specified or acceptable to Engineer.

3.02 TEMPORARY ELECTRICITY AND LIGHTING:

A. Use of Existing System:

1. Owner's existing system may be used for temporary electricity.
2. Provide connections to existing facilities, size to provide service required for power and lighting.
3. Power Source: Make connections to Owner's service, located at point indicated or instructed by Owner.
4. Modify, supplement, and extend service as necessary to meet needed requirements and prevent overloading of existing system.
5. Protect system to prevent interference with Owner's normal usage.
6. Cost of power used will be paid by Contractor.

3.03 TEMPORARY HEAT AND VENTILATION:

A. General:

1. Provide temporary heat, ventilation, and cooling as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation of materials, and to protect materials and finishes from damage. Protect from adverse effects of low temperatures or high humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
2. Methods of heating and fuel shall be suitable for particular purposes. Portable heaters shall be standard approved units with controls.

B. Use of Existing Systems:

1. Existing systems may be used for temporary heating, cooling, and ventilating. Modify and extend systems, or supplement, as necessary to comply with specified requirements.
 - a. Maintain or replace existing filters; install temporary filters in extensions as necessary to keep occupied or finished areas free of dust.
 - b. Provide connections to existing facilities; extend and supplement with temporary units as required to comply with requirements.

C. Costs of Installation and Operation:

1. Pay fees and charges for applications, permits, and inspections.
2. Pay costs of installation, operation, maintenance, removal of equipment, and restoration of existing or permanent facilities if used.
3. Cost of power and fuel used will be paid by Contractor.

3.04 TEMPORARY WATER:

1. Owner's existing system may be used for temporary water.
 2. Make connections to existing facilities to provide water for construction purposes.
 - a. Water Source: Make connections to Owner's service located at point indicated or where instructed by Owner.
 3. Modify, supplement, and extend system as necessary to meet temporary water requirements and prevent overloading of existing system.
 4. Regulate system to prevent interference with Owner's usage.
- B. Costs of Installation and Operation:
1. Pay all costs for installation, maintenance, and removal.
 2. Cost of water used will be paid by Contractor.

3.05 TEMPORARY GAS:

- A. Use of Existing System:
1. Not Permitted.
- B. Costs of Installation and Operation:
1. Pay all costs for installation, maintenance, and removal.
 2. Cost of gas used will be paid by Contractor.

3.06 TEMPORARY SANITARY FACILITIES:

- A. Contractor-Furnished Facilities:
1. Furnish, install, and maintain temporary sanitary facilities for use through construction period. Remove on completion of Work.
 2. Provide for all construction workers under this Contract and representatives at the Site.
 3. Toilet facilities shall be of the chemical, aerated recirculation, or combustion type, properly vented, and fully enclosed with a glass- fiber-reinforced polyester shell or similar nonabsorbent material.
 4. Supply and maintain toilet tissue, paper towels, paper cups and similar disposable materials as appropriate for each facility. Provide appropriate covered waste containers for used material.
- B. Use of Existing Facilities:
1. Not Permitted.

3.07 TEMPORARY CONSTRUCTION AIDS:

- A. General:
1. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work; staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment.
 2. Materials may be new or used, must be suitable for the intended purpose, and meet the requirements of applicable codes, regulations, and standards.
- B. Use of Existing Stairs, Elevators, Hoists, and Similar Facilities:
1. Stairs in existing building may be used by construction personnel:
 2. Elevators in existing buildings may be used for construction labor.
 3. Maintain all existing facilities and equipment in a condition equivalent to or better than condition at beginning of usage.

3.08 TEMPORARY SAFETY AND HEALTH:

- A. General: Contractor shall be solely responsible for initiating, maintaining, and supervising all safety and health precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of and shall provide necessary protections to prevent injury or loss to, all employees on the Work and other persons and organizations who may be affected thereby.

3.09 TEMPORARY FIRE PROTECTION:

- A. General:
1. Contractor shall be responsible for development of a fire prevention and protection program for all Work under this Contract.
 2. The program shall comply with the applicable provisions for safety and protection specified in the Contract Documents and with applicable parts of the NFPA 10 and 241.
 3. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near such usable stairwell.
 4. Store combustible materials in containers in fire-safe locations.
 5. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
 6. Provide supervision of welding operations and similar sources of fire ignition.
 7. Post warning and instructions at each extinguisher location, and instruct construction personnel on proper use of extinguishers and other available facilities at Project Site. Post local fire department telephone number on or near each telephone instrument at Project Site.

3.10 INSTALLATION AND REMOVAL:

- A. Relocation: Relocate construction aids as required by progress of construction, storage limitations, or Work requirements and to accommodate requirements of Owner and other contractors at the Site.
- B. Removal: Remove temporary materials, equipment, and services when construction needs can be met and allowed by use of permanent construction, or at completion of the Project.
- C. Repair: Clean and repair damage caused by installation or by use of temporary facilities.
1. Remove foundations and underground installations for construction aids.
 2. Grade the areas of the Site affected by temporary installations to required elevations and clean the area.

END OF SECTION 01 51 00

SECTION 01 60 00 – EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes administrative and procedural requirements governing Contractor's selection of products for use in the Project.

1.02 RELATED REQUIREMENTS:

- A. The following Sections contain requirements that relate to this Section:
- B. For the applicability of industry standards to products specified: DIVISIONS 2 through 26.
- C. For the Submittal schedule see Sections 01 33 00.

1.03 DEFINITIONS:

- A. Definitions used in this Article are not intended to change the meaning of other terms used in these Contract Documents, such as "specialties," "systems," "structures," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
 - 1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "Material," "Equipment," "system," and terms of similar intent.
 - a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 - 2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
 - 3. "Equipment" is a product with operational or nonoperational parts, whether motorized, or manually operated, that may require service connections, such as wiring or piping.

1.04 SUBMITTALS:

- A. Submittal of preliminary procurement schedule is specified in Section 01 33 00

1.05 QUALITY ASSURANCE:

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
- B. Compatibility of Options: When the Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
- C. Nameplates: Along with required labels and operating data, manufacturer or producer's nameplates, imprints, or trademarks may be placed on surfaces exposed to view.
 - 1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
 - 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated Equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer including address (and telephone number).
 - b. Model and serial number.
 - c. Capacity.

1.06 TRANSPORTATION AND SHIPMENT:

- A. Shipment Preparation:
 - 1. Contractor shall require manufacturers and Suppliers to prepare products for shipment in a manner to facilitate unloading and handling, and to protect against damage, deterioration, or unnecessary exposure to the elements in transit and storage. Provisions for protection shall include the following:
 - a. Crates or other suitable packaging materials.
 - b. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery.
 - c. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.
 - d. Grease packing or oil lubrication in all bearings and similar items.
- B. Marking: Each product item shall be tagged or marked as identified in the delivery schedule or on Submittals. Complete packing lists and bills of material shall be included with each shipment. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together, and the packages or bundles are properly tagged or marked.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
 - 1. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected. Inspect shipment to assure:
 - a. Product complies with requirements of Contract Documents and reviewed Submittals.
 - b. Quantities are correct.
 - c. Containers and packages are intact, and labels are legible.
 - d. Products are properly protected and undamaged.
 - 2. Store products at the Site in a manner that will facilitate inspection and measurement of quantity or counting of units. Mark deliveries of component parts of Equipment to identify the Equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units.
 - 3. Store heavy Materials away from the Project structure in a manner that will not endanger the supporting construction.
 - 4. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, and with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
 - 5. Protect motors, electrical Equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter.
 - 6. Protect exposed machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds.
 - 7. Protect bearings and similar items with grease packing or oil lubrication.
 - 8. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation.
- B. Handling:
 - 1. Provide equipment and personnel necessary to unload and handle products, by methods to prevent damage or soiling to products, or packaging.
 - 2. Handle by methods to prevent bending or oversteering. Where lifting points are designated, lift components only at those points.

3. Provide additional protection to surrounding surfaces as necessary to prevent damage.
4. Repair damage and touchup coatings if equipment and materials affected during handling or installation.
- C. Maintenance of Storage:
 1. Inspect stored products on a scheduled basis.
 2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained.
 3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents.
 4. For mechanical and electrical Equipment in long-term storage, provide manufacturer's service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service Equipment on a regularly scheduled basis.
- D. Protection After Installation: Provide substantial coverings as necessary to protect installed products from damage from subsequent construction operations. Remove coverings when no longer needed or as specified.

1.08 EXISTING EQUIPMENT AND MATERIALS:

- A. Products to be Reused:
 1. Turn over blind flanges to Owner after making tie-ins.
- B. Products Not to be Reused:
 1. Equipment and Materials designated to be removed but not reused or delivered to Owner, shall become the property of the Contractor and shall be removed from the Site.

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION:

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise specified or indicated, new at the time of installation.
 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
 2. Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Continued Availability: Where, because of the nature of its application, Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to Owner at a later date.
 4. Conform to applicable Specifications, codes, standards, and regulatory agencies.
 5. Comply with size, make, type, and quality specified, or as specifically approved in writing by Engineer.
 6. Manufactured and Fabricated Products:
 - a. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
 - b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
 - c. Equipment and Materials shall be suitable for service conditions intended.
 - d. Equipment capacities, sizes, and dimensions indicated or specified shall be adhered to unless variations are specifically approved in writing by Engineer.
 - e. Provide labels and nameplates where required by regulatory agencies or to state identification and essential operating data.

7. Do not use products for any purpose other than that for which designed.
8. To the fullest extent possible, provide products of the same kind from a single source.
9. All equipment shown on the P&IDs supplied by Contractor shall be supplied with an identification name plate as approved by Owner.
 - a. Nameplates shall be like in kind to existing equipment.
10. All material shown on the P&IDs supplied by Contractor shall be supplied with an equipment tag as approved by Owner.
 - a. Tags shall be stainless-steel with thickness of 0.040 inches. The metal tag shall be stamped with the valve identification number and service. Tags shall be permanently attached to the valve using 18-gage stainless-steel wire.

PART 3 - EXECUTION

3.01 INSTALLATION OF PRODUCTS:

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place except as required for proper movement and performance, and accurately located and aligned with other Work.
 1. Obtain and distribute copies of manufacturer's printed instructions and recommendations if not a part of Submittals, containers, or packaging to parties involved in the installation, including a copy to Engineer
 2. Maintain one complete set of instructions at the Site during installation and until completion.
 3. Handle, install, connect, clean, condition, and adjust products in accordance with such instructions and in conformance with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.
- B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- C. Seal exterior wall and penetrations.
 1. Wall penetration covers and flashing shall be like and kind to existing materials in color, shape, and construction.

END OF SECTION 01 60 00

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY:

- A. Definition: Cutting and patching includes cutting into existing construction to provide for the installation of Work, and the repair required to restore materials to their original or better condition.
 - 1. Cutting and patching is performed as part of the Work and for coordination of the Work, to uncover Work for access or inspection, to obtain samples for testing, to permit alterations to be performed, or for other similar purposes.
 - 2. Cutting and patching performed during the manufacture of products or during the initial fabrication, erection, or installation process is not considered to be cutting and patching under this definition. Drilling of holes to install fasteners and similar operations is also not considered to be cutting and patching.

1.02 RELATED REQUIREMENTS:

- A. Refer to other Sections of these Specifications for specific cutting and patching requirements and limitations applicable to individual units of Work.

1.03 SUBMITTALS:

- A. Cutting and Patching Proposal: Submit a proposal describing procedures well in advance of the time cutting and patching will be performed if Owner requires approval of these procedures before proceeding. Request approval to proceed. Include the following information, as applicable, in the proposal:
 - 1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.
 - 2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
 - 3. List products to be used and firms or entities that will perform Work.
 - 4. Indicate dates when cutting and patching will be performed.
 - 5. List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
 - 6. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure.
 - 7. Approval by Engineer to proceed with cutting and patching does not waive Engineer's right to later require complete removal and replacement of defective Work.

1.04 QUALITY ASSURANCE:

- A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.
 - 1. Obtain approval of the cutting and patching proposal before cutting and patching the following structural elements:
 - a. Foundation construction.
 - b. Bearing and retaining walls.
 - c. Structural concrete.
 - d. Structural steel.

- e. Lintels.
- f. Timber and primary wood framing.
- g. Structural decking.
- h. Stair systems.
- i. Miscellaneous structural metals.
- j. Exterior curtain-wall construction.
- k. Equipment supports.
- l. Piping, ductwork, vessels, and Equipment.
- m. Structural systems for special construction.
- B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
 - 1. Obtain approval of the cutting and patching proposal before cutting and patching the following operating elements or safety related systems:
 - a. Primary operational systems and Equipment.
 - b. Water, moisture, or vapor barriers.
 - c. Membranes and flashings.
 - d. Control systems.
 - e. Communication systems.
 - f. Electrical wiring systems.
 - g. Operating systems for special construction.
- C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the building's aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually unsatisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. GENERAL: Except as otherwise indicated, specified, or as directed by Engineer, use materials for cutting and patching that are identical to existing materials. If identical materials are not available or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Before cutting, examine the surfaces to be cut and patched and the conditions under which the Work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the Work.

3.02 PREPARATION:

- A. Temporary Support: Provide adequate temporary support of Work to be cut to prevent failure.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that may be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

- C. Precautions: Take precautions not to cut existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated, until provisions have been made to bypass them.

3.03 PERFORMANCE:

- A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete Work without delay.
 - 1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
- B. Cutting:
 - 1. Cut existing construction using methods that are least likely to damage elements to be retained, or adjoining construction. Where possible, review proposed procedures with the original installer.
 - 2. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces. Temporarily cover openings when not in use.
 - 3. Bypass utility services such as pipe and conduit before cutting, where such utility services are shown or required to be removed, relocated, or abandoned. Cut off conduit and pipe in walls or partitions to be removed. After bypass and cutting, cap, valve, or plug and seal tight remaining portion of pipe and conduit to prevent entrance of moisture or other foreign matter.
- C. Patching:
 - 1. Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the Work.
 - 2. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
 - 3. Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining Work in a manner which will eliminate evidence of patching and refinishing.

3.04 CLEANING:

- A. Thoroughly clean areas and spaces where Work is performed. Remove dirt, dust, grease, paint splatter, mortar, oils, sealants, and items of similar nature. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01 73 29

SECTION 01 75 00 – MANUFACTURER'S FIELD SERVICES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section includes requirements of manufacturers for services to be performed at the Project Site in regard to erection, start-up, and testing of Equipment.

1.02 SERVICES REQUIRED:

- A. Services with Equipment and Materials Installed Under this Contract:
 - 1. Coordinate services of qualified field personnel from the Equipment Supplier or manufacturers of Equipment furnished or installed under this Contract, as required to perform all manufacturer's Field Services called for in the Specifications. Field personnel shall be certified by the Equipment Supplier or manufacturer of the specific product or system as having the necessary knowledge and experience to perform the required functions.
 - 2. Where such service is specified, Contractor shall not perform any Work related to the installation or operation of Equipment furnished and installed under this Contract without direct observation and guidance of the Equipment Supplier's or manufacturer's field personnel unless Engineer concurs otherwise.
- B. Owner will provide a qualified field technician for equipment supplied by Owner.

PART 2 - PRODUCTS: SPECIFIED IN APPLICABLE SECTIONS.

PART 3 - EXECUTION

3.01 OPERATION AND TESTING:

- A. Contractor shall place all equipment and systems installed into successful operation including the following:
 - 1. Supplying the services of qualified representatives of manufacturers of equipment and material furnished when, in the opinion of Engineer, such services are required, at no additional cost to Owner.
 - 2. Supplying at least one (1) full time Supervisor for each Subcontractor to supervise, coordinate, and control the Subcontractor's work.
 - 3. Following instructions of manufacturer's representatives for equipment and materials supplied by either Contractor or Owner.
 - 4. Following operational instructions given in manuals supplied by the manufacturers of equipment and materials.
 - 5. Providing all construction labor required for initial operation until such time as individual items, systems, or sections of the Work are accepted for operation by Owner, which labor shall be supplied when required, including overtime, weekend, holiday and around-the-clock basis to meet the startup program of Owner and Engineer.
 - 6. Cooperate with Owner, work with Owner's personnel, and follow Owner's standard operating procedures.
 - 7. Providing construction labor as required, in addition to Owner's operating and maintenance personnel, after "acceptance for operation" to perform specified work such as strainer cleaning, and to complete the construction in accordance with the Contract requirements to ensure no interruptions to the startup operational phase. This labor shall be furnished on an overtime basis, if required by Owner's start up sequence.

8. Providing temporary piping and wiring which may be required for operation during partial system operating conditions, and any construction labor required because of these temporary hookups.
- B. Placing Equipment in Operation:
 1. Support the placing of all Equipment installed under this Contract into successful operation according to instructions of the Equipment Supplier, Engineer or field representative (appointed by Engineer or Owner), including making all required adjustments, tests, operation checks, and the following:
 - a. Cleaning, sounding, blowing-out, and flushing of lubricating oil and water systems, and other pipelines.
 - b. Lubrication (lubricants supplied by Contractor).
 - c. Tests of lubrication system safety interlocks and system performance.
 - d. Final alignment checks and measurements made under observation of Engineer and Owner. Alignment checks shall include opening connections, if required, to ensure there are no abnormal stresses on Equipment from pipes, ducts, or other attachments. Alignment shall be within tolerances specified by the manufacturer, and measurements shall be recorded and furnished to Engineer.
 - e. Motor rotation checks before connecting couplings.
 - f. Inspection of sleeve bearings for adequate contact.
 - g. Checking of anchor-bolt tensions, grout, and shims. Tighten anchor bolts with calibrated torque wrenches using care not to over stress bolts.
 - h. Piping leak checks.
 2. After "run-in" and acceptance of alignment, affix major Equipment in place using standard tapered dowels with jack-out nuts at head end to facilitate removal.
 3. Furnish all necessary attendants and personnel as part of the Work to accomplish the above operations until such time as individual items, systems, Equipment, or sections of the plant are acceptable for operation by Owner.
 4. Owner will provide electricity, and water, for placing Equipment in operation. Owner's operating personnel will assist.
- C. Owner will accept equipment and systems for operation that have been placed into successful operation by Contractor. "Acceptance for operation" means that Owner will release Contractor from operation of the particular item, system, or section of the Work and will assume operational and routine maintenance duties and responsibility by supplying his own operating and maintenance personnel. "Routine maintenance" referred to above includes lubrication and blowing down drip legs, but does not include repairs, realignment, flange tightening, gasket replacement, valve repacking, strainer cleaning, or work resulting from defective material or workmanship. "Acceptance for operation" does not relieve Contractor from responsibilities related to defective materials and workmanship; neither does it constitute final acceptance for making final payment. Acceptance for operation will be made in writing by Owner.
- D. Performance Tests:
 1. Equipment Furnished Under this Contract:
 - a. Owner will conduct acceptance tests after installation to determine if the Equipment installed as part of the Work perform in accordance with Contract Documents and

- as guaranteed. Final acceptance of Equipment will be based on acceptable results of such tests.
- b. No tests will be conducted on Equipment for which Supplier's or manufacturer's Field Service is specified unless Supplier's or manufacturer's field representative is present and declares in writing that the Equipment is ready for such test.
 - c. Contractor will be notified by Owner so that Contractor can have a representative or manufacturer's representative present during any tests of Equipment for which Supplier's or manufacturer's Field Service is not specified.
 - d. The tests will be made as set forth in the Contract Documents unless the interested parties mutually agree upon some other manner of testing.

END OF SECTION 01 75 00

SECTION 01 78 00 – CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes administrative and procedural requirements for Contract closeout including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Project record document submittal.
 - 3. Submittal of warranties.
 - 4. Final cleaning.
- B. Closeout requirements for specific construction activities are included in the appropriate Sections of the Specifications.

1.02 RELATED REQUIREMENTS:

- A. Prerequisites to Substantial Completion and Final Acceptance: GENERAL CONDITIONS.
- B. Submittals: Section 01 33 00.
- C. Manufacturer's Field Service: Section 01 75 00.
- D. Warranties: Section 01 78 36.

1.03 SUBSTANTIAL COMPLETION:

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as Substantially Complete.
 - a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
 - b. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete Work, and reasons the Work is not complete.
 - 2. Advise Owner of pending insurance changeover requirements.
 - 3. Submit specific warranties, workmanship Bonds, maintenance agreements, final certifications, and similar documents.
 - 4. Obtain and submit releases enabling Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 5. Submit record drawings, instruction books and operating manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
 - 6. Deliver tools, spare parts, extra stock, and similar items.
 - 7. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 8. Complete start-up testing of systems and instruction of Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the Site, along with mockups, construction tools, and similar elements.
 - 9. Complete final cleanup requirements, including touchup painting.
 - 10. Touch up and otherwise repair and restore marred, exposed finishes.

- B. Inspection Procedures: On receipt of a request for inspection, Engineer will either proceed with inspection or advise Contractor of unfilled requirements. Engineer will prepare the Certificate of Substantial Completion following inspection or advise Contractor of construction that must be completed or corrected before the certificate will be issued.
 - 1. Engineer will repeat inspection when requested and assured by Contractor that the Work is Substantially Complete.
 - 2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.04 FINAL ACCEPTANCE:

- A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
 - 1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
 - 2. Submit an updated final statement, accounting for final additional changes to the Contract Price.
 - 3. Submit a certified copy of Engineer's final inspection list of items to be completed or corrected, endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by Engineer.
- B. Reinspection Procedure: Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to Engineer.
 - 1. Upon completion of reinspection, Engineer will prepare a certificate of final acceptance. If the Work is incomplete, Engineer will advise Contractor of Work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 - 2. If necessary, reinspection will be repeated.

1.05 RECORD DOCUMENT SUBMITTALS:

- A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - 1. Record information concurrently with construction progress.
 - 2. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work. Mark each document "PROJECT RECORD" in neat, large, printed letters.
 - 3. Mark new information that is important to Owner but was not shown on Contract Drawings or Shop Drawings.
 - 4. Note related Change Order numbers where applicable.
 - 5. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.
 - 6. Upon completion of the Work, submit record drawings to Engineer for Owner's records.

7. Include the following:
 - a. Depths of various elements of foundation in relation to finish first floor datum.
 - b. Horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.
 - c. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of construction.
 - d. Where Submittals are used for mark-up, record a cross-reference at corresponding location on Drawings.
 - e. Field changes of dimension and detail.
 - f. Changes made by Change Order or other Modifications.
 - g. Details not on original Contract Drawings.
- C. Record Specifications: Maintain one complete copy of the Project Manual including Addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and Modifications issued in printed form during construction.
 1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
 2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
 3. Note related record drawing information and product data.
 4. Upon completion of the Work, submit record Specifications to Engineer for Owner's records.
 5. Include the following:
 - a. Manufacturer, trade name, catalog number, and Supplier of each product and item of Equipment actually installed, particularly optional and substitute items.
 - b. Changes made by Addendum, Change Order, or other Modifications.
 - c. Related Submittals.
- D. Electronic Documentation:
 1. Provide electronic versions of record documents showing "as-constructed" conditions, "as-constructed" construction progress schedule, master field drawing list showing final revisions, instruction books, and operating manuals via email on Adobe PDF generated from the native file format.
- E. Warranties and Bonds: Shall be according the Terms and Conditions established by Indiana University.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 FINAL CLEANING:

- A. General: Contractor shall keep the Site premises free from accumulations of waste materials, rubbish, and other debris resulting from the Work
- B. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.

- C. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
 - 1. Extra materials of value remaining after completion of associated Work become Owner's property. Dispose of these materials as directed by Owner.
- D. Repairs:
 - 1. Repair damaged protective coated surfaces.
 - 2. Repair roads, walks, fences, and other items damaged or deteriorated because of construction operations.
 - 3. Restore all ground areas affected by construction operations.

END OF SECTION 01 78 00

SECTION 01 78 36 – WARRANTIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers standard warranties on products and special warranties.
 - 1. Refer to the Terms and Conditions for terms of the Contractor's period for correction of the Work.

1.02 RELATED SECTIONS:

- A. The following Sections contain requirements that relate to this Section:
 - 1. Procedures for submitting warranties: Section 01 33 00.
 - 2. Contract closeout procedures: Section 01 78 00
 - 3. Specific requirements for warranties on products and installations specified to be warranted: DIVISIONS 02 through 26.
 - 4. Certifications and other commitments and agreements for continuing services to Owner: Specified throughout the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve Suppliers, manufacturers, and Subcontractors required to countersign special warranties with Contractor.

1.03 DEFINITIONS:

- A. Standard product warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by manufacturer to Owner.
- B. Special warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for Owner.

1.04 WARRANTY REQUIREMENTS:

- A. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted construction.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Expressed warranties made to Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the Law. Expressed warranty periods shall not be interpreted as limitations on the time in which Owner can enforce such other duties, obligations, rights, or remedies.
 - 1. Rejection of Warranties: Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

- E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, Owner reserves the right to refuse to accept the Work, until Contractor presents evidence that entities required to countersign such commitments are willing to do so.

1.05 SUBMITTALS:

- A. Submit written warranties to Engineer prior to the date certified for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the Date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of Engineer.
 - 1. When a designated portion of the Work is completed and occupied or used by Owner, by separate agreement with Contractor during the construction period, submit properly executed warranties to Engineer within 15 days of completion of that designated portion of the Work.
- B. When the Contract Documents require Contractor, or Contractor and a Subcontractor, Supplier, or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by required parties. Submit a draft to Owner, through Engineer, for approval prior to final execution.
 - 1. Refer to DIVISIONS 02 through 26 Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submit all warranties electronically to Owner via Adobe PDF.
 - 1. When warranted construction requires operation and maintenance manuals, provide additional electronic copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 01 78 36

SECTION 01 91 13 – GENERAL COMMISSIONING

PART 1 GENERAL

1.01 DESCRIPTION

- A. The University will hire a Commissioning Authority to verify that the systems work as intended. The Commissioning Authority will inform the Owner of the results of the commissioning and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.
- B. Commissioning is the process to verify to the Owner that systems, equipment, mechanical, electrical, controls and special systems function together properly to meet performance requirements and design intent, and as described in the Contract Documents. The Construction Manager, Contractor, and subcontractors shall be responsible for participation in the commissioning process as outlined below and in references and attachments throughout the Contract Documents. The Contractor shall furnish labor and materials sufficient to meet all requirements of building commissioning under this contract.
- C. Various sections in the Division 23 and Division 26 Specifications outline the specific commissioning responsibilities of each Contractor for the division and also obligate the Construction manager (CM) to coordinate and manage the commissioning responsibility of those Contractors.

1.02 REQUIREMENTS INCLUDED

- A. Duties of Construction Manager and Contractor
- B. Duties of Commissioning Authority
- C. Acceptance Procedures
- D. Performance Period
- E. Training and Instruction

1.03 RELATED SECTIONS

- A. Section 230800 – Commissioning of Mechanical Systems
- B. Section 260800 – Commissioning of Electrical Systems

1.04 TERMS

- A. Acceptable Performance: A component or system being able to meet specified design parameters under actual load including satisfactory documented completion of all functional performance tests, control system trending and resolution of outstanding issues.
- B. Basis of Design: The Basis of Design is the documentation provided by the design engineer documenting design decisions that were made to meet the design intent as defined by Owner. The Basis of Design describes the systems, components, conditions and methods to meet the design intent.
- C. Commissioning Plan: The Commissioning Plan is prepared by the Owner's Commissioning Authority and defines the scope and format of the commissioning process and the responsibilities of all involved parties. The Commissioning Plan is provided to all commissioning team members to inform them of the intent and scope of the commissioning work to ensure inclusion in the project scope and to expedite the commissioning process.

- D. Functional Performance Testing: That full range of checks and tests carried out to determine if all components, sub-systems, systems and interfaces between systems function in accordance with the Contract Documents. In this context, “function” includes all modes and sequences of control operation, all interlocks and conditional control responses and all specified responses to abnormal emergency conditions. The functional performance tests will be prepared by the Commissioning Authority.
- E. Commissioning: The process to assure the Owner that building equipment, controls and systems function together properly to meet design intent and performance requirements shown in a composite manner in the Contract Documents.
- F. Resolution Log: The purpose of this log is to provide a method for tracking and resolution of deficiencies discovered as a result of the commissioning process. This list also includes the current disposition of issues and the date of final resolution as confirmed by the Commissioning Authority. Deficiencies are defined as those issues where products, execution or performance do not satisfy the Specifications and/or the design intent. The Resolution Log will be created and managed by the Commissioning Authority.
- G. Pre-functional Construction Checklists: Checklist is prepared by the Commissioning Authority. Checklist shall be by system or equipment to verify installation and start-up of equipment is complete and ready for functional testing. These documents require signature by the Contractor prior to continuing with the commissioning process.

1.05 DUTIES OF CONSTRUCTION MANAGER AND CONTRACTORS

- A. Provide copies of all shop drawings, manufacturer’s literature, maintenance information or other information as may be needed for systems to be commissioned to the Commissioning Authority.
- B. Collect the information requested by Commissioning Authority for development of a complete Commissioning Plan, a web-based Commissioning application, and functional tests and provide to the Commissioning Authority. The Contractor shall review these documents and confirm in writing to the Owner, and Commissioning Authority any known areas of conflict or areas requiring clarifications.
- C. Collect all proposed start-up and Pre-functional Construction Checklists documentation.
- D. To use the web-based Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance at one training class is required for all Contractors. This training will take place at the construction Cx kick off. The application will need to be accessed by Contractors’ tablet/ computer in the field. Checklist must be completed in the field. Computer or tablet will need to be supplied by each Contractor.
- E. Plan for and incorporate commissioning activities into the construction schedule.
- F. Provide Commissioning Authority with submittals for all systems to be commissioned including controls system and wiring diagrams and narrative sequences of operation, in time for use in preparing the Functional Test Procedures.
- G. Provide a fully operational system per Specifications, started, verified, debugged, calibrated, balanced, tested and under automatic control.
- H. Provide at the end of the job the following items for inclusion in the systems manual.
 - 1. As built, Control drawings, sequences of control/ operation
 - 2. A table of all set points
 - 3. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown. This needs to be listed in a word or excel formatted document.

4. A list of all manufacture recommended preventive maintenance procedures for all commissioned equipment and systems. This needs to be listed in a word formatted document.
- I. Provide qualified personnel to participate in the commissioning tests, including seasonal testing.
- J. Cooperate with the Commissioning Authority's personnel.
- K. Provide access to site for the Commissioning Authority for review, verification and testing activities.
- L. Provide organized storage space for project drawings, Specifications, equipment and materials submittals, shop drawings and operation and maintenance manuals in the job site trailers or job site office space.
- M. Provide updates to all project documentation to reflect all supplemental instructions, addenda or other revisions to the project construction documents. Updates and supplemental instructions must be posted to the master set of documentation for review and reference by all Contractors and for the Commissioning Authority's use.
- N. Provide adequate time and resources to perform functional testing of system to be commissioned in contract.
- O. Coordinate participation of the mechanical, electrical, controls, 3rd party testing agencies, and TAB subcontractors in the commissioning process.
- P. Participate in any efforts to finalize sequences of operations with Owner, Designers and Commissioning Authority.
- Q. Verify that coordination, installation, quality control and final testing have been completed such that installed systems and equipment comply with construction documents.
- R. Review the Commissioning Plan, Project Reports and test results and submit comments to the Commissioning Authority.
- S. In a timely manner, address issues identified during construction that may affect the commissioning process or final system performance.
- T. Perform start-up and testing of electrical equipment and systems and document as required with start-up reports and completion of Pre-functional Construction Checklists. These checklists include installation documentation, start-up documentation, controls point-to-point documentation and calibration documentation, verification that controls sequence of operations meets design intent and TAB final documentation. Reports will be stored in the Contractor's field trailer. Sub-contractor will coordinate efforts to complete the pre-functional documentation.
- U. Issue a written Notice of Readiness for each system to Commissioning Authority upon completion of all systems work, start-up and Pre-functional Construction Checklists requirements by trade sub-contractors.
- V. Provide a detailed start up plan for CxA's review, comment and recommendation.
- W. Operate equipment and systems as required for functional performance testing. This includes, but is not limited to, manipulating the appropriate controls systems to execute the Functional Test Procedures.
- X. Participate in the fine-tuning or troubleshooting of system performance, if either of these measures becomes necessary.
- Y. Compensate Owner for retesting and/or troubleshooting time required by the Commissioning Authority because Contractor's systems do not meet specified performance. Back-charge Subcontractors as necessary to collect reimbursement for Commissioning Authority compensation.
- Z. Review operating and maintenance data for verification, organization, distribution and conformance to requirement of the Contract Documents.

- AA. Submit complete operation and maintenance information and as-built drawings to the Commissioning Authority for compliance review of the requirement of the Contract Documents.
- BB. Provide documentation of training for the systems listed to be commissioned.
- CC. Provide proprietary test equipment and qualified personnel to operate test equipment required to test all the systems and equipment in this project.

1.06 DUTIES OF COMMISSIONING AUTHORITY

- A. Develop the Commissioning Plan.
- B. Develop Functional Test Procedures from Contract Documents and final equipment submittals including narrative sequences of operation, control diagrams and software code for execution with the assistance of Contractor staff as required.
- C. Review the Contractor's submittals relative to the systems to be commissioned.
- D. Perform site observations to follow installation progress and to verify system installation quality and readiness for testing.
- E. Observe or review documentation of validation activities including electrical testing and functional tests for normal and off-normal operating sequences.
- F. Review submittal of all required pre-functional and start-up documentation provided by Contractor for completeness and reasonableness. This includes installation documentation, start-up documentation, and point-to-point checklists prior to initiation of functional testing.
- G. Schedule, direct and witness complete functional testing as defined in the Commissioning Plan and Functional Test Procedures. All testing shall be performed by the Contractor and documented by the Commissioning Authority
- H. Witness and verify satisfactory completion of equipment and system tests and inter-systems functional performance tests.
- I. Conduct commissioning meetings.
- J. Provide site observation, functional tests or other project reports in a timely manner.
- K. Document inconsistencies or deficiencies in system operations and system compliance. System deficiencies shall be forwarded to the Owner's Representative and documented in a Resolution Log.
- L. Coordinate via the Construction manager participation of Owner's personnel with equipment, component and systems performance verification and participation in required training.
- M. When commissioning has been successfully completed, recommend acceptance to the Owner.
- N. Once all functional tests have been successfully completed and all outstanding issues resolved, the Commissioning Authority will provide the Owner with a Final Commissioning Report of all commissioning activities that occurred during the project.
- O. Provide technically qualified personnel when scheduled.
- P. Verify that the specified training schedule of Owner's personnel is provided.
- Q. The Commissioning Authority will formally communicate with the Contractor and Subcontractor via approved project channels. It is expected, however, that informal communication and coordination will be conducted directly with the subcontractors; records of all contacts will be sent to the Engineer through the normal channels.
- R. The Commissioning Authority is not authorized to release, revoke, alter or expand requirements of Contract Documents, to approve or accept any portion of the work or to perform any duties of the Contractor or Subcontractor.

1.07 COMMISSIONING PLAN

- A. The Commissioning Plan is a tool through which the commissioning process is described and incorporates the Owner, Engineer, Contractor, Subcontractor and Commissioning Authority roles relative to the commissioning process. Commissioning team members are all subcontractors, contractors and design professionals whose participation is of benefit in the delivery of a fully functioning building to the Owner. The plan shall describe the communication, authority and responsibility of commissioning team members. The Commissioning Plan will include the following:
1. The purpose of commissioning
 2. Detail the commissioning process
 3. Commissioning team members' responsibilities
 4. Describe Pre-functional Construction Checklist Procedures
 5. Provide a guideline for acceptance of each piece of equipment or system
 6. Systems to be commissioned

1.08 SYSTEMS TO BE COMMISSIONED

- A. Systems and Equipment to Be Functionally Tested: The features of the systems listed below are to be functionally tested and other building features will be evaluated for installation quality during construction. The functional performance testing will include the following systems and equipment:

1. Mechanical Systems

System	Estimated Quantity	Sampling Rate
Chillers CH-3 and CH-4	2	100%
Cooling Tower 1B Cells CT-5, CT-6, CT-7	3	100%
Pumps	6	100%
Valves	3	100%

2. Electrical Systems

System	Estimated Quantity	Sampling Rate
480V Unit Substation – CH-3 and CH-4 Feeder	2	100%
Cooling Tower 1B Cells	3	100%
Pump Motor Controls	6	100%

1.09 COMMISSIONING ACTIVITIES

- A. The Commissioning Schedule: This schedule defines the milestones and conditions that must be achieved before system testing and other commissioning activities can commence. The schedule also includes the expected duration of the various tasks so that the commissioning process can be incorporated into the overall construction schedule.
- B. Preparation for Testing: To prepare for the system performance testing, the Commissioning Authority will examine the design and Construction Documents, develop with appropriate Subcontractors Pre-functional Construction Checklists of construction

- responsibilities that must be completed prior to testing and develop detailed Functional Test Procedures and data forms.
- C. Using the Pre-functional Construction Checklists, the Subcontractor must verify that the systems they install are in compliance with the Construction Documents and are fully functional. Commissioning is not intended to be a testing or inspection function that replaces any of the Subcontractors' obligations for testing and proof of performance. Functional testing will only begin when checklists are completed by the appropriate subcontractors, submitted online and verified by the Commissioning Authority.
 - D. Functional Testing: Functional testing is performed by experienced and qualified technicians of the Subcontractor(s), responsible for installation as facilitated by the Commissioning Authority and may be observed by other members of the commissioning team. Functional testing will verify proper sequencing, operation and performance of installed equipment and systems under realistic operating conditions. The functional testing will follow with written Functional Test Procedures with test results documented for permanent record.
 - E. Documentation: In addition to the Pre-functional Construction Checklists and Functional Test Procedures, written documentation will be maintained for all other commissioning activities. Project communication reports shall be issued by the Commissioning Authority to the Subcontractor and key members of the commissioning team to document apparent deficiencies identified during examination of design and construction documents, daily activities on-site, construction deficiencies and successful or unsuccessful functional test results. At the end of the commissioning process, all documentation will be assembled and summarized in the Final Commissioning Report.
 - F. Deficiency Resolution: When a Project Report is issued to address an identified deficiency, the Contractor shall forward the reports to the appropriate parties to initiate corrective action in an expeditious manner. The designer is relied on for supplemental instructions or design modifications and issuance of final design details and the Subcontractors are relied on for implementation of that design. Change orders must be issued through proper contract channels.

1.10 FUNCTIONAL TEST PROCEDURES

- A. The Functional Test Procedures include, but are not limited to, the following:
 - 1. Verification of all equipment's ability to perform to the design intent.
 - 2. Verification of the performance of sub-systems consisting of combinations of equipment.
 - 3. Verification of the performance of the automatic controls.

PART 2 PRODUCTS

2.01 Not used in this section.

PART 3 EXECUTION

3.01 GENERAL

- A. Operating equipment and systems shall be tested in presence of Owner's Commissioning Authority to demonstrate compliance with specified requirements.
 - 1. Notify Owner, in writing, fourteen (14) days prior to tests scheduled under requirements of this Section.

2. Testing shall be conducted under specified design operating conditions as recommended or approved by Owner.
- B. Functional performance testing shall be completed and accepted by Owner as a condition of final completion.
- C. All elements of systems shall be tested to demonstrate that total systems satisfy all requirements of these Specifications. Testing shall be accomplished on hierarchical basis. Test each piece of equipment for proper operation, followed by each sub-system, followed by entire system, followed by entireties to other major systems.
- D. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing sub contractor. Manufacturer shall provide the test equipment, demonstrate its use, operate test equipment and assist the Commissioning Authority in the commissioning process.
- E. Acceptance Documentation: A copy of the functional performance tests results shall be necessary acceptance documentation along with other specified requirements.

3.02 ACCEPTANCE PROCEDURES

- A. Prior to functional performance testing of each system, the Commissioning Authority shall observe and verify that the physical installation of components and systems being tested is substantially installed in accordance with the Contract Documents.
- B. Subcontractor's Tests
 1. System shall be checked for proper installation, shall be adjusted and calibrated to verify that it is ready to function as specified.
 2. All system elements shall be checked to verify that they have been installed properly and that all connections have been made correctly.
 3. All discrete elements and sub-systems shall be adjusted and checked for proper operation.
 4. Start-up and operational tests shall be complete, with all required Pre-functional Construction Checklists submitted for review by Commissioning Authority within five (5) days of each activity, prior to starting functional performance testing.
- C. CxA-witnessed Functional Tests
 1. Objective of these tests is to demonstrate that system is operating and complying with specified performance requirements.
 2. Owner-witnessed functional performance tests shall be performed on complete system. Each function shall be demonstrated to satisfaction of the Owner's Commissioning Authority on paragraph-by-paragraph basis of Commissioning Authority's written test procedure, developed to demonstrate conformance to requirements of the Specifications.
 3. Functional performance tests shall be witnessed and endorsed by the Commissioning Authority upon satisfactory completion.
 4. Actual testing program shall be conducted in accordance with prior approved procedures and shall be documented as required herein.
 5. Subcontractor shall notify Commissioning Authority and Owner at least two (2) weeks prior to date of functional performance tests.
- D. The functional performance testing process shall be accomplished for all equipment, sub-systems, systems and system interfaces. All must be tested for acceptances and there shall be a separate checklist for each to ensure documentation specific to each is complete.
- E. Each system shall be operated through all modes of system operation (e.g., seasonal, occupied, unoccupied, warm-up, cool-down, etc., as applicable) including every individual interlock and conditional control logic, all control sequences, both full-load

and part-load conditions and simulation of all abnormal conditions for which there is a specified system or controls response. The warm-up and cool-down test shall be a performance test.

- F. Temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset and component failure, shall be imposed at different operation loads to determine system stability and recovery time.
- G. When the functional performance of all individual systems has been proven, the interface or coordinated responses between systems shall be checked.
- H. Corrective Measures: If acceptable performance cannot be achieved, the cause of the deficiency will be identified. If it is determined that the deficiency was caused by the system or component not being installed per the manufacturer's recommendations or Contract Documents, the necessary corrective measures shall be carried out by the Sub contractor. Every check or test for which acceptable performance was not achieved shall be repeated after the necessary corrective measures have been completed. This re-testing process should be repeated until acceptable performance is achieved. The Sub contractor will be allowed one retest after initial testing of the equipment. If the retest fails the Sub contractor shall be financially responsible, at standard rates, to reimburse the Commissioning Authority for the additional time taken to achieve acceptable performance.

3.03 TRAINING AND INSTRUCTION

- A. Training and instruction of Owner personnel is a part of the commissioning process and essential for the proper operation of the facility. The sub contractors and vendors providing the training will complete training plans and submit to the Commissioning Authority for review and approval in conjunction with the Owner's representative.

3.04 RETESTING OR ADDITIONAL TESTING DUE TO FAILURES

- A. The cost, including the CxA's time, to retest a PC or FPT shall be the Construction Manager's (CM).
- B. The time for the CxA to direct any retesting required because a specific PC or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged to the Construction Manager, who may choose to recover costs from the party responsible for executing the faulty pre-functional test.
- C. If a second, subsequent startup, retest, or increased sampling is required, for any reason, or if Installing Subcontractor is not ready for a startup or test at the scheduled time, the CM shall compensate the Owner for the CxA's additional time and expenses. Compensation shall be computed by multiplying hours worked by CxA times CxA's established billing rate and adding the cost of CxA's expenses (including by way of example but not limitation: air travel, car rental, lodging, long distance, reproduction, special insurance, procured equipment, leased equipment, delivery service, and postage). CM may unilaterally withhold said funds from payments otherwise due to Installing Subcontractor.
 - 1. The Subcontractor shall respond in writing to the CxA and CM at least as often as commissioning meetings are being scheduled concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
 - 2. The CxA retains the original non-conformance forms until the end of the project.
 - 3. Any required retesting or increased test sampling by any subcontractor shall not be considered a justified reason for a claim of delay or for a time extension by the prime sub contractor.

- D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CM. In such case, the Subcontractor shall provide the Owner with the following:
1. Within one week of notification from the CM, the Subcontractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM within two weeks of the original notice.
 2. Within two weeks of the original notification, the Subcontractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The CM will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples of the proposed solution will be installed by the Subcontractor and the CM will be allowed to test the installations for up to one week, upon which the CM will decide whether to accept the solution.
 5. Upon acceptance, the Subcontractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.05 SCHEDULE

- A. Refer to Commissioning Plan for commissioning milestones that need to be incorporated into construction schedule.

END OF SECTION 01 91 13

SECTION 02 41 19 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

1.02 SUMMARY:

- A. This Section includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of selected site elements.
 - 3. Salvage of existing items to be reused or recycled.

1.03 REFERENCE STANDARDS:

- A. The American Society of Safety Engineers
 - 1. ASSE A10.6-2006: Safety Requirements for Demolition Operations (ANSI)
- B. Code of Federal Regulations
 - 1. 40 CFR 82-2012: Protection of Stratospheric Ozone
- C. NFPA
 - 1. NFPA 241-2013: Safeguarding Construction, Alteration, and Demolition Operations
- D. Resilient Floor Covering Institute
 - 1. Recommended Work Practices for the Removal of Resilient Floor Coverings. 2011.

1.04 DEFINITIONS:

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.05 MATERIALS OWNERSHIP:

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
 - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.06 PREINSTALLATION MEETINGS:

- A. Pre-demolition Conference: Conduct conference at Posvar Plant, Pittsburgh, PA, unless otherwise indicated.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.07 SUBMITTALS:

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- D. Schedule of Selective Demolition Activities: Indicate the following:
 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted as much as possible.
 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 3. Coordination for shutoff, capping, and continuation of utility services.
 4. Use of elevator and stairs.
 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- E. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Submit before Work begins.
- F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.
- H. Inventory: Submit a list of items that have been removed and salvaged.

1.08 QUALITY ASSURANCE:

- A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.09 FIELD CONDITIONS:

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect/Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.
- F. Storage or sale of removed items or materials on-site is not permitted.

- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 COORDINATION:

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Perform or engage a professional Engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
 - 1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
- D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
- E. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- F. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video and templates.
 - 1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
 - 2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.02 PREPARATION:

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.03 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 2. Arrange to shut off utilities with utility companies.
 3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
 - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.04 PROTECTION:

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Specifications
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

3.05 SELECTIVE DEMOLITION, GENERAL:

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
 6. Maintain adequate ventilation when using cutting torches.
 7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 10. Dispose of demolished items and materials promptly.
 - B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - C. Work in Historic Areas: Selective demolition may be performed only in areas of Project that are not designated as historic.
 - D. Removed and Salvaged Items:
 1. Clean salvaged items.
 2. Pack or crate items after cleaning. Identify contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
 - E. Removed and Reinstalled Items:
 1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
 - F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- 3.06 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS:
- A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch (19 mm) at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

- B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.
- E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

3.07 DISPOSAL OF DEMOLISHED MATERIALS:

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction. Disposal should be in accordance with Division 1 specification requirements.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.08 CLEANING:

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 10 00 – CONCRETE FORMWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. All project specifications, drawings, and general provisions, including UPUI Division 01 Specification Sections, apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and correct installation. Any specific references mentioned herein are for convenience only.

1.02 SUMMARY:

- A. This Section includes formwork for cast-in-place concrete.

1.03 RELATED REQUIREMENTS:

- A. Section 03 20 00 - Concrete Reinforcement.
- B. Section 03 30 00 – Concrete.

1.04 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. American Concrete Institute (ACI):
 - a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
 - b. ACI 301 - Specifications for Structural Concrete.
 - c. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - d. ACI 347R - Guide to Formwork for Concrete.
 - 2. ASTM International (ASTM):
 - a. ASTM C31/C31M REV A – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - b. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FACING:

- A. Where concrete will be exposed to view after construction:
 - 1. Use exterior grade plywood at least 5/8 inch thick or steel forms capable of producing a smooth, uniform appearance.
 - 2. Do not use form-facing materials with raised grain, torn surfaces, worn edges, dents, or other defects that will impair the texture of concrete surfaces.
- B. Where concrete will not be exposed to view after construction:
 - 1. Exterior grade plywood at least 5/8 inch thick.
 - 2. Steel.
 - 3. Wood fiberboard.
 - 4. Dressed lumber free of loose knots.
- C. Treat forms with commercially available form releasing agents that will not bond with, stain, or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion, nor shall it impede the wetting of surfaces to be cured with water or curing compounds. Form releasing agents shall be VOC compliant with a

SECTION 03 10 00 – CONCRETE FORMWORK: continued

maximum VOC content of 3.8 lbs./gal. (450 g/L), or less where area restrictions are more stringent.

- D. Clean forms of sawdust, dust, dirt, and other foreign materials.

2.02 FORM TIES:

- A. Break back, coil, or screw type, except where otherwise specified.
- B. Use water-seal coil type in walls below grade and in walls of water bearing structures. Removable through-wall tapered ties shall not be used.
- C. Coil type shall leave conical depression in concrete.
- D. Space as required against pressure of fresh concrete.
- E. The portion of the form tie remaining in place shall provide for a clearance of two times the minimum dimension of the tie, but not less than 3/4 inch, from the formed surface.

2.03 CHAMFER STRIPS:

- A. Chamfer: 3/4 inch except where otherwise indicated.
- B. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

PART 3 - EXECUTION

3.01 FORM CONSTRUCTION:

- A. Conform to ACI 301, 318, and 347R, except Shop Drawings for formwork, shoring, and reshoring shall not be submitted for approval.
- B. Adequately brace, stiffen, and support forms to prevent perceptible deflection or settlement, and to hold plumb, level, and true to line.
- C. Construct and maintain forms to the tolerances given in ACI 117.
- D. Construct sufficiently tight to prevent mortar leakage.
- E. Avoid offsets between adjacent forms and construct so that shores, braces, and stiffening members are in line with those below.
- F. Space studs and stringers as required to support facing against concrete pressure, but not more than 12 inches for 5/8-inch plywood or 16 inches for 3/4-inch plywood. Maximum deflection of facing materials reflected on concrete surfaces exposed to view shall be 1/240 of the span between structural members of the formwork.
- G. Use wales, strongbacks, shores, and bracing as required.
- H. Form all necessary openings or chases for piping, ductwork, and similar items where indicated or as required for the Work.
- I. Construct forms to be removable in sections without marring concrete surface.
- J. Surface of forms shall provide a smooth, dense, plane surface to finished concrete where exposed to view.
- K. Contractor shall be responsible for structural adequacy, design, engineering, and construction of the formwork.
- L. Stay-in-place metal forms shall not be used.

3.02 TIME-IN-PLACE FOR FORMS:

- A. It is the responsibility of Contractor to consider all applicable factors and leave the formwork in place until it is safe to remove them.
- B. All removal shall be performed in a manner which will prevent damage to the concrete and ensure the complete safety of the structure.

SECTION 03 10 00 – CONCRETE FORMWORK: continued

- C. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements.
- D. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C31/C31M REV A and ASTM C39/C39M at the expense of Contractor by an independent laboratory that complies with ASTM C1077. Control cylinders shall be tested within 4 hours after removal from the Site.
- E. Forms shall not be removed unless the minimum time or minimum compressive strength requirements below are met.
 - 1. Formwork Not Supporting Weight of Concrete:
 - a. Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground and other vertical type formwork not supporting the weight of concrete shall remain in place 24-hours minimum after concrete placement is completed.
 - 2. Formwork Supporting Weight of Concrete:
 - a. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, no forms or shoring shall be loosened or removed until control concrete test cylinders indicate the concrete has attained the following compressive strengths for the respective structural members:

<u>Structural Member</u>	<u>Percent of Design Compressive Strength</u>
Unshored slab and beam forms or forms which can be removed without disturbing shores	70
Slab or beam shoring	85

END OF SECTION 03 10 00

SECTION 03 20 00 – CONCRETE REINFORCEMENTPART 1 - GENERAL1.01 RELATED DOCUMENTS:

- A. All project specifications, drawings, and general provisions, including UPUI Division 01 Specification Sections, apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and correct installation. Any specific references mentioned herein are for convenience only.

1.02 SUMMARY:

- A. This Section includes steel reinforcement bars, ties, welded wire fabric, bolsters, chair supports, and accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 03 10 00 - Concrete Formwork.
- B. Section 03 30 00 - Concrete.

1.04 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. American Society for Testing and Materials (ASTM):
 - a. A615/A615M – Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
 - b. A706/A706M – Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
 - c. A1064/A1064M – Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
 - 2. American Concrete Institute (ACI):
 - a. 117 – Specifications for Tolerances for Concrete Construction Materials.
 - b. 301 – Specifications for Structural Concrete.
 - c. 318 – Building Code Requirements for Structural Concrete.
 - d. SP 66 – Detailing Manual.
 - 3. American Welding Society (AWS):
 - a. A5.5 – Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
 - b. B2.1 – Specification for Welding Procedure and Performance Qualification.
 - c. D1.4 - Structural Welding Code – Steel Reinforcing Bars.
 - 4. Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Standard Practice.
 - b. RB4.1 – Supports for Reinforcement Used in Concrete.

1.05 SUBMITTALS:

- A. Submit as specified in DIVISION 01.
- B. Include, but not limited to, the following:
 - 1. Complete bar schedule, bar details, and erection drawings to conform to ACI SP 66.
 - 2. Drawing with each type of bent bar marked with identification mark. Straight bars shall have mark number or be identified by size and length.
 - 3. Erection drawings shall be clear, easily legible, and to a minimum scale of:
 - a. 1/4 inch = 1 foot (1:50).
 - b. 1/8 inch = 1 foot (1:100) if bars in each face are shown in separate views.

SECTION 03 20 00 – CONCRETE REINFORCEMENT: continued

4. Size and location of all openings.
5. Concrete protective cover.
6. Grade of steel.
7. Lap splice lengths.
8. Total weight of bars for each foundation or structure.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Label steel reinforcement bundles with name of foundation or structure.
- B. Store steel reinforcement blocked up off the ground and in orderly stacks.
- C. Store only bars with the same identifying label in the same stack.

1.07 TESTING:

- A. Perform at the mill for each heat.
- B. Submit certified test results upon request.

PART 2 - PRODUCTS

2.01 CONCRETE REINFORCING STEELBARS, TIES, AND STIRRUPS:

- A. Materials:
 1. Conform to ASTM A615, Grade 60, except as otherwise specified.
 2. Cold-drawn wire for spiral column ties shall conform to ASTM A1064.
 3. Reinforcement indicated or specified to be welded shall conform to ASTM A706.
- B. Fabrication of Bars:
 1. Fabricate with cold bends conforming to the recommended dimensions shown in ACI 318.
 2. Fabricate bars according to the tolerances given in ACI 117.
 3. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel.
 4. Attach metal or plastic tags with identifying mark or length corresponding to mark number or length on Drawing. Straight bars shall have mark number or size and length. Bent bars shall have mark number.
 5. Contractor may, at their option, continue steel reinforcement through openings in walls and slabs, then field-cut the opening so that there will be the required concrete cover between ends of bars and edge of opening.

2.02 WELDED WIRE REINFORCEMENT:

- A. Conform to ASTM 1064.
- B. Wire sizes W1.4 and smaller shall be galvanized.
- C. Provide mats only. Rolled fabric is not acceptable.

2.03 BOLSTERS, CHAIRS, AND ACCESSORIES:

- A. Conform to ACI SP 66, the CRSI Manual of Standard Practice, and CRSI RB4.1.
- B. Provide all spacers, bolsters, chairs, ties, and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during the concrete placement.
- C. Metal accessories shall be galvanized or plastic-coated where legs will be exposed in finished concrete surfaces.
- D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

SECTION 03 20 00 – CONCRETE REINFORCEMENT: continued

2.04 PRECAST CONCRETE BLOCK BAR SUPPORTS:

- A. May be used only for bar supports in slabs on ground.
- B. Conform to ACI SP-66, the CRSI Manual of Standard Practice, and CRSI RB4.1.
- C. Each block shall have a minimum of 9 square inches (5800 square millimeters) of bearing area. Space as required by the particular condition of weight, bearing surface, and rigidity of the steel reinforcement.
- D. Precast concrete blocks shall meet the same 28-day compressive strength as surrounding concrete unless otherwise approved by Engineer.

PART 3 - EXECUTION

3.01 PLACEMENT OF CONCRETE REINFORCING STEEL:

- A. Place all steel reinforcement before concrete is cast in accordance with approved erection drawings, ACI 117, ACI 318, and the CRSI Manual of Standard Practice.
- B. Remove oil, mill scale, pitting, mud, loose rust, ice, and other materials that would reduce bond from bars before placing.
- C. Tie securely with 16 gage (1.6 mm) or larger annealed iron wire.
- D. Place to maintain concrete cover to conform to ACI 117 and ACI 318, unless otherwise indicated.
- E. Splice steel where indicated. Splices shall be in full contact and shall conform to ACI 318.
 - 1. Unless otherwise indicated, lap splices shall be Class B as defined by ACI 318.
 - 2. Splice steel using Cadweld Series T-splices where indicated or approved.
 - a. Provide a manufacturer's representative to give on site instructions to all welders who will perform the splices in the field.
 - b. Contractor shall have the manufacturer's representative instruct, observe, and approve in writing those persons doing the welding.
 - c. Contractor shall arrange for the manufacturer's representative to return at the request of the Engineer.
 - 3. Splices in members indicated as "tension tie members" shall be made with Cadweld Series T-splices or Lenton mechanical splices in accordance with ACI 318.
 - 4. Any additional Contractor-proposed splice shall be submitted for acceptance of location and splice length.
- F. Lap welded wire reinforcement in accordance with of ACI 318, but not less than the length of one mesh plus 2 inches (50 mm).
- G. Connection of reinforcement bars to steel shapes or plate shall be with a Cadweld Series B-splice.
- H. Do not bend bars embedded in hardened or partially hardened concrete without approval from Engineer. If bending is permitted, conform to procedures of ACI 301 unless otherwise prescribed by the governing building code.
- I. Do not weld reinforcing bars unless specifically indicated. Where welding is indicated, provide bars conforming to ASTM A706/A706M and comply with AWS D1.4.

END OF SECTION 03 20 00

SECTION 03 30 00 – CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. All project specifications, drawings, and general provisions, including UPUI Division 01 Specification Sections, apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and correct installation. Any specific references mentioned herein are for convenience only.

1.02 SUMMARY:

- A. This Section includes concrete and related items.

1.03 RELATED REQUIREMENTS:

- A. Section 03 10 00 - Concrete Formwork.
- B. Section 03 20 00 - Concrete Reinforcement.

1.04 REFERENCE STANDARDS:

- A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise indicated.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - 1. American Concrete Institute (ACI):
 - a. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - b. ACI 301 - Specifications for Structural Concrete.
 - c. ACI 302.1R - Guide for Concrete Floor and Slab Construction.
 - d. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 - e. ACI 305R – Guide to Hot Weather Concreting.
 - f. ACI 306R – Guide to Cold Weather Concreting.
 - g. ACI 308.1 - Specification for Curing Concrete.
 - h. ACI 309R - Guide for Consolidation of Concrete.
 - i. ACI 313 - Standard Practice for Design and Construction of Concrete Silos and Stacking Tubes for Storing Granular Materials.
 - j. ACI 318 - Building Code Requirements for Structural Concrete.
 - k. ACI 506R - Guide to Shotcrete.
 - l. ACI 506.2 - Specification for Shotcrete.
 - 2. ASTM International (ASTM):
 - a. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
 - b. ASTM C31/C31M REV A – Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
 - d. ASTM C39/C39M – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - e. ASTM C40/C40M – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - f. ASTM C42/C42M – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

SECTION 03 30 00 – CONCRETE: continued

- g. ASTM C78/C78M REV B - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
- h. ASTM C88 – Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- i. ASTM C94/C94M – Standard Specification for Ready-Mixed Concrete.
- j. ASTM C114 – Standard Test Methods for Chemical Analysis of Hydraulic Cement.
- k. ASTM C117 – Standard Test Method for Material Finer than 75 μ (No. 200) Sieve in Mineral Aggregates by Washing.
- l. ASTM C136/C136M – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- m. ASTM C142/C142M – Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- n. ASTM C143/C143M REV A – Standard Test Method for Slump of Hydraulic Cement Concrete.
- o. ASTM C150/C150M – Standard Specification for Portland Cement.
- p. ASTM C172/AC172M REV A – Standard Practice for Sampling Freshly Mixed Concrete.
- q. ASTM C192/C192M – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
- r. ASTM C231/C231M – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- s. ASTM C233/C233M - Standard Test Methods for Air-Entraining Admixtures for Concrete.
- t. ASTM C260/C260M REVA – Standard Specification for Air-Entraining Admixtures for Concrete.
- u. ASTM C295/C295M – Standard Guide for Petrographic Examination of Aggregates for Concrete.
- v. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- w. ASTM C430 – Standard Test Method for Fineness of Hydraulic Cement by the 45 μ (No. 325) Sieve.
- x. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
- y. ASTM C566 –Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying.
- z. ASTM C595/C595M - Standard Specification for Blended Hydraulic Cements.
- aa. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- bb. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- cc. ASTM C1107/C1107M REVA - Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).
- dd. ASTM C1193 – Standard Guide for Use of Joint Sealants.
- ee. ASTM C1218/C1218M - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
- ff. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

SECTION 03 30 00 – CONCRETE: continued

- gg. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).
 - hh. ASTM D1752 REVA - Standard Specification for Standard Specification for - Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - ii. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers.
 - jj. ASTM E1155M – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers (Metric).
 - 3. Concrete Plant Manufacturers Bureau (CPMB):
 - a. 100 - Concrete Plant Standards.
 - b. 102 - Recommended Guide Specifications for Batching Equipment and Control Systems in Concrete Batch Plants.
 - 4. Plant Mixer Manufacturers Division (PMMD):
 - a. 100 - Concrete Plant Mixer Standards.
 - 5. Federal Specification (FS):
 - a. SS-S-200 - Sealants, Joint: Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement.
 - b. TT-S-227 - Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
 - 6. National Bureau of Standards (NBS) Specifications for Scales.
 - 7. Truck Mixer Manufacturers Bureau (TMMB):
 - a. Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.
- 1.05 SUBMITTALS:
- A. Submit as specified in Division 01.
 - B. Include, but not limited to, product data and Shop Drawings of the following:
 - 1. Nonshrink grouts.
 - 2. Admixtures.
 - 3. Curing agents.
 - 4. Expansion joint materials.
 - 5. Joint sealants.
 - 6. Waterstops.
 - C. Mill Certificates:
 - 1. Submit to Engineer a minimum of one copy for each cement shipment.
 - D. Concrete Mix Design Proportions:
 - 1. Submit as specified in PART 2, Paragraph 2.01.D. - Mix Proportions, this Section.
 - 2. Submit for each mix design, including aggregate gradation data.
 - 3. Resubmit for any change in each mix design.
 - E. Production Test Reports: Submit as specified in Division 01 and PART 2, Paragraph 2.01.E. - Measurement of Materials, this Section.
- 1.06 QUALITY ASSURANCE:
- A. Field Testing: Shall be performed by an ACI Concrete Field Testing Technician Grade 1.

SECTION 03 30 00 – CONCRETE: continued

PART 2 - PRODUCTS

2.01 CONCRETE:

A. Materials:

1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - a. Portland cement: ASTM C150, Type I. Supplement with the following:
 - (1) Fly ash: ASTM C618, Class F.
 - (2) Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
 - b. Blended Hydraulic Cement: ASTM C595/C595M, Type IP cement.
 - c. The maximum amount retained on the No. 325 sieve shall be 10% as determined in accordance with ASTM C430.
 - d. The maximum amount of alkalis ($\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$) shall be 0.60% determined in accordance with ASTM C114. A running average of three Samples shall not exceed a maximum of 0.50%.
 - e. Use one brand of cement throughout the Project unless otherwise approved by Engineer.
2. Fine Aggregate:
 - a. Conform to ASTM C33.
 - b. Approved service record of 3 years with a history indicating that the fine aggregate is not chemically reactive.
 - c. For a new fine aggregate source, or when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295.
 - d. Fine aggregate considered deleterious or potentially deleterious shall not be used without approval.
 - e. Maintain fine aggregate free of ice and frozen lumps.
 - f. Fineness modulus shall be between 2.3 and 3.1.
3. Coarse Aggregate:
 - a. Conform to ASTM C33.
 - (1) Limits for deleterious substances and physical property requirements shall conform to Table 3 and applicable class designation 5S, 5M, or 1N.
 - b. Approved service record of 3 years with a history indicating that the coarse aggregate is not chemically reactive.
 - c. For a new coarse-aggregate source, when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295 and tests conforming to ASTM C1260.
 - d. Coarse aggregate considered deleterious or potentially deleterious shall not be used without approval.
 - e. Blast furnace slag will not be permitted.
 - f. Maintain coarse aggregate free of ice and frozen lumps.
 - g. Grading Requirements:
 - (1) Size No. 57, from 1-inch (25-mm) to No. 4 (4.75-mm) sieve for all concrete unless otherwise specified.
4. Mixing Water:

SECTION 03 30 00 – CONCRETE: continued

- a. Conform to ASTM C1602 or C94
 - b. Or Potable water will be acceptable.
- 5. Admixtures:
 - a. Water-Reducing Type:
 - (1) Conform to ASTM C494, Type A.
 - (2) Conform to manufacturer's recommendations for use.
 - (3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
 - b. Air-Entraining Type:
 - (1) Conform to ASTM C260.
 - (2) Conform to manufacturer's recommendations for use.
 - (3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
 - (4) Testing of air-entraining admixtures shall conform to ASTM C233.
 - c. Other Admixtures: Use only with Engineer's written concurrence.
 - (1) Water-Reducing, Retarding Type: Conform to ASTM C494, Type D.
 - d. Admixtures shall not contain any chloride ions.
 - e. Storage: Admixtures shall be stored in such a manner as to avoid contamination, evaporation, freezing, temperature changes, settling, or any damage which would adversely affect their characteristics.
- B. Laboratory Testing of Materials for Use in Concrete:
 - 1. An approved independent testing laboratory shall be selected and paid by Owner to perform all required laboratory tests of materials proposed for use in the production of concrete and to determine mix proportions when laboratory trial batches are required.
 - 2. Contractor shall deliver representative Samples of all proposed concrete materials to the laboratory for the following testing:
 - a. Fine Aggregate:
 - (1) ASTM C33.
 - (2) ASTM C40.
 - (3) ASTM C88.
 - (4) ASTM C117.
 - (5) ASTM C136.
 - (6) ASTM C142.
 - (7) Fineness modulus.
 - (8) ASTM C295 and ASTM C1260 or approved service records.
 - b. Coarse Aggregate:
 - (1) ASTM C33.
 - (2) ASTM C88.
 - (3) ASTM C136.
 - (4) ASTM C142.
 - c. Air-entraining admixture shall be tested conforming to ASTM C233.
 - 3. The laboratory test results shall be part of the design mix submittal specified in this PART 2, Paragraph 2.01.D. - Mix Proportions.
- C. Concrete Qualities Required:
 - 1. Compressive Strength:
 - a. Minimum 28-day compressive strength = 4,500 psi for all construction unless otherwise indicated.
 - b. Minimum 28-day compressive strength = 2,000 psi for fill concrete and mud slabs.

SECTION 03 30 00 – CONCRETE: continued

- c. Compressive-strength determinations shall be made from one set of cylinders tested in accordance with ASTM C39. One set is defined as two 6-inch (150-mm) diameter by 12-inch (300-mm) long or three 4-inch (100-mm) diameter by 8-inch (200-mm) long concrete cylinders.
 - 2. Slump of concrete shall be between 2 inches (50 mm) and 4 inches (100 mm) as tested in accordance with ASTM C143.
 - 3. Air Content:
 - a. 6% $\pm$ 1.5% unless otherwise indicated or specified.
 - b. 3% maximum for all concrete receiving steel-troweled finish.
 - c. Per manufacturer's recommendations for concrete receiving a topping, coloring, coating, or surface hardener.
 - d. Testing shall be in accordance with ASTM C231.
 - 4. Water-Cementitious Materials Ratio:
 - a. In addition to the aforementioned requirements, maximum water-cementitious materials ratio shall be limited as follows:
 - (1) 0.45 for all concrete unless otherwise specified.
 - (2) 0.40 for concrete exposed to freezing and thawing in a moist condition or to deicing chemicals.
 - b. Testing shall be in accordance with ASTM C1218.
- D. Mix Proportions:
 - 1. Concrete shall be homogeneous, readily placeable, uniformly workable, and finishable; proportioned to conform to ACI 211.1.
 - 2. Mix proportions for all concrete, unless otherwise specified, shall be selected preferably on the basis of field experience; but in the case where sufficient or suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design.
 - a. Field experience using test results within the preceding year, with the materials and plant to be employed may be the basis of mix proportioning, provided that not less than 30 consecutive satisfactory compressive-strength tests on concrete using the proposed materials with a similar mix are available. A compressive-strength test is defined as the average 28-day compressive strength of two 6-inch (150-mm) by 12-inch (300-mm) or three 4-inch (100-mm) by 8-inch (200-mm) companion cylinders made conforming to ASTM C172 and ASTM C31 and tested conforming to ASTM C39.
 - (1) The standard deviation of compressive-strength tests shall be computed as a basis for design of the mix. The design average compressive strength shall exceed the specified strength by at least:
 - (a) 400 psi (2760 kPa) if standard deviation is less than 300 psi (2070 kPa).
 - (b) 550 psi (3800 kPa) if standard deviation is 300 to 400 psi (2070 to 2760 kPa).
 - (c) 700 psi (4830 kPa) if standard deviation is 400 to 500 psi (2760 to 3450 kPa).
 - (d) 900 psi (6200 kPa) if standard deviation is 500 to 600 psi (3450 to 4140 kPa).
 - (e) 1,200 psi (8275 kPa) if standard deviation is greater than 600 psi (4140 kPa).
 - (2) Submit the following test data to Engineer for approval prior to placing concrete:

SECTION 03 30 00 – CONCRETE: continued

- (a) Fine Aggregate:
 - 1). ASTM C33.
 - 2). ASTM C40.
 - 3). ASTM C88.
 - 4). ASTM C117.
 - 5). ASTM C136.
 - 6). ASTM C142.
 - 7). Fineness modulus.
 - 8). ASTM C295 and ASTM C1260 or approved service records.
- (b) Coarse Aggregate:
 - 1). ASTM C33.
 - 2). ASTM C88.
 - 3). ASTM C136.
 - 4). ASTM C142.
 - 5). ASTM C295 and ASTM C1260 or approved service records.
- (c) Cement:
 - 1). Mill certificate.
 - 2). ASTM C430.
- (d) Concrete:
 - 1). Fine and coarse aggregate, water and cement sources.
 - 2). Mix proportions, slump and air content.
 - 3). Data on 30 consecutive satisfactory compressive strength tests and standard deviation calculations.
- b. Laboratory Trial Batch: When laboratory trial batches are used as a basis for determining mix proportions, all such Work shall be performed by the laboratory as specified in PART 2, Paragraph 2.01.B. - Laboratory Testing of Materials for Use in Concrete, this Section.
 - (1) Laboratory trial batches shall be used to establish a water-cement ratio, compression-strength curve with at least three points, each representing the strength of a separate trial batch. At least one point shall be above and one below the strength required. Each point on the curve shall represent the average of at least three cylinders (or cross section beams) tested at 28 days or an earlier age when approved by Engineer. The slump and air content shall be at the maximum limits specified in PART 2, Paragraph 2.01.C. - Concrete Qualities Required, this Section.
 - (2) A point on the water-cement ratio, compressive-strength curve shall be selected that will provide an average compressive strength at least 1,200 psi (8275 kPa) greater than the specified minimum strength.
 - (3) Submit the following test data to Engineer for approval prior to placing concrete.
 - (a) Fine Aggregate:
 - 1). ASTM C33.
 - 2). ASTM C40.
 - 3). ASTM C88.
 - 4). ASTM C117.
 - 5). ASTM C136.
 - 6). ASTM C142.
 - 7). Fineness modulus.

SECTION 03 30 00 – CONCRETE: continued

- 8). ASTM C295 and ASTM C1260 or approved service records.
 - (b) Coarse Aggregate:
 - 1). ASTM C33.
 - 2). ASTM C88.
 - 3). ASTM C136.
 - 4). ASTM C142.
 - 5). ASTM C295 and ASTM C1260 or approved service records.
 - (c) Cement:
 - 1). Mill certificate.
 - 2). ASTM C430.
 - (d) Concrete:
 - 1). Fine and coarse aggregate, water and cement sources.
 - 2). Laboratory mix proportions, slump and air content.
 - 3). Water-cement ratio, compressive-strength curve.
 - 4). ASTM C1218.
- 3. Prior to placing any concrete, the laboratory selected by Contractor shall report the results of the testing and mix designs to the following:
 - a. Engineer, one copy.
 - b. Resident Project Representative, Field Office (one copy).
 - c. Contractor (copies as required).
 - d. Concrete Supplier (copies as required).
- E. Measurement of Materials:
 - 1. General Requirements:
 - a. Conform to ACI 304R.
 - b. Beam or springless dial-type scale conforming with NBS - "Specifications for Scales."
 - c. Volumetric measurement of water shall be performed with an approved automatic valve.
 - 2. Concrete Plant Scale Accuracy and Calibration Frequency:
 - a. The concrete plant scales shall be accurate to $\pm 0.4\%$ of the capacity of the scale.
 - b. The scales shall be calibrated at intervals as specified in PART 3, Article 3.09 - Testing, this Section.
 - 3. Individual Batch Accuracy:
 - a. Cement: $\pm 1.0\%$.
 - b. Water: $\pm 1.0\%$ by volume or weight.
 - c. Aggregates: $\pm 2.0\%$.
 - d. Admixtures: $\pm 3.0\%$ by volume or weight.
 - e. Fly Ash: $\pm 1.0\%$.
- F. Mixing and Delivery:
 - 1. Conform to ACI 304R.
 - 2. Cement temperature, when added to mix, shall not exceed 170°F (77°C).
 - 3. Adjust the amount of mix water to compensate for the moisture content of the aggregates.
 - 4. Concrete Plant:
 - a. Conform to "Concrete Plant Mixer Standards" of the Plant Mixer Manufacturers Division, Concrete Plant Manufacturers Bureau, and "Concrete Plant Standards" of the Concrete Plant Manufacturers Bureau.
 - b. Charge with 5% to 10% of the mixing water both in advance and after the addition of aggregates and cement.

SECTION 03 30 00 – CONCRETE: continued

- c. Charge with remaining water uniformly with the other materials.
- d. Avoid charging in excess of manufacturer's rating.
- e. Discharge mixed concrete completely prior to recharging.
- f. Mixing Time:
 - (1) Start immediately when all ingredients, except the last of the water, are in the mixer.
 - (2) Minimum mixing time shall conform with mixer manufacturer's instructions, but not be less than the following:

Capacity of Mixer <u>Cubic Yards</u>	Minimum Time <u>of Mixing</u>
1 or less.....	1 minute
2.....	1 minute, 15 seconds
3.....	1 minute, 30 seconds
4.....	1 minute, 45 seconds
5.....	2 minutes
6.....	2 minutes, 15 seconds

Add 15 seconds' mixing time for each additional cubic yard of concrete.

- 5. Mixing of Concrete at Plant Off Jobsite:
 - a. Mix concrete in central mixer or truck mixer. Transport in truck mixer turning at agitation speeds only.
 - b. Water added to concrete having a slump below the specified minimum shall be at Contractor's risk. If the water added produces a slump greater than the specified maximum, the concrete will be rejected. If water is added, the concrete shall be remixed for a minimum of 25 revolutions. Water shall not be added after the truck mixer has begun to discharge concrete.
 - c. Truck mixer shall conform to "Truck Mixer, Agitator, and Front Discharge Concrete Carrier Standards" of the Truck Mixer Manufacturers Bureau.
 - d. Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.
 - e. Contractor shall furnish Owner with a concrete delivery ticket for each load of concrete. The ticket shall have the following information recorded:
 - (1) Serial number of ticket.
 - (2) Time batched.
 - (3) Time arrived on jobsite.
 - (4) Amount of concrete (by volume).
 - (5) Mix number.
 - (6) Amount of all water added at jobsite by Contractor.
 - (7) Name of ready-mix batch plant.
 - (8) Date.
 - (9) Truck number.
 - (10) Name of purchaser.
- 6. Plant and truck mixer uniformity shall be tested according to ASTM C94. Frequency of tests shall be as specified in PART 3, this Section.

2.02 GROUT:

- A. Grout for Dry Packing:

SECTION 03 30 00 – CONCRETE: continued

1. Volume: 1 part Portland cement to 2 parts sand.
 2. Keep water to a minimum as required for placing by the dry packing method.
 3. Place after the mixed grout has been allowed to stand for 2 hours.
 4. The sand and cement shall be as specified for concrete.
- B. Flowable Nonshrinking Grout:
1. Required for setting handrail posts, for setting equipment recommended by the manufacturer to be set with nonshrinking grout, and in other places indicated.
 2. Grout shall be nonmetallic and conform to ASTM C1107.
 3. Prepare and place conforming to manufacturer's printed instructions.
 4. For equipment bases, the concrete surfaces shall be grit blasted or roughened with a chipping hammer prior to grouting. The foundation plates shall be cleaned of any grease, oil, paint, primers, or epoxy coatings.
- C. Grout for Bonding:
1. Proportion (by weight): 1 part cement to 1-1/2 parts sand.
 2. Keep water to a minimum.

2.03 BONDING AGENT:

- A. Provide moisture-insensitive, epoxy-resin bonding agent conforming to ASTM C881, Type V.

2.04 CONCRETE ACCESSORIES:

- A. PVC Waterstops:
1. 6-inch ribbed serrated virgin polyvinyl chloride equal to one of the following:
 - a. Greenstreak, Inc. - Greenstreak Style 679.
 - b. Vinylex Corporation - R6-38.
 - c. Southern Metals - 17FR.
 2. Base Seal: Virgin polyvinyl chloride equal to one of the following:
 - a. Nonexpansion Joints:
 - (1) Greenstreak, Inc. - Greenstreak Style 771.
 - (2) Vinylex Corporation - BS9-532.
 - b. Expansion Joints:
 - (1) Greenstreak, Inc. - Greenstreak Style 772.
 - (2) Vinylex Corporation - BSE9-532.
 3. Provide factory fabricated waterstop corner transitions and intersections leaving only straight butt joint splices for the field.
 4. Waterstops shall be provided with factory-installed hog rings at 12-inch centers along each flange.
 5. Use for all locations unless otherwise specified.
- B. Plastic Waterstops:
1. Swellable, Bentonite Waterstop:
 - a. Greenstreak, Inc. - Swellstop Profile 594 (3/4 inch by 1 inch).
 - b. CETCO Building Materials - Waterstop-RX101.
 2. Provide all accessories as recommended by the manufacturer including, but not limited to, primers, adhesives, and sealants to ensure watertight construction. Install per manufacturer's written instructions and recommendations.
- C. Preformed Contraction Joints: Zip Joint T-shaped plastic strip as manufactured by BoMetals, Inc., Powder Springs, Georgia. Depth of preformed construction joint shall exceed 1/4 of the slab thickness.

SECTION 03 30 00 – CONCRETE: continued

2.05 CURING AGENT:

- A. Apply to all concrete surfaces unless otherwise indicated or specified.
- B. Curing agent shall conform as follows:
 - 1. ASTM C309, Type 1-D: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.
 - 2. ASTM C309, Type 2: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.
- C. Curing compound used on floors to be sealed, painted, tiled, topped, dampproofed, waterproofed, or covered with resilient floor covering shall be guaranteed not to interfere with application of sealer, paint, tile mortar, or tile adhesive after a 28-day curing period.
- D. Curing compound shall be VOC compliant with a maximum VOC content of 2.9 lbs./gal (350 g/L), or less where Project location regulations are more stringent.

2.06 CONCRETE FLOOR CURING AND SEALING AGENT:

- A. Apply to all interior concrete floor surfaces subject to vehicle or pedestrian traffic.
- B. Curing and sealing agent shall conform as follows:
 - 1. ASTM C1315, Type I, Class A: Use where slabs are not exposed to direct sunlight after placement.
 - 2. ASTM C1315, Type I, Class A with Fugitive Dye: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.
 - 3. ASTM C1315, Type II, Class A: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.
- C. Apply as soon as possible and in conformance with manufacturer's written instructions.

PART 3 - EXECUTION

3.01 PREPARATION FOR CONCRETE PLACEMENT:

- A. Openings Through Concrete: Provide openings through concrete as indicated and for the proper installation of all equipment, piping, wiring, ductwork and similar items, installed under this Contract.
- B. Installation of Embedded Items:
 - 1. Provide for accurate installation of embedded items installed under this Contract.
 - 2. Securely fix floor drains in place to prevent flotation while placing concrete. Uniformly and accurately slope finish floor slab toward the drains.
 - 3. Embedded items shall be as indicated or specified, or as selected by Contractor and approved by Engineer.
 - 4. During cold weather, protect pipe sleeves, shear pockets, and blockouts from moisture which may freeze, expand, and crack the sleeve, pocket or blockout and concrete structure.
 - 5. Grease or tape anchor bolt threads to protect from concrete splatter.
- C. Installation of Joints:
 - 1. Construction Joints:
 - a. Location:

SECTION 03 30 00 – CONCRETE: continued

- (1) Locate joints, which are not indicated or specified, in conformance with ACI 318.
 - (2) Locate joints to limit the length of all concrete placements to not more than 50 feet .
 - (3) Obtain Engineer's approval of joints located by Contractor prior to preparation of reinforcing steel drawings.
 - b. Preparation and Installation:
 - (1) Clean and break laitance or other foreign material from bonding surface.
 - (2) Tighten forms remaining in place (where applicable) to prevent seepage between forms and hardened concrete.
 - (3) Provide waterstops and shear keys as indicated or specified and as required in any new construction joint requested by Contractor.
 - c. Waterstops:
 - (1) Install in all construction joints where indicated.
 - (2) Install conforming to manufacturer's printed instructions. All joints and splices of PVC waterstop shall be 100% fused. Use thermostatically controlled splicing iron as recommended by manufacturer.
 - 2. Expansion Joints:
 - a. Install filler, backer rod and sealant in strict conformance with manufacturer's written instructions.
 - b. Reinforcing steel shall not extend through expansion joints unless indicated otherwise.
 - c. Attach rigid joint filler to the face of the joint prior to placing adjacent concrete. The filler shall occupy the entire width of the joint.
 - d. Install sealant backer rod for sealant except where indicated to be omitted. Install bond breaker where indicated.
 - e. Clean joints surfaces immediately before application of sealant.
 - f. Install joint sealants to conform to ASTM C1193. Tool sealants to provide smooth, uniform bead with a slightly concave surface, eliminate air pockets, and insure sealant contact and adhesion with sides of joint.
 - g. Protect joints from moisture and ice during freezing.
 - 3. Contraction Joints: As specified in this PART 3, Article 3.03 - Finishing, this Section.
- D. Cutting and Bonding to Existing Concrete:
- 1. Cutting Existing Concrete:
 - a. Use methods and equipment that will avoid damage to adjacent parts of the structure from heavy blows or vibration.
 - b. Cut existing concrete with power concrete saw where possible to prevent spalling and chipping and to form neat, straight edge.
 - c. Remove all loose or cracked concrete resulting from cutting existing concrete, leaving only sound, undamaged concrete adjacent to new Work.
 - d. Leave access opening edges with a neat, true grout surface to the opening size indicated.
 - e. Cut reinforcing steel with sufficient length remaining (approximately 38 bar diameters) for bending and lapping into new construction.
 - 2. Bonding to Existing Concrete:
 - a. Roughen concrete to 1/4-inch (6-mm) amplitude by use of a pneumatic chipping hammer or other approved means.

SECTION 03 30 00 – CONCRETE: continued

- b. Thoroughly clean the concrete surface and apply the bonding agent in accordance with manufacturer's written instructions.

3.02 PLACING OF CONCRETE:

A. Conventional Placing:

1. General Requirements:

- a. Conform to ACI 304R.
- b. Bonding surfaces, including reinforcement, shall be clean, free of laitance and foreign materials.
- c. Face horizontal bonding surfaces with 1-inch (25-mm) thick coat of fresh "grout for bonding." Wet all other surfaces.
- d. Place concrete on properly prepared and unfrozen subgrade and only in dewatered excavation and forms.
- e. Use forms for all concrete except where otherwise indicated or specified.
- f. Do not place concrete that has partially hardened or has been contaminated by foreign materials.
- g. Prevent mud or foreign materials from entering the concrete or forms during placement operations.

2. Conveying:

- a. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.
- b. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.
- c. Aluminum conveying equipment shall not be used.

3. Depositing:

- a. Place concrete in continuous horizontal lifts not to exceed 2 feet (600 mm), and place concrete against bulkheads and keyways at vertical joints.
- b. Maximum free drop of concrete and grout for bonding shall be 5 feet (1.5 meters), in walls 10 inches (250 mm) or less in thickness, with 1-foot (300-mm) additional drop allowed for each inch (25 mm) of wall thickness over 10 inches (250 mm), with a maximum drop of 10 feet (3 meters).
- c. When vapor barrier is used, keep lapped joints closed and take precautions to avoid puncturing the barrier.

4. Consolidation of Concrete:

- a. Consolidate concrete in conformance with ACI 309R. Characteristics and application of concrete vibrators shall be as set forth in Table 5.1.5.
- b. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
- c. Vibrate concrete only until the concrete is thoroughly consolidated and the voids filled, as evidenced by the leveled appearance of the concrete at the exposed surface and the embedment of the surface aggregate.
- d. Insert internal vibrators vertically to the full depth of the layer being placed and into the previous layer. Do not drag vibrators through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole will be left in the concrete. Do not flow concrete from one location to another by use of a vibrator.

SECTION 03 30 00 – CONCRETE: continued

- e. Consolidate concrete layer to full depth when using a surface vibrator. Use thinner layers or a more powerful vibrator if necessary to achieve complete consolidation.
 - f. Use form vibrators only where sections are too thin or where sections are inaccessible for internal vibrators.
 - 5. Time Requirements:
 - a. Place concrete at a sufficient rate to assure that lifts below have not taken initial set before fresh concrete is deposited.
 - b. Place concrete within 45 minutes after mixing. This period may be extended to 1 hour and 30 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.
 - B. Placing Concrete at Joints:
 - 1. Bed horizontal joints with 1 inch (25 mm) of grout for bonding.
 - 2. Take precautions to ensure tight, well-bonded construction joints with no air pockets or voids.
 - 3. Take special precautions to avoid bending or displacing waterstop while placing concrete around it.
 - 4. Delay construction at a joint a minimum of 16 hours where placement is continued past joint, except where otherwise indicated.
- 3.03 FINISHING:
- A. Unformed Surfaces:
 - 1. Screed Finish:
 - a. Use as first stage for all concrete finishes.
 - b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.
 - c. Immediately after screeding, use a wood float, darby, or bullfloat to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet when used as final finish.
 - 2. Floated Finish:
 - a. Use as second stage of broomed, troweled, or magnesium-troweled finish.
 - b. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.
 - c. Refer to floor flatness and levelness for flatness criteria and tolerances.
 - 3. Broomed Finish:
 - a. Use as final finish on all outdoor slabs including pavements and sidewalks.
 - b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch deep.
 - 4. Troweled Finish:
 - a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.
 - b. Trowel with mechanical steel trowel to obtain a smooth, dense finish. Hand steel trowel shall be used in areas not accessible by mechanical trowel. The final troweling shall be done after the concrete has become hard enough so that no

SECTION 03 30 00 – CONCRETE: continued

- mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
 - c. Do not trowel before surface water has evaporated or has been removed with a squeegee.
 - d. Refer to floor flatness and levelness for flatness criteria and tolerances.
 - e. Do not add sand or cement to the floor surface.
 - 5. Magnesium-Troweled Finish:
 - a. Perform as specified in PART 3, Paragraph 3.03.A.4. - Troweled Finish, this Section, except use a magnesium trowel by hand instead of a steel trowel to obtain a dense, but not slick, finish.
 - b. Use where floor will receive protective coating after curing.
 - 6. Stair-Tread Finish:
 - a. Apply non-slip abrasive aggregate to all interior and exterior concrete stair treads and landings that do not have abrasive nosings and all ramps.
 - b. Spread fine abrasive aggregate uniformly on concrete before it has set, in the amount not less than 1/4-pound (1-kg) aggregate per square foot (square meter), and install per the manufacturer's written instructions.
 - c. Abrasive aggregate shall be EMAG 20 as manufactured by the Lambert Corporation, Orlando, Florida or approved equal.
 - d. Seal abrasive aggregate after installation to prevent dusting per manufacturer's written instructions.
 - 7. Contraction Joints:
 - a. Locate as indicated.
 - b. Maintain true alignment with straightedge.
 - c. Joints shall be grooved except where sawed joints are indicated.
 - (1) Slab on grade joints shall be sawed.
 - d. Grooved Joints:
 - (1) Perform during the finishing process.
 - (2) Width of groove shall not exceed 1/4 inch (6 mm).
 - (3) Depth of groove shall be at least 1 inch (25 mm).
 - e. Sawed Joints:
 - (1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required 4 to 12 hours after finishing.)
 - (2) Make joints approximately 1/8 inch (3 mm) wide with depth equal to 1/4 the slab thickness unless otherwise indicated.
 - (3) Seal where indicated with the same type sealant specified for expansion joint sealant.
 - 8. Floor Flatness and Levelness:
 - a. Applicable for steel and magnesium troweled finish floors, and other floors as indicated or specified.
 - b. Finish to a true uniform surface so that surface irregularities do not exceed 1/8 inch in 10 feet, except at floor drains.
 - c. All slabs on grade not meeting the above minimum tolerance tests shall be removed and replaced at Contractor's expense.
 - d. All elevated floors not meeting the above minimum tolerance tests shall be ground and retopped at the Contractor's expense.
- B. Formed Surfaces:

SECTION 03 30 00 – CONCRETE: continued

1. Repair surface defects as specified in PART 3, Paragraph 3.03.C. - Repair of Defective Surfaces, this Section.
- C. Repair of Defective Surfaces:
 1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.
 2. Repairing:
 - a. Repair as soon as forms have been removed.
 - b. Chip surface back to minimum depth of 1/2 inch (13 mm), chip edges perpendicular to surface, prewet depression and brush with neat cement immediately before patching.
 - c. Patch surfaces using stiff mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
 - d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and ramming rod for compacting the holes.
 - e. Moist-cure for 3 days or use curing compound.
 - f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.04 CURING:

- A. Cure concrete by one of the following methods in accordance with ACI 308.1:
 1. Leaving in forms for a minimum of 7 days. Keep formwork wet to prevent drying of concrete surfaces.
 2. Use of saturated bats, soaker hoses, or sprinkler for a minimum of 7 days. Keep concrete continuously wet.
 3. Using polyethylene sheets applied in full contact with surfaces.
 4. Using one coat of a liquid membrane forming compound as specified. Apply immediately after removal of forms (which have been continuously wet); or in case of a slab, after the concrete has been finished and is hardened sufficiently to walk on.
 5. Curing of concrete during hot or cold weather shall conform to PART 3 - Hot Weather Concreting and Cold Weather Concreting, this Section.

3.05 HOT WEATHER CONCRETING:

- A. Follow the recommendations of ACI 305R if any of the following conditions occur:
 1. When the temperature is 90°F (32°C) or above.
 2. When the temperature is likely to rise above 90°F (32°C) within the 24-hour period after concrete placement.
 3. When there is any combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.
- B. Concrete shall have a maximum temperature of 85°F (29°C) during placement.
- C. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
- D. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305R (Figure 4.2) does not exceed 0.2 pound per square foot (1.0 kg per square meter) per hour.
- E. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.
- F. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.

SECTION 03 30 00 – CONCRETE: continued

- G. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water-saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After the 24-hour interval, continue curing using one of the following methods:
 - 1. Moist curing for 6 days.
 - 2. Application of one coat of curing compound as specified.
 - 3. Application and maintenance of curing paper or heat-reflecting plastic sheets for 6 more days.
- H. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing using one of the following methods:
 - 1. Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for 6 days.
 - 2. Strip forms and apply curing compound as specified. Do not allow concrete surfaces to dry prior to application of curing compound.

3.06 COLD WEATHER CONCRETING:

- A. When the temperature is 40°F (4.4°C) or is likely to fall below 40°F (4.4°C) during the 24-hour period after concrete placement, follow the recommendations of ACI 306R to prevent loss of concrete strength or quality.
- B. Minimum temperature for concrete as mixed shall be as indicated on lines 2, 3, and 4 of Table 5.1 of ACI 306R. Maximum temperature for concrete as mixed shall be 10°F (5.6°C) greater than the corresponding minimum temperature.
- C. Place and maintain concrete so that its temperature is never less than the temperature indicated on line 1 of Table 5.1 of ACI 306R. Maintain the required temperature for the time duration indicated on Tables 5.1 and 7.1 of ACI 306R.
- D. Monitor temperature of concrete in place at corners or edges of formwork as applicable.
- E. Air Heaters:
 - 1. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines.
 - 2. Oil- or coke-burning salamanders will not be permitted.
 - 3. Heaters shall be ultramatic portable heaters made by the Union Chill Mat Company or Engineer approved equal.
 - 4. Personnel shall be present at all times to maintain safe, continuous operation of heating system.
- F. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.
- G. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
- H. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on line 1 of Table 5.1 of ACI 306R.
- I. Cure the concrete in accordance with Chapter 10 of ACI 306R.

3.07 MISCELLANEOUS CONCRETE ITEMS:

- A. Concrete Mud Slab:
 - 1. Apply to the ground surface immediately beneath all "on-grade" slabs and footings where indicated or specified.

SECTION 03 30 00 – CONCRETE: continued

2. Mud slab shall consist of a concrete slab of the thickness indicated but not less than 2 inches.
 3. Accurately screed so that the top of the mud slab will not be higher than the bottom elevation of structural slabs or footings to be placed thereon.
 4. Do not place mud slab until after all excavating, (piling,) (and caissons) in the area have been completed and all drain lines, conduits, and other items under the area are completed and properly backfilled and compacted.
- B. Equipment Bases:
1. Construct equipment bases, pads, and foundations as indicated or, when not indicated, conforming to equipment manufacturer's requirements.
 2. Reinforce conforming to typical detail unless otherwise indicated.
 3. Equipment bases shall include concrete, reinforcing steel, formwork as required, and anchor bolts. Place grout for equipment installed under this Contract.
 4. Finish top area of bases between anchor bolts and forms with a troweled finish.
- C. Cleanup:
1. During final cleanup, thoroughly clean floor, apply a second coat of curing/waxing compound, and polish as required.
 2. Repair floor damage as directed by Engineer.

3.08 TESTING:

- A. Field Testing of Concrete Plant and Mixing Trucks:
1. The concrete plant shall be inspected and tested to ensure conformance with ACI 304R and the "Concrete Plant Standards of the Concrete Plant Manufacturers Bureau." The scales shall be calibrated at the initial setup and at 3-month intervals thereafter.
 2. Mixing trucks shall be inspected and tested to ensure conformance with ACI 304R and "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau" of the National Ready-Mix Concrete Association. Tests shall be done at initial setup and every 3 months thereafter.
 3. Submit test reports when requested.
- B. Field Testing of Concrete and Making of Concrete Test Cylinders:
1. Contractor shall furnish test equipment, test cylinder molds, and certified personnel to perform all required field tests, make the required concrete test cylinders, and deliver test cylinders to the testing laboratory. The prescribed tests shall be made in the presence of or with the concurrence of the Owner.
 2. Field testing personnel shall be on Site throughout placement of concrete.
 3. Concrete sampling for tests and cylinder making shall be done conforming to ASTM C172. Samples shall be taken at random and at the point of truck discharge.
 4. Perform the following tests:
 - a. Moisture content, ASTM C566. Perform this test a minimum of twice a day and adjust the amount of mix water to compensate for the moisture content of the aggregates.
 - b. Prepare test cylinders conforming to ASTM C31, with not less than two sets of cylinders (four 6-inch (150-mm) by 12-inch (300-mm) or six 4-inch (100-mm) by 8-inch (200-mm) cylinders) from each day's placement for each 100 cubic yards (75 cubic meters) or fraction thereof.
 - c. Slump test conforming to ASTM C143. Perform tests on the first batch produced each day, for every 50 cubic yards (38 cubic meters) or fraction thereafter, and with every set of test cylinders. Additional tests shall be run when directed by Engineer.

SECTION 03 30 00 – CONCRETE: continued

- d. Air content test conforming to ASTM C231. Perform for first batch of day and with each set of test cylinders.
 - e. The batch of concrete being tested for slump or air content shall not be placed until acceptable results are obtained.
 - f. Discard concrete used for slump and air tests.
 - g. Perform concrete and air temperature tests for first batch of day and with each set of test cylinders. Additional readings shall be taken when directed by Engineer.
 - h. Any batch of concrete with slump or air content not in conformance with Specifications shall be rejected.
 - i. Furnish slump, air content, and temperature test results to the testing laboratory for inclusion in the cylinder test reports.
- C. Laboratory Testing of Aggregates and Concrete During Construction:
- 1. An independent testing laboratory will be selected and paid by Owner to perform the required laboratory tests and statistical evaluations of aggregates and concrete being used in the Work.
 - a. Laboratory will cure and test concrete cylinders conforming to ASTM C192 and C39, testing one set of cylinders at 7 days of age and one set at 28 days of age.
 - b. Contractor shall have the right to observe all phases of concrete cylinder curing and testing. Should Contractor observe any deviations from the prescribed testing procedures that he considers detrimental to concrete strength test results, he shall immediately notify Owner in writing.
 - c. Contractor shall assist laboratory in obtaining Samples of fine and coarse aggregate for testing.
 - d. Contractor shall make arrangements with the testing laboratory to receive copies of test reports. The cost of providing a maximum of two copies of each report to the Contractor will be paid by Owner.
 - e. Should the test results indicate low strength concrete as defined in PART 3, Article 3.07 - Low-Strength Concrete, this Section, Contractor shall take immediate corrective action.
 - f. Should the statistical data indicate an excessive margin of safety, the concrete mix may be modified subject to Engineer's approval.
 - g. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.
 - 2. An independent testing laboratory shall be selected and paid by Contractor to perform the required laboratory tests and statistical evaluations of aggregates and concrete being used in the Work.
 - a. Laboratory shall cure and test concrete cylinders conforming to ASTM C192 and C39, testing one set of cylinders at 7 days of age and one set at 28 days of age.
 - b. Engineer shall have the right to observe all phases of concrete cylinder curing and testing.
 - c. Should the test results indicate low strength concrete as defined in PART 3, Article 3.07 - Low-Strength Concrete, this Section, Contractor shall take immediate corrective action.
 - d. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.
 - 3. Owner shall have the right to observe all phases of concrete cylinder curing and testing. Should Owner observe any deviations from the prescribed testing procedures that he

SECTION 03 30 00 – CONCRETE: continued

- considers detrimental to concrete strength test results, they shall immediately notify Contractor in writing.
4. Contractor shall assist laboratory in obtaining Samples of fine and coarse aggregate for testing.
 5. Contractor shall make arrangements with the testing laboratory to receive copies of test reports. The cost of providing a maximum of two copies of each report to the Owner will be paid by Contractor.
 6. Should the statistical data indicate an excessive margin of safety, the concrete mix may be modified subject to Engineer's approval.
 7. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.
- 3.09 REPAIR, REPLACEMENT, AND FIELD MODIFICATIONS:
- A. Embedded items and concrete that are misplaced or damaged during construction shall not be repaired, replaced, or field-modified without approval of Engineer.

END OF SECTION 03 30 00

SECTION 04 22 00 - CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. All project specifications, drawings, and general provisions, including UPUI Division 01 Specification Sections, apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and correct installation. Any specific references mentioned herein are for convenience only.

1.02 SUMMARY:

- A. This Section Includes:
 - 1. Concrete masonry units.
 - 2. Decorative concrete masonry units.
 - 3. Pre-faced concrete masonry units.
 - 4. Mortar and grout.
 - 5. Steel reinforcing bars.
 - 6. Masonry-joint reinforcement.
 - 7. Embedded flashing.
 - 8. Miscellaneous masonry accessories.
 - 9. Masonry-cell fill.

1.03 RELATED REQUIREMENTS:

- A. Section 05 12 00 - Structural Steel Framing for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.

1.04 REFERENCED STANDARDS:

- A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- B. American Concrete Institute (ACI):
 - 1. ACI 315: Details and Detailing of Concrete Reinforcement.
- C. ASTM International (ASTM):
 - 1. ASTM A36/A36M - Specification for Carbon Structural Steel.
 - 2. ASTM A82/A82M - Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 3. ASTM A153/A153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 4. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 5. ASTM A580/A580M - Specification for Stainless Steel Wire.
 - 6. ASTM A615/A615M - Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 7. ASTM A641/A641M - Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 8. ASTM A653/A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 9. ASTM A666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - 10. ASTM A951/A951M - Specification for Steel Wire for Masonry Joint Reinforcement.
 - 11. ASTM A996/A996M: Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

12. ASTM A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
13. ASTM B32 - Specification for Solder Metal.
14. ASTM B370 - Specification for Copper Sheet and Strip for Building Construction.
15. ASTM C55 - Specification for Concrete Building Brick.
16. ASTM C90 - Specification for Loadbearing Concrete Masonry Units.
17. ASTM C91/C91M - Specification for Masonry Cement.
18. ASTM C109/C109M - Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
19. ASTM C114 - Test Methods for Chemical Analysis of Hydraulic Cement.
20. ASTM C140 - Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
21. ASTM C143/C143M - Test Method for Slump of Hydraulic Cement Concrete.
22. ASTM C144 - Specification for Aggregate for Masonry Mortar.
23. ASTM C150/C150M - Specification for Portland Cement.
24. ASTM C207 - Specification for Hydrated Lime for Masonry Purposes.
25. ASTM C270 - Specification for Mortar for Unit Masonry.
26. ASTM C331/C331M - Specification for Lightweight Aggregates for Concrete Masonry Units.
27. ASTM C395 - Specification for Chemical-Resistant Resin Mortars.
28. ASTM C404 - Specification for Aggregates for Masonry Grout.
29. ASTM C476 - Specification for Grout for Masonry.
30. ASTM C494/C494M - Specification for Chemical Admixtures for Concrete.
31. ASTM C549 - Specification for Perlite Loose Fill Insulation.
32. ASTM C578 - Specification for Rigid, Cellular Polystyrene Thermal Insulation.
33. ASTM C744 - Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
34. ASTM C780 - Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
35. ASTM C920 - Specification for Elastomeric Joint Sealants.
36. ASTM C979/C979M - Specification for Pigments for Integrally Colored Concrete.
37. ASTM C1019 - Test Method for Sampling and Testing Grout.
38. ASTM C1093 - Practice for Accreditation of Testing Agencies for Unit Masonry.
39. ASTM C1314 - Test Method for Compressive Strength of Masonry Prisms.
40. ASTM C1329/C 1329M - Specification for Mortar Cement.
41. ASTM C1506 - Test Method for Water Retention of Hydraulic Cement-Based Mortars and Plasters.
42. ASTM C1623 - Specification for Manufactured Concrete Masonry Lintels.
43. ASTM D226/D226M - Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
44. ASTM D1056 - Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
45. ASTM D2000 - Classification System for Rubber Products in Automotive Applications.
46. ASTM D2287 - Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
47. ASTM D4637/D4637M - Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
48. ASTM E119 - Test Methods for Fire Tests of Building Construction and Materials.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

- 49. ASTM E514/ 514M - Test Method for Water Penetration and Leakage Through Masonry.
 - D. The Masonry Society (TMS), American Concrete Institute (ACI), and American Society of Civil Engineers (ASCE):
 - 1. TMS 402/ACI 530/ASCE 5 - Building Code Requirements for Masonry Structures.
 - 2. TMS 602/ACI 530.1/ASCE 6 - Specification for Masonry Structures.
 - E. National Concrete Masonry Association (NCMA):
 - 1. NCMA TEK 8-4A - Cleaning Concrete Masonry.
 - F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - 1. Architectural Sheet Metal Manual.
- 1.05 DEFINITIONS:
- A. CMU(s): Concrete masonry unit(s).
 - B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.
- 1.06 SUBMITTALS:
- A. Product Data: For each type of product.
 - B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
 - C. Qualification Data: For testing agency.
 - D. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
 - 3. Mortar admixtures.
 - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 5. Grout mixes. Include description of type and proportions of ingredients.
 - 6. Reinforcing bars.
 - 7. Joint reinforcement.
 - 8. Anchors, ties, and metal accessories.
 - E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with Property Specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 - 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
 - F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.
- 1.07 QUALITY ASSURANCE:
- A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 01 40 00 - Quality Requirements for mockups.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1.08 DELIVERY, STORAGE, AND HANDLING:

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 FIELD CONDITIONS:

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40°F (4°C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2.02 PERFORMANCE REQUIREMENTS:

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.

2.03 UNIT MASONRY, GENERAL:

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6 except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

2.04 CONCRETE MASONRY UNITS:

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners unless otherwise indicated
- B. CMUs: ASTM C90.
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi
 2. Density Classification: Normal weight
 3. Size (Width): Manufactured to dimensions 3/8 inch (10 mm) less-than-nominal dimensions.

2.05 MASONRY LINTELS:

- A. General: Provide one of the following:
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.06 MORTAR AND GROUT MATERIALS:

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 1. Alkali content shall not be more than 0.1% when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.
- E. Mortar Cement: ASTM C1329/C1329M.
- F. Aggregate for Mortar: ASTM C144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100% passing the No. 16 (1.18-mm) sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C404.
- H. Water: Potable.

2.07 REINFORCEMENT:

- A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: Comply with ASTM A951/A951M.
1. Interior Walls: Ladder type, Hot-dip galvanized carbon steel.
 2. Exterior Walls: Hot-dip galvanized carbon steel.
 3. Exterior (Cavity) Walls: Truss Eye-Wire type, Hot-dip galvanized carbon steel. Size per cavity wall, use insulation dimensions and thicknesses indicated
 4. Wire Size for Side Rods: 0.187-inch diameter.
 5. Wire Size for Cross Rods: 0.187-inch diameter.
 6. Spacing of Cross Rods: Not more than 16 inches o.c.
 7. Provide in lengths of not less than 10 feet.

2.08 TIES AND ANCHORS:

- A. General: Ties and anchors shall extend at least 1-1/2 inches (38 mm) into masonry but with at least a 5/8-inch (16-mm) cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
 2. Stainless-Steel Wire: ASTM A580/A580M, Type 304.
 3. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, G60 (Z180) zinc coating.
 4. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
 5. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
 6. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch (6.35-mm) diameter, hot-dip galvanized steel wire.
 2. Tie Section: Triangular-shaped wire tie made from 0.187-inch (4.76-mm) diameter, hot-dip galvanized steel wire.
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. Corrugated-Metal Ties: Metal strips not less than 7/8 inch (22 mm) wide with corrugations having a wavelength of 0.3 to 0.5 inch (7.6 to 12.7 mm) and an amplitude of 0.06 to 0.10 inch (1.5 to 2.5 mm) made from 0.075-inch (1.90 mm) thick steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete.
 - a. 0.079-inch thick, galvanized sheet may be used at interior walls unless otherwise indicated.
 - E. Partition Top Anchors: 0.105-inch (2.66-mm) thick metal plate with a 3/8-inch (9.5-mm) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- 2.09 MISCELLANEOUS MASONRY ACCESSORIES:
- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene or PVC.
 - B. Preformed Control-Joint Gaskets: Made from PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
 - C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).
- 2.10 MASONRY-CELL FILL:
- A. Loose-Fill Insulation: Perlite complying with ASTM C549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
 - B. Lightweight-Aggregate Fill: ASTM C331/C331M.
- 2.11 MORTAR AND GROUT MIXES:
- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Use Portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
 - B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project Site.
 - C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion and Property Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 1. For masonry below grade or in contact with earth, use Type S.
 2. For reinforced masonry, use Type S.
 3. For mortar parge coats, use Type S.
 4. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 5. For interior nonload-bearing partitions, Type O may be used instead of Type N.
 - D. Grout for Unit Masonry: Comply with ASTM C476.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C476, Table 1
 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C143/C143M.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
1. Application: Use epoxy pointing mortar for exposed mortar joints with pre-faced CMUs.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
 4. Verify that substrates are free of substances that would impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL:

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES:

- A. Dimensions and Locations of Elements:
1. For dimensions in cross section or elevation, do not vary by more than +1/2 inch (12 mm) or -1/4 inch (6 mm).
 2. For location of elements in plan, do not vary from that indicated by more than ±1/2 inch (12 mm).
 3. For location of elements in elevation, do not vary from that indicated by more than ±1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.
- B. Lines and Levels:
1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2-inch (12-mm) maximum.
 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2-inch (12-mm) maximum.
 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2-inch (12-mm) maximum.
 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm).
- C. Joints:
1. For bed joints, do not vary from thickness indicated by more than $\pm 1/8$ inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
 3. For head and collar joints, do not vary from thickness indicated by more than +3/8 inch (9 mm) or -1/4 inch (6 mm).
 4. For exposed head joints, do not vary from thickness indicated by more than $\pm 1/8$ inch (3 mm).

3.04 LAYING MASONRY WALLS:

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches (100 mm). Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 07 84 43 - Joint Firestopping.

3.05 MORTAR BEDDING AND JOINTING:

- A. Lay hollow CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
- B. Lay solid CMUs with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 2. Wet joint surfaces thoroughly before applying mortar.
 3. Rake out mortar joints for pointing with sealant.
- D. Rake out mortar joints at pre-faced CMUs to a uniform depth of 1/4 inch (6 mm) and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- E. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- F. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.06 MASONRY-CELL FILL:

- A. Pour lightweight-aggregate fill into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one story high, but not more than 20 feet (6 m).
- B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.07 MASONRY-JOINT REINFORCEMENT:

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 1. Space reinforcement not more than 16 inches (406 mm) o.c.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at corners by using prefabricated L-shaped units.

3.08 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE:

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.
- 3.09 CONTROL AND EXPANSION JOINTS:
- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
 - B. Form control joints in concrete masonry as follows:
 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
 2. Install preformed control-joint gaskets designed to fit standard sash block.
 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
- 3.10 LINTELS:
- A. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
 - B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.
- 3.11 FLASHING:
- A. General: Install embedded flashing at ledges and other obstructions to downward flow of water in wall where indicated.
 - B. Install flashing as follows unless otherwise indicated:
 - C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
 - D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- 3.12 REINFORCED UNIT MASONRY INSTALLATION:
- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
 - B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
 - C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).
- 3.13 FIELD QUALITY CONTROL:
- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
 - B. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.
 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 3. Place grout only after inspectors have verified proportions of site-prepared grout.
 - C. Testing Prior to Construction: One set of tests.
 - D. Testing Frequency: One set of tests for each 5,000 sq. ft. (464 sq. m) of wall area or portion thereof.
 - E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
 - F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
 - G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.
 - H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.
- 3.14 REPAIRING, POINTING, AND CLEANING:
- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
 - B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
 - C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
 - D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 3. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
- 3.15 MASONRY WASTE DISPOSAL:
- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project Site.
 1. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

SECTION 04 22 00 – CONCRETE UNIT MASONRY: continued

- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 22 00

SECTION 05 12 00 – STEEL

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes fabrication and erection of the structural steel and other steel or metal items as defined in AISC Manual, Code of Standard Practice.

1.02 RELATED REQUIREMENTS:

- A. Concrete: Division 03.
- B. Section 05 53 00 – METAL GRATINGS

1.03 REFERENCE STANDARDS:

- A. American Institute of Steel Construction:
 - 1. AISC 303-2005 - Code of Standard Practice for Steel Buildings and Bridges (available at www.aisc.org).
 - 2. AISC 341-2005 and AISC 341s1-2005 - Seismic Provisions for Structural Steel Buildings Including Supplement No. 1 (available at www.aisc.org).
 - 3. AISC 360-2005 - Specifications for Structural Steel Buildings (available at www.aisc.org).
- B. American Welding Society:
 - 1. AWS D1.1/D1.1M-2006 - Structural Welding Code - Steel.
 - 2. AWS D1.8/D1.8M-2005 - Structural Welding Code - Seismic Supplement.
- C. ASTM International:
 - 1. ASTM A6/A6M-05a - Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - 2. ASTM A36/A36M-05 - Specification for Carbon Structural Steel.
 - 3. ASTM A53/A53M-06 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 4. ASTM A108-03 - Specification for Steel Bar, Carbon, Cold-Finished.
 - 5. ASTM A123/A123M-02 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 6. ASTM A153/A153M-05 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 7. ASTM A193/A193M-06a - Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature or High Pressure Service and other Special Purpose Applications.
 - 8. ASTM A216/A216M-04 - Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - 9. ASTM A325-06 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 10. ASTM A354-04 - Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
 - 11. ASTM A449-04b - Specification for Hex Cap Screws, Bolts, and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
 - 12. ASTM A490-06 - Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
 - 13. ASTM A500-03a - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
 - 14. ASTM A529/A529M-05 - Specification for High-Strength Carbon-Manganese Steel of Structural Quality.

SECTION 05 12 00 – STEEL: continued

15. ASTM A563-04a - Specification for Carbon and Alloy Steel Nuts.
16. ASTM A572/A572M-06 - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
17. ASTM A588/A588M-05 - Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 inches (100 mm) Thick.
18. ASTM A668/A668M-04 - Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
19. ASTM A780-01 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
20. ASTM A847/A847M-05 - Specification for Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance.
21. ASTM A913/A913M-04 - Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process (QST).
22. ASTM A992/A992M-06a - Specification for Structural Steel Shapes.
23. ASTM B695-04 - Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
24. ASTM C1107-05 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
25. ASTM E94-04 - Guide for Radiographic Examination.
26. ASTM E119-05a - Test Methods for Fire Tests of Building Construction and Materials.
27. ASTM E164-03 - Practice for Ultrasonic Contact Examination of Weldments.
28. ASTM E165-02 - Test Method for Liquid Penetrant Examination.
29. ASTM E709-01 - Guide for Magnetic Particle Examination.
30. ASTM F436-04 - Specification for Hardened Steel Washers.
31. ASTM F959-06 - Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
32. ASTM F1554-04 - Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
33. ASTM F1852-05 - Specification for Twist-Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- D. Master Painters Institute:
 1. MPI#18-2004 - Single Component Organic Zinc Rich Primer.
 2. MPI#19-2004 - Inorganic Zinc Rich Primer.
 3. MPI#79-2004 - Alkyd Anti-Corrosive Metal Primer.
- E. Research Council on Structural Connections:
 1. Specification for Structural Joints Using ASTM A325 or A490 Bolts. 2004.
- F. SSPC - The Society for Protective Coatings:
 1. SSPC-PA 1 2000 (Revised 2004) - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
 2. SSPC-Paint 20 2002 (Revised 2004) - Paint Specification No. 20 Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic").
 3. SSPC-Paint 23 1982 (Revised 2004) - Paint Specification No. 23 Latex Primer for Steel Surfaces.
 4. SSPC-Paint 25 1997 (Revised 2004) - Paint Specification No. 25 Zinc Oxide, Alkyd, Linseed Oil Primer for Use over Hand Cleaned Steel, Type I and Type II.
 5. SSPC-Paint 25 BCS 1997 (Revised 2004) - Paint Specification No. 25 BCS Zinc Oxide, Alkyd, Linseed Oil Primer for Use over Blast Cleaned Steel.

SECTION 05 12 00 – STEEL: continued

6. SSPC-PS Guide 7.00 1982 (Revised 2004) - Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems.
7. SSPC-QP 3 2000 (Revised 2004) - Standard Procedure for Evaluating Qualifications of Shop Painting Applicators.
8. SSPC-SP 1 1982 (Revised 2004) - Surface Preparation Specification No. 1: Solvent Cleaning.
9. SSPC-SP 2 1982 (Revised 2004) - Surface Preparation Specification No. 2: Hand Tool Cleaning.
10. SSPC-SP 3 1982 (Revised 2004) - Surface Preparation Specification No. 3: Power Tool Cleaning.
11. SSPC-SP 5/NACE No. 1 2000 (Revised 2004) - Joint Surface Preparation Standard SSPC-SP 5/NACE No. 1 - White Metal Blast Cleaning.
12. SSPC-SP 6/NACE No. 3 2000 (Revised 2004) - Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning.
13. SSPC-SP 7/NACE No. 4 2004 - Joint Surface Preparation Standard SSPC-SP 7/NACE No. 4: Brush-Off Blast Cleaning.
14. SSPC-SP 8 1982 (Revised 2004) - Surface Preparation Specification No. 8: Pickling.
15. SSPC-SP 10/NACE No. 2 2004 - Joint Surface Preparation Standard SSPC-SP 10/NACE No. 2: Near-White Blast Cleaning.
16. SSPC-SP 11 1987 (Revised 2004) - Surface Preparation Specification No. 11: Power Tool Cleaning to Bare Metal.
17. SSPC-SP 14/NACE No. 8 1999 (Revised 2004) - Joint Surface Preparation Standard SSPC-SP 14/NACE No. 8 - Industrial Blast Cleaning.
- G. Occupational Safety and Health Administration (OSHA) - All applicable OSHA regulations, including, but not limited to 29 CFR Part 1910 and Part 1926 Subpart R - Steel Erection.

1.04 SUBMITTALS:

- A. Submit as specified in Division 01.
- B. Includes, but not limited to, the following:
 1. Fabrication and erection drawings for all Work. A reproduction of Engineer-prepared Contract Drawings may be used for erection drawings such as to indicate information on erection or to identify detail drawing references. Where the drawings are revised to show this additional information, Engineer's title block and professional seal shall be removed from the drawing. These erection drawings shall be revised for subsequent Engineer revisions to the Contract Drawings.
 2. Fabrication and erection drawings shall be grouped in sets or sequences and shall be identified separately for each building, structure, or area.
 3. Fabrication and erection drawings shall be prepared using a three dimensional steel modeling and detailing software system. All miscellaneous steel items such as guardrail, handrail, stairs, and ladders shall be included in the same three dimensional model as main structural steel and detailed using the same system.
 4. In the event that drawing revisions are necessary, fabrication and erection drawings shall be clearly clouded showing all changes from the previous revision.
 5. All necessary information for the fabrication, including connection material specifications and sizes as well as filler metal for welds, of the component part of the structure, presented on drawings to conform to recognized standard practice, AISC Manual and AWS Code.

SECTION 05 12 00 – STEEL: continued

6. Drawings indicating stud shear connector spacing regardless of whether connectors are shop-applied or field-applied.
 7. Drawings showing each piece including anchor bolts marked for identification to correspond to erection drawings.
 8. Proposed method and location for erection piece mark numbering.
 9. Manufacturer's literature on products including, but not limited to, grating, stair treads, stair nosings, stud shear connectors, grout, concrete anchors, and protective coatings.
 10. AWS Certified Welding Inspector Certificates.
 11. Welder qualification records.
 12. Qualified welding procedure specifications and procedure qualification test results if welding processes differ from those prequalified by AWS.
- 1.05 QUALITY ASSURANCE:
- A. Fabricator Qualifications: Fabricator shall participate in the AISC Certification Program and be designated an AISC Certified Plant, Category BU (formerly known as Category STD).
 - B. Welder Qualifications:
 1. Welders shall be previously qualified by passing the tests prescribed in the AWS D1.1 or by passing such other tests as Engineer may accept. Welders of stainless steel shall be previously qualified in accordance with AWS D1.6.
 2. Welders shall have been tested within the past 12 months, and their qualification shall be considered as remaining in effect unless the welder is not engaged in a given process of welding for a period exceeding 6 months.
 - C. Comply with applicable provisions of the following specifications and documents:
 1. AISC 303.
 2. AISC 360.
 3. RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
 - D. Preinstallation Conference: Conduct conference at Project Site.
 - E. Inspection: Material or workmanship may be subject to inspection in the shop and field. Engineer shall have unrestricted entry to fabrication facilities and erection site at all times while work is being performed.
- 1.06 DELIVERY, STORAGE, AND HANDLING:
- A. Handle and store all steel and appurtenances as specified in Division 01.
 - B. Deliver steel in the order needed for erection as follows:
 1. Loose base plates.
 2. Steel embedded in concrete.
 3. Erection bolts.
 4. First tier columns and framing for all its levels (including stairs, ladders, and guardrail).
 5. Columns and framing for remaining tiers in order.
 - C. Railcars and/or trucks shall be loaded and cribbed so they can be readily unloaded.
 - D. All steel and its coatings shall be protected from damage caused by handling, storage, and shipping.
 - E. All materials and documentation shall be inspected immediately upon receipt at the erection site to determine that all items in the bill of material have been supplied, to assure that all documentation has been received, and to check for any damage.
 - F. Store all steel and appurtenances blocked-up off the ground and in orderly stacks.

SECTION 05 12 00 – STEEL: continued

- G. Protect all items with shop applied protective coatings from corrosion. Store in an environment and manner consistent with type of coating.

PART 2 - PRODUCTS2.01 BASIC MATERIALS:

- A. Steel: Conform to the following unless otherwise indicated or specified.
1. Wide flange (WF) shapes, tees cut from WF, and Channels: ASTM A992 (50 ksi yield strength) or ASTM A572, Grade 50.
 2. M shapes, S shapes, HP (bearing piles), and angles: ASTM A572 Gr. 50.
 3. Structural plates and bars: ASTM A572 Gr. 50.
- B. Corrosion-Resistant Steel: Conform to ASTM A588, Grade 50.
- C. Rail Steel: Conform to No. 1 rail, ASTM A1 of the weight indicated or specified.
- D. Stainless or Heat-Resisting Chromium-Nickel Steel: Conform to ASTM A167 and A240.
- E. Connection Bolts, Nuts, Washers, and Compressible Washer-Type, Direct Tension Indicators:
1. Conform to ASTM F3125 Grade A325, Type 1, unless otherwise indicated or specified.
 2. Be galvanized when connecting galvanized steel.
 3. Conform to F3125, Type 3, for use with A588, Grade 50.
 4. Compressible Washer-Type, Direct-Tension Indicators:
 - a. ASTM F959 Type 325 for use with A325 bolts.
 - b. ASTM F959 Type 490 for use with A490 bolts.
 - c. Galvanized for use with galvanized bolts.
 5. Nuts: Heavy Hex conforming to ASTM A563 Grade DH.
 6. Flat and beveled washers: Conform to ASTM F436.
- F. Anchor Bolts:
1. Conform to ASTM F1554, Grade 36, unless otherwise indicated to be stainless steel or high strength.
 2. Machine Bolts: Conform to ASTM F1554, Grade 36.
 3. Stainless Steel: Conform to ASTM F593, Type 304, with nuts conforming to ASTM F594. Sleeves shall conform to ASTM A312.
 4. High Strength: Conform to ASTM A449 with nuts conforming to ASTM A563.
 5. Washers:
 - a. For ASTM F1554 and A449 Bolts: Conform to F436.
 - b. For Stainless-Steel Bolts: Conform to ASTM A167, Type 304, and dimensional tolerances of F436.
 6. Galvanize all anchor bolts, nuts, and washers except stainless steel.
- G. Pipe or round Hollow Structural Sections (HSS) for Structural Uses, Guardrail, and Handrail: Conform to one of the following:
1. ASTM A53, Type E or S, Grade B
 2. ASTM A106, Grade B
 3. ASTM A500, Grade B
- H. Square and Rectangular Tubing Hollow Structural Sections (HSS): Conform to ASTM A500, Grade C.
- I. Grating:
1. Main Bars: Conform to ASTM A1011, Commercial Steel (Type B).
 2. Cross Bars: Same as main bars.

SECTION 05 12 00 – STEEL: continued

- J. Shear Stud Connectors: Manufacture from cold-finished carbon steel conforming to ASTM A108, Grade 1015 or 1020.
- K. Checkered Plate: Conform to ASTM A786 with A36 material and with deformations of the 4-way type.
- L. Threaded Rods: Conform to ASTM A36.
- M. Welding:
 - 1. For ASTM A36 steel, use E70 electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1 AWS D1.1.
 - 2. For ASTM A588 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Tables 3.1 and 3.3, AWS D1.1.
 - 3. For ASTM A572, Grade 50 steel or ASTM A992 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1, AWS D1.1.
 - 4. For ASTM A167 or ASTM A312 stainless steel, use shielded metal arc welding, gas metal arc welding, gas tungsten arc welding, or flux-cored arc welding. Select "matching" electrodes in accordance with Table 3.3 of AWS D1.6.
- N. Galvanizing:
 - 1. Conform to ASTM A123.
 - 2. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.

2.02 STEEL FABRICATION:

- A. Fabricate all steel to conform to AISC Code of Standard Practice for Structural Steel Buildings and Bridges, AISC 360, and applicable portions of OSHA 29 CFR Part 1910 and Part 1926.
- B. Permissible variations for sweep, camber, length, and cross section of all steel members shall conform to ASTM A6, AISC Manual, Part 1 and AISC Code of Standard Practice unless indicated otherwise.
- C. Field-measure existing steel and structures where necessary to ensure fabrication fit-up of new steel.
- D. All pieces shall be clearly marked with a permanent identifying erection mark number. Method and location of marking shall be approved by Engineer. Erection markings for galvanized steel shall be mechanically stamped on steel tags with 1/8-inch minimum thickness. Tags shall be bent to provide clearance for galvanizing between the member and the tag, except at the tag ends. Tag ends shall be welded to the member.
- E. Fabricator shall mark all shear connector locations (if field-applied) for composite beams by means of center punch and paint circle or other approved means so that field layout of shear connectors is not required. Do not paint shear connector contact surface.
- F. Provide grout holes in base plates having the least dimension greater than 24 inches. Holes shall be as close to center as practicable and minimum of 2 inches in diameter.
- G. Shop Milling:
 - 1. Perform at the base of columns and at the top of column base plates, except that rolled-steel bearing plates of 4-inch thickness or less may be straightened by pressing.

SECTION 05 12 00 – STEEL: continued

2. Perform on butted ends for bolted or partial penetration-welded column splices. Shop milling is not required for welded column splices with full penetration welds.
 3. Perform at ends of columns which butt against a plate.
- H. Welding:
1. All welding shall be shielded metal arc, submerged arc, or flux-cored arc, or gas metal arc. For gas metal arc welding, the short-circuiting mode of filler metal transfer is not permitted. Other welding processes may be used provided they are qualified by applicable tests as prescribed in the AWS D1.1 (AWS D1.6 for stainless steel) and approved by Engineer prior to use. For the use of any other welding process, submit a qualified welding procedure specification and the procedure qualification test results. Welding processes shall be approved for use only after receipt of specific written approval from the Engineer.
 2. Conform to AWS Code and AISC Manual.
 3. Perform fabrication welding inspection in accordance with AWS D1.1. (AWS D1.6 for stainless steel). This welding inspection shall be performed by AWS Certified Welding Inspector(s) (CWI). All such Certified Welding Inspectors shall be qualified and certified in accordance with the provisions of AWS QC1. Only individuals so qualified shall be authorized to perform fabrication/erection or verification inspection of the welding performed under the provisions of AWS D1.1 (AWS D1.6 for stainless steel) and these Contract Documents. Certifications verifying the qualifications of welding inspectors shall be submitted prior to commencement of structural welding operations or prior to welding inspection performed by an individual welding inspector. Defective welds shall be corrected.
- I. Shop Connections:
1. Weld or bolt except when otherwise indicated or specified.
 2. Shop portions of connections may be welded equivalent to any bolted connection specified if Engineer concurs.
 3. Welded connections shall be as indicated or in accordance with acceptable alternative designs:
 - a. Welds of connection angles to beam webs shall conform to AISC Manual, Part 10, Table 10-2 with particular regard for minimum web thickness. Provide longer connection angles or reinforce web as required.
 - b. All butt-joint groove welds shall be complete penetration welds unless otherwise indicated and shall conform to the applicable standards in AISC Manual, Part 8, with special emphasis on maintaining root opening. Accomplish this for single-bevel, butt-joint welds by using backup plates or by chipping out and welding on the opposite side.
 - c. Prepare weld bevels with a mechanically guided cutting torch or by grinding.
 - d. Remove all run-out tabs.
 4. Bolted connections shall conform to AISC Manual, Parts 9 and 10.
 - a. All bolted connections shall be made with Bearing Type connections using 3/4-inch bolts, nuts, and washers unless otherwise indicated or specified.
 - b. Bearing Type Connections: Capacity of beam connections shall have a minimum capacity of that specified in AISC Manual, Part 10, Table 10.1 for "Standard Holes" in bearing type connections (thread condition N) with the number of bolt rows indicated. A minimum of one hardened washer shall be supplied with each bolt.

SECTION 05 12 00 – STEEL: continued

- c. Use the minimum number of rows of bolts for beam connections so that bottom row is at or below the centerline of the beam.
 - d. Bolts to be installed in the shop shall be tightened in accordance with the provisions for field connections in PART 3.
 - J. Provisions for Field Connections:
 - 1. Provide with bolted connections unless otherwise indicated or specified. The number of rows and number of bolts indicated on the Drawings or stated in the Specifications is the minimum number of rows or bolts. Provide additional bolts or connection devices, if necessary, to comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
 - 2. Provide for field welding only when so indicated or where approved by Engineer.
 - 3. Provide all members to be field-welded with bolted erection connections adequate to resist erection stresses prior to field welding.
 - K. Comply with OSHA 29 CFR 1926, Subpart R - Steel Erection.
- 2.03 COLUMN BASE AND EQUIPMENT ANCHOR BOLTS:
- A. Furnish for all columns and equipment furnished and installed under this Contract, (and as required to install all equipment furnished by others for installation under this Contract unless otherwise indicated).
- 2.04 GUARDRAIL AND HANDRAIL:
- A. Where indicated as round HSS or pipe: HSS1.900x0.145 or 1-1/2-inch nominal (1.9-inch OD) round, black standard-weight pipe.
 - B. Where indicated as angle: angle sizes for posts and railing as indicated.
 - C. Post spacing shall not exceed 6 feet from center-to-center.
 - D. Form and weld all HSS and pipe railing. Grind all welds smooth and even with the surface of the HSS and pipe, including field welds required for erection.
 - E. Carefully form all HSS and pipe railing where change of direction or elevation occurs.
 - F. Guardrail posts shall be vertical (plumb) unless otherwise indicated.
- 2.05 EDGE ANGLES, PLATES, AND LINTELS:
- A. Furnish around and over openings as indicated.
 - B. Keep plates and edge angles flush at intersections and fillet-weld to give a neat appearance at the exposed intersecting surfaces.
 - C. Provide lintel length of opening width +1 foot 4 inches unless otherwise indicated.
 - D. Properly align, level, and plumb edge angles and plates before concrete is placed.
- 2.06 KICK PLATES:
- A. Furnish at the edge of uncovered openings and at the edge of walkways and platforms, except as otherwise indicated.
- 2.07 STEEL FLOOR GRATING:
- A. One-piece, resistance-welded, carbon-steel construction without notching of bearing or cross bars before welding and conforming to NAAMM MBG 531 or 532.
 - B. Main Bearing Bars:
 - 1. Thickness: 3/16 inch; 3/8 inch for heavy duty grating.
 - 2. Depth: As indicated.

SECTION 05 12 00 – STEEL: continued

3. Spacing: Not more than 1-3/16 inches on center; 1-3/8 inches on center for heavy duty grating.
4. Configuration of top surface of main bars unless otherwise indicated:
 - a. Exterior - Exposed to Weather: Serrated.
 - b. Interior - Not Exposed to Weather: Plain.
- C. Cross Bars:
 1. Spacing: 4 inches o.c.
 2. One of the following shapes and minimum sizes:
 - a. Hexagon: 5/16-inch diameter of inscribed circle; 7/16 inch for heavy duty grating.
 - b. Rectangular: 1/2 inch by 3/16 inch; 5/8 inch by 1/4 inch for heavy duty grating.
 - c. Square: 1/4 inch with spiral twist; 1/2 inch for heavy duty grating.
 - d. Round: 3/8-inch diameter, 1/2 inch for heavy duty grating.
- D. Fabrication:
 1. Fabrication shall conform to NAAMM MBG 531; MBG 532 for heavy duty grating, and MBG 533.
 2. Crossbars shall match crossbars of adjacent sections to form a continuous pattern of straight lines.
 3. Provide all openings in grating indicated and as required for installation of all piping, wiring, and equipment installed under this Contract.
 4. Band all openings 4 inches and larger with a metal bar same size as main bearing bar and extend 4 inches above top of grating. Band bars shall be same depth as bearing bars. Weld to each bearing bar with a 3/16-inch fillet weld 3/4 inch long. Tack weld to all crossbars.
 5. Trim-band all locations as follows:
 - a. Open end of grating at head of a ladder.
 - b. Manway opening.
 - c. Hinged sections.
 - d. Grating panels with four crossbars or less.
 - e. Other locations as indicated.
 6. Provide kickplates where indicated and at all handrail on floors or platforms 4 foot or more above adjacent floors or ground where persons can pass or machinery is located.
- E. Shop Finish:
 1. Coat with manufacturer's standard black paint at 3-mil dry-film thickness, by spraying, dipping, or flow coating only where indicated.
- F. Grating shall be manufactured by one of the following:
 1. Tru-Weld Grating, Inc., Wexford, Pennsylvania.
 2. Amico-Klemp Corporation, Chicago, Illinois.
 3. IKG-Borden, Clark, New Jersey.
 4. Approved equal.
- G. Provisions for Grating Connections:
 1. Provide sufficient quantity of grating connecting devices to provide two fasteners at each support +10% extra fasteners.
 2. Clip-type connections using welded studs: Nelson Stud Welding Company, Type CPL.
 3. Clip-type connections using mechanical beam clamps:
 - a. Hilti X MGR Grating Fastening System.
 - b. Grating Fasteners, Inc. G-Clips.
 - c. Lindapter North America Grate-Fast.

SECTION 05 12 00 – STEEL: continued

4. Clip-type connections using powder actuated fasteners: Hilti X BT Grating Fastening System.

5. Finish of grating fasteners shall match finish of grating.

2.08 STAIRS:

A. General Construction:

1. Stringer sizes indicated are minimum acceptable size.
2. Cross-brace stringers to provide lateral stability where the horizontal run exceeds 12 feet.
3. Provide struts and hangers where indicated or as otherwise required for proper support.

B. Treads:

1. Open-riser type with grating conforming to PART 2 - Steel Floor Grating, this Section, and of the same type as specified herein, with main bars 1 inch by 3/16 inch unless indicated otherwise.
2. Treads damaged during construction shall be replaced immediately.
3. Nosings for grating stair treads shall be:
 - a. Cast abrasive, removable, flush mounted 1-1/4 inch to 1-1/2 inch wide and 5/16 inch thick. Nosings shall be secured to a carrier angle by countersunk flathead stainless-steel bolts, washers, and nuts. Color shall be (manufacturer's standard - black) (safety yellow).
 - (1) Wooster Products, Inc. - Type 120 Ferrogrit.
 - (2) American Safety Tread Co. - Style 820 Feracast.
 - (3) Engineer-approved equal.
 - b. As indicated on Drawings.
4. Bolt tread to each stringer with a minimum of two 3/8-inch bolts.

C. Grating Landings:

1. Landings shall be of grating conforming to PART 2 - Steel Floor Grating, this Section.

2.09 CHECKERED PLATE:

- A. Plate shall be of thickness indicated with surface deformations of the 4-way type.
- B. Fasten in place with screws spaced at 18 inches with a minimum of one at each corner of each piece or as otherwise indicated.
- C. Screws shall be 1/4-inch countersunk stainless steel.

2.10 CONCRETE ANCHORS:

- A. Furnish and install manually expanded and adhesive anchor types.
- B. Furnish sizes indicated and install to conform to manufacturer's printed instructions.
- C. Anchors shall be manufactured by one of the following:
 1. Hilti Inc., Tulsa, Oklahoma.
 2. ITW Ramset/Red Head, Wood Dale, Illinois.
 3. Simpson Strong-Tie Co., Pleasanton, California.
- D. Concrete anchors that are not specifically indicated to be high strength steel or stainless steel shall be carbon steel with surface plating or galvanizing in accordance with manufacturer's standard.
- E. Anchors indicated to be high strength steel anchors shall be surface plated or galvanized in accordance with manufacturer's standard.
- F. Anchors indicated to be stainless steel shall be manufactured from 300 series stainless steel per the manufacturer's standard unless specifically indicated to conform to Type 304, 316.

SECTION 05 12 00 – STEEL: continued

- G. Installed adhesive anchors shall not be disturbed or loaded until the anchor has been in place longer than the manufacturer's cure time for the adhesive.

2.11 SHOP-PROTECTIVE COATING:

- A. Apply primer in shop to all steel including connections, except for the following surfaces:
 - 1. Where encased in concrete.
 - 2. Covered with gunite.
 - 3. Within 3 inches adjacent to field welds.
 - 4. On faying surfaces of bolted connections when using alkyd primer.
 - 5. Top flange and anchors on composite beams.

2.12 SHOP-PROTECTIVE COATING:

- A. Surface Preparation: Prepare all surfaces except galvanized (or otherwise specified) in accordance with SSPC-SP3.
- B. Apply shop coat of medium oil alkyd, primer, 2 mil dry-film thickness, to all steel except for the following surfaces:
 - 1. Where encased in concrete.
 - 2. Covered with gunite.
 - 3. Within 3 inches adjacent to field welds.
 - 4. Within 3 inches of a bolted connection including all surfaces in contact with washers.
 - 5. Top flange and anchors on composite beams.
- C. Manufacturer:
 - 1. Ameron - Amercoat 5108.
 - 2. Carboline - Carbocoat 150 HG.
 - 3. ICI Devoe - Rustguard 4140.
 - 4. International - Interlac 393.
 - 5. Sherwin-Williams - Kem Bond HS.
 - 6. Tnemec - Azeron HS 88.

2.13 SHOP-PROTECTIVE COATING:

- A. Surface Preparation: Prepare all surfaces except galvanized (or otherwise specified) in accordance with SSPC-6 and 1.0- to 1.5-mil profile depth.
- B. Apply shop coat of inorganic zinc-rich primer (ethyl silicate base), 3-mil dry-film thickness, to all steel including connections except for the following surfaces:
 - 1. Where encased in concrete.
 - 2. Covered with gunite.
 - 3. Within 3 inches adjacent to field welds.
 - 4. Top flange and anchors on composite beams.
- C. The shop applied inorganic zinc rich primer along with the specified surface preparation shall meet the requirements for Class A relative to painted faying surfaces, slip coefficient, hole type, cure time, etc., as required by RCSC "Specification for Structural Joints Using High-Strength Bolts". Unless otherwise indicated or specified, submit paint manufacturer's certification that the paint to be incorporated with the specified surface preparation will meet the above stipulated requirements.
- D. Manufacturer:
 - 1. Ameron - Dimetcote 9 Series.
 - 2. Carboline - Carbozinc 11 Series.

SECTION 05 12 00 – STEEL: continued

3. ICI Devoe - Catha-Coat 304 Series.
4. International - Interzinc 22 Series.
5. Sherwin-Williams - Zinc Clad II Plus.
6. Tnemec - Tnemezinc 90-96.
- E. Coating shall not exceed specified mil thickness by more than 20%. If this tolerance is exceeded, take corrective action and ensure compatibility with finish coats.

2.14 GALVANIZING:

- A. General:
 1. Galvanize all exterior steel (including structural steel members, grating, floor plate, and fasteners) after fabrication.
 2. Do not galvanize ASTM A490 bolts or crane rails.
 3. Conform to ASTM A123 for structural shapes and plates.
 4. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.
- B. Fabrication:
 1. Safeguard against embrittlement in accordance with ASTM A143.
 2. Safeguard against warping and distortion in accordance with ASTM A384.
 3. Fabrication details shall be in accordance with ASTM A385 to allow for the creation of high quality zinc coatings.
 4. Cutting, drilling, and welding shall be performed before galvanizing.
 5. Weld slag shall be removed before galvanizing.
 6. Edges of tightly contacting surfaces shall be seal welded using minimum 1/8-inch fillet welds.
 7. Vent holes shall be provided for piping or tubular assemblies (including guardrail and handrail) as required by ASTM A385.
 8. Potential issues which could cause a problem in galvanizing shall be brought to the Engineer's attention prior to galvanizing.
- C. Galvanizing of Steel Hardware:
 1. Nuts shall be tapped oversize in accordance with ASTM A563.
 2. Nut threads shall be re-tapped after hot-dip galvanizing to provide proper fit.
 3. Direct tension indicators shall be mechanically galvanized by the manufacturer in accordance with Class 50 of ASTM B695.
- D. Repair:
 1. Any damage to galvanizing shall be repaired in accordance with ASTM A780.
 2. Before repair of damaged galvanized coating, exposed substrate metal shall be cleaned to bright metal and free of all visual rust, oil, or grease. Any nonadhering galvanizing shall be removed to the extent that the surrounding galvanizing is integral and adherent.
 3. If surface defects exceed 2% of a member's area, the defects shall be repaired by redipping the member in the zinc bath.
 4. Cold repair using an organic zinc rich coating shall be permitted if the following conditions exist:
 - a. Total damaged area is less than 1% of the total coated area of the member being repaired.
 - b. No single repair is greater than 2 square inches (1300 mm²).
 - c. No single repair is greater than 12 inches (300 mm) long.
 5. For cold repair:

SECTION 05 12 00 – STEEL: continued

- a. Repair areas in accordance with ASTM A780, Method A2.
 - b. Apply organic zinc-rich primer containing a minimum of 93% zinc in dry film by weight. Apply in multiple coats (allowing proper recoat time) to achieve 8-mil dry film thickness.
 - c. Color shall approximately match the color of galvanizing.
 - d. Cold galvanizing compound shall be one of the following:
 - (1) Crown North American Professional Products Co. Inc. - Cold galvanizing compound.
 - (2) Sentry Chemical Company - Galvonic.
 - (3) Subox, Division of Carboline - Galvanox Type II.
 - (4) ZRC Worldwide - Cold Galvanizing Compound.
6. Hot repairs shall be made in the shop if any of the following conditions exist:
 - a. Total damaged area is greater than 1% but less than 2% of the total coated area of the member being repaired.
 - b. Any single repair is at least 2 square inches (1300 mm²) in area.
 - c. Any single repair is 12 inches (300 mm) long or more.
 7. Hot repair shall be made using zinc alloy rod or powder manufactured for the repair of galvanized steel.
 8. Flux, heavy ash, or heavy dross inclusions shall be removed by brushing, grinding, or filing as required.
 9. Galvanized steel which has been rejected shall be stripped, regalvanized, and submitted again for inspection.
 10. Correction of excessive warpage that exceeds ASTM A6/A6M criteria shall be performed by press straightening if possible.
 11. The application of localized heating to straighten shall be approved by Engineer.
 12. If galvanized tension control bolts are used, all bare steel surfaces (i.e., bolt ends) shall be repair galvanized in accordance with this Section.

PART 3 - EXECUTION3.01 PREPARATION:

- A. Field-check location and elevation of column anchor bolts and footings before erecting structural steel columns.
- B. Field-measure existing steel for plumbness and elevation at connecting points.
- C. Submit the method and sequence of erection for acceptance.
- D. Assure that all preassemblies not specifically indicated on Contract Drawings to be preassembled before lifting shall maintain structural integrity during lifting.

3.02 STEEL ERECTION:

- A. Erect all steel to conform to AISC specifications, codes, and standards or any local, state or federal codes which may exceed such requirements. Comply with applicable OSHA regulations including 29 CFR 1926, Subpart R - Steel Erection.
- B. Protect existing structure from weather when connecting steel to existing structure.
- C. Protect steel and anchor bolt sleeves from entrapped water that can cause damage from freezing or corrosion.
- D. Column Base Plates:

SECTION 05 12 00 – STEEL: continued

1. Prior to setting base plates, clean out sleeves of all foreign material and liquid. Clean bearing surface on foundation and bottom of base plate.
 2. Grout under base plates with a flowable nonshrink grout, taking special care not to disturb their grade and alignment.
 3. Flowable nonshrink grout shall conform to ASTM C1107 and be one of the following:
 - a. Cormix Construction Chemicals, Dallas, Texas - Supreme Grout.
 - b. L&M Construction Chemicals, Inc., Omaha, Nebraska - Crystex.
 - c. Master Builders Company, Cleveland, Ohio - Masterflow 713 Grout.
 - d. Sauereisen Cement Company, Pittsburgh, Pennsylvania - Sauereisen F100.
 - e. Five Star Products, Inc., Fairfield, Connecticut - Five Star Grout.
 4. Cut off exposed edges of the grout at 45 degrees along the edges of the base plates after grout has acquired its initial set.
 5. In hot or cold weather conform to manufacturer's recommendations for temperature control for grouting operations.
- E. Erection Bracing:
1. Provide all necessary erection bracing and be responsible for structural adequacy, design, engineering, and construction of erection bracing.
 2. Provide all necessary temporary struts, ties, cables, temporary flooring, planking, and scaffolding in connection with the erection of the structural steel or support of erection machinery.
 3. Place as required to maintain proper position against loads from erection equipment, construction material, and wind.
 4. Leave bracing in place until sufficient steel connections, concrete slabs, exterior walls, and roof decks are in place to ensure stability of the structure.
- F. Connections:
1. Unless otherwise indicated, connections shall be bolted (slip-critical) (bearing) type.
 2. Tighten high-strength bolts to correct bolt tension in accordance with AISC Manual, Part 16, "Specification for Structural Joints Using High-Strength Bolts."
 - a. Slip-critical Type Connections: Tighten all bolts to the pretensioned condition.
 - b. Bearing Type Connections: Tighten all bolts to the pretensioned condition, except that beam-to-beam connections in floor framing which do not connect to any bracing members may be tightened to the snug-tightened condition:
 - c. Comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
 3. Compressible Washer-Type, Direct-Tension Indicators:
 - a. The use of compressible washer-type, direct-tension indicators is an acceptable alternative to the requirements of PART 3, Paragraph 2.F. - Connections, this Section, in determining specified minimum bolt tension.
 - b. Direct-tension indicators shall be manufactured by one of the following:
 - (1) Turnasure, L.L.C., Langhorne, Pennsylvania.
 - (2) Applied Bolting Technology Products, Inc.
 - (3) Approved equal.
 - c. Manufacture, install, and store in accordance with manufacturer's written instructions and ASTM F959.
 - d. Provide Skidmore-Wilhelm Bolt Tension Calibrator or approved equal to allow Engineer random verification that the direct-tension indicators provide proper bolt tension.

SECTION 05 12 00 – STEEL: continued

4. Where required for connection fit-up, bolt holes may be adjusted in one of the following manners (flame cutting or flame enlargement of holes is not allowed):
 - a. Reamed to AISC allowable maximum size for oversized holes.
 - b. Holes may be filled with weld metal, ground smooth, and field-drilled.
 - c. Other Engineer-approved method.
5. Welded Connections:
 - a. Make welded connections as indicated and leave all erection bolts in place after completion of welding unless otherwise indicated.
 - b. Reinforce connections when members requiring fillet welds are not in contact.
 - c. Use backup bars or spacer bars on all butt welds where root opening exceeds 3/16-inch.
 - d. Remove all run-out tabs.
- G. Welding and Welders:
 1. The requirements for erection welding and welders shall be the same as specified for basic materials and for steel fabrication.
 2. All welds shall be stamped with a mark identifying the welder. Remove welders from Work after two defective welds.
 3. Perform erection-welding inspection in accordance with AWS D1.1. (AWS D1.6 for stainless steel.) This welding inspection shall be performed by AWS Certified Welding Inspector(s) (CWI). All such Certified Welding Inspectors shall be qualified and certified in accordance with the provisions of AWS QC1. Only individuals so qualified shall perform fabrication/erection or verification inspection of the welding performed under the provisions of AWS D1.1 Code (AWS D1.6 for stainless steel) and these Contract Documents. Certifications verifying the qualifications of welding inspectors shall be submitted prior to commencement of structural welding operations or prior to welding inspection performed by an individual welding inspector. Defective welds shall be corrected.
- H. Protect pipe sleeves, other anchorage members, and concrete bases from deleterious materials at all times, and from water which may cause ice damage during freezing weather.
- I. Guardrail and Handrail:
 1. Form and weld all HSS and pipe railing. Grind all welds smooth and even with the surface of the HSS/pipe.
 2. Carefully fit all HSS and pipe railing where change of direction or elevation occurs.
 3. Install all rails and posts plumb, level, straight and true, and in alignment.
 4. Top rail shall clear all fixed objects by at least 3 inches vertically and horizontally.
 5. Furnish and install plates, bolts, and additional items as indicated or required for fastening to supporting members.
- J. Grating:
 1. Grating installation shall conform to NAAMM MBG 531 or MBG 532 and as specified herein.
 2. Space fasteners as required to overcome irregularities and maintain grating contact with supports. Minimum anchorage of each panel shall be two fasteners at each support.
 3. Install grating fasteners per manufacturer's printed instructions.
 4. All grating shall be removable unless otherwise indicated.
- K. Concrete Anchors:
 1. Install anchors to conform to manufacturer's printed instructions.

SECTION 05 12 00 – STEEL: continued

2. The hole tolerances, drill bits, and anchor installation torque shall be as per manufacturer's printed recommendations.

3.03 FIELD-PROTECTIVE COATINGS:

- A. Surface preparation, priming, and finish coating are specified in Section 09 90 00.

3.04 REPAIR OF GALVANIZED SURFACES:

- A. Repair all damaged galvanized surfaces in accordance with the "Galvanizing" paragraph in PART 2, this Section.

END OF SECTION 05 12 00

SECTION 09 90 00 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in Part 2.
- B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
 - 1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
 - 2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
 - 3. Concealed surfaces subject to corrosion or attack if unprotected shall be prime-coated and touched up prior to concealment under insulation or other protective layer.
 - 4. Where Equipment and Materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
 - 5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

1.03 RELATED REQUIREMENTS:

- A. Shop Painting and Coatings: All applicable Divisions.
- B. Factory Prefinished Items: All applicable Divisions.
- C. Colors:
 - 1. Color of finish coatings shall match existing.
 - 2. When second and finish coats of a system are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.

1.04 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. American National Standards Institute (ANSI):
 - a. A13.1 - Scheme for the Identification of Piping Systems.
 - b. Z53.1 - Safety Color Code for Marking Physical Hazards.
 - 2. ASTM International (ASTM):
 - a. D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
 - b. D4258 - Surface Cleaning Concrete for Coating.
 - c. D4259 - Abrading Concrete.

- d. D4260 - Acid Etching Concrete.
 - 3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
 - a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
 - b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.
 - c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
 - d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
 - e. SP6 - Commercial Blast Cleaning: Two-thirds of every nine square inches free of all visible residues; remainder only light discoloration.
 - f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
 - g. SP10 - Near-White Blast Cleaning: At least 95% of every nine square inches shall be free of all visible residues.
 - h. SP11 - Power Tool Cleaning to Bare Metal.
 - i. SP12 – Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
 - j. SP13 – Surface Preparation of Concrete.
- 1.05 SUBMITTALS:
- A. Includes, but not limited to, the following:
 - 1. Schedule of products and paint systems to be used. Schedule shall include the following information:
 - a. Surfaces for system to be applied.
 - b. Surface preparation method and degree of cleanliness.
 - c. Product manufacturer, name, and number.
 - d. Method of application.
 - e. Dry film mil thickness per coat of coating to be applied.
 - 2. Color charts for selection and acceptance.
 - 3. Technical and material safety data sheets.
 - 4. Sample panels, two approximately 4 inches by 8 inches (100 mm by 200 mm), of all colors.
 - 5. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
 - 6. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.
 - 7. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.06 QUALITY ASSURANCE:

- A. Certification: Coating work shall be performed by an SSPC certified contractor having a minimum of Category QP 1 certification for work without hazardous paint removal, and Category QP 2 certification for work involving hazardous paint removal.
- B. Include on label of container:
 - 1. Manufacturer's name, product name, and number.
 - 2. Type of paint and generic name.
 - 3. Color name and number.
 - 4. Storage and temperature limits.
 - 5. Mixing and application instructions, including requirements for precautions which must be taken.
 - 6. Drying, recoat, or curing time.
- C. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at end of this Section.
- D. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.
- E. Specified VOC shall mean unthinned maximum VOC certified by manufacturer. VOC content as a result of thinning shall not exceed that allowed by federal or local environmental regulations.

1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery of Materials:
 - 1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
 - 2. Allow sufficient time for testing if required.
- B. Storage of Materials:
 - 1. Store only acceptable materials on Project Site.
 - 2. Provide separate area and suitable containers for storage of coatings and related coating equipment.
 - 3. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

1.08 REGULATORY REQUIREMENTS:

- A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the U.S. EPA and the local and regional jurisdictions. Notify Engineer of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.
- B. Lead Content: Use only coatings that are totally lead free.
- C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
- D. Asbestos Content: Materials shall not contain asbestos.
- E. Mercury Content: Materials shall not contain mercury or mercury compounds.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Acceptable manufacturers for each coating system are listed on the associated Protective Coating System datasheet at the end of this Section.

2.02 GENERAL:

- A. Materials furnished for each coating system must be compatible to the substrate.
- B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
- C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:

- A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:

- A. Apply the following coating system to the Condenser Water piping system:
 - 1. PCS A-3: Steel – Severe Exposure - Exterior or Interior

2.05 COLOR CODING OF PIPING:

- A. Color Coding of Piping: Exterior and interior by color coding entire pipe.
 - 1. General:
 - a. Coat piping with solid colors as specified below for entire length of pipe in exposed finished and unfinished areas. Exclude areas in pipe chases and furred areas.
 - 1. Color Coding:

<u>Area or Item</u>	<u>Color</u>
Condenser Water Piping	Orange (to match existing)

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

- A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
 - 1. If grease or oils are present, SSPC-SP1 shall precede any other method specified for metal substrates.
 - 2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.
- B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third of the total dry film thickness of complete system.
- C. Prepare only those areas which will receive the first coat of the system on the same day.
 - 1. On steel substrates, apply coating before rust bloom forms.
- D. Concrete and masonry surfaces shall be adequately cured prior to coating application.
 - 1. Use surface cleaning methods, followed by mechanical or chemical surface preparation as specified in SSPC SP13.
 - a. Acid etching (ASTM D 4260) shall not be used for vertical surfaces.
 - b. Acid etching shall only be used where:
 - (1) Procedures are in place for removal of acid residues and the handling, containment, and disposal of hazardous materials.
 - (2) Measures for protection of worker health and safety are provided.

3.02 APPLICATION:

- A. Apply coatings in accordance with coating manufacturer's recommendations.
- B. Use properly designed brushes, rollers, and spray equipment for all applications.
- C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
- D. Dry film thickness of each system shall meet the minimum specified. Maximum dry film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements if less. Where a dry film thickness range is specified, the range shall not be less than or exceeded.
- E. Shop and field painting shall remain 3 inches (75mm) away from unprepared surface of any substrate such as areas to be welded or bolted.
- F. Environmental Conditions:
 - 1. Atmospheric temperature must be 50°F (10°C) or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
 - 2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
 - 3. Relative humidity must be less than 85%. The ambient temperature and the temperature of the surface to be painted must be at least 5°F (2.8°C) above the dew point.
 - 4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
- G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.
- H. Protection:
 - 1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
 - 2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
 - 3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
 - 4. Provide signs to indicate fresh paint areas.
 - 5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.
 - 6. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:

- A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.
- B. Contractor shall provide and use a dry film gauge to check each coat mil (mm) thickness when dry, and the total system mil (mm) thickness when completed.
- C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
- D. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.

- E. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5°F (2.8°C) or more above the dew point.

3.04 CLEANING AND REPAIRS:

- A. Remove spilled, dripped, or splattered paint from surfaces.
- B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION 09 90 00

SERVICE: Steel – Severe Exposure - Exterior or Interior

Surface Preparation:	Shop or Field First Coat: SSPC-SP10 and profile depth 1.5 to 2.5 mils (38 to 63 microns). Field Touch-Up (of Shop-applied first coat): SSPC-SP11 and profile depth 1.0 to 1.5 mils (25 to 38 microns).
First (Prime) Coat:	Shop: Two package inorganic zinc -rich primer with minimum 80% zinc in dry film by weight. Apply at 2.0 to 4.0 mils (50 to 100 microns) dry film thickness. Field: Touch up with organic zinc-rich primer with minimum 80% zinc in dry film by weight. Apply at 2.0 to 4.0 mils (50 to 100 microns) dry film thickness.
Second Coat:	High-Build polyamide epoxy with minimum 65% solids by volume. Apply at 4.0 to 6.0 mils (100 to 150 microns) dry film thickness.
Third Coat (Exterior):	High solids aliphatic acrylic polyurethane gloss enamel with minimum 65% solids by volume. Apply at 3.0 to 5.0 mils (75 to 125 microns) dry film thickness.
System Total:	Minimum 10.0 mils (250 microns) dry film thickness(Exterior). Minimum 6.0 mils (150 microns) dry film thickness (Interior).
VOC (per coat):	Maximum 2.8 lb/gal (340 g/L).

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	TOUCH UP	SECOND COAT	THIRD COAT
PPG	Dimetcote 9 Series	Amercoat 68HS	Amercoat 385	Amercoat 450H
Carboline	Carbozinc 11Series	Carbozinc 859	Carboguard 890 Series	Carbothane 133
International	Interzinc 22 Series	Interzinc 52	Intergard 475 HS	Interthane 990
Sherwin-Williams	Zinc Clad II Plus	Zinc Clad IV	Macropoxy 646 B58-	HS Polyurethane
Tnemec	Series 90E-92 Tneme-Zinc	Series 90-97 Tneme-Zinc	Series N69 Epoxoline II	Series 1074 Endura-Shield II

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (latest edition):
 - 1. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart B
 - "Regulations Relating to Labor," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
 - 2. InterNational Electrical Testing Association (NETA):
 - a. ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. MG 1 - Motors and Generators.
 - 4. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code
 - 5. IEEE 841-2009 - Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp)

1.04 COORDINATION:

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

1.05 SUBMITTALS

- A. All motors provided by the Contractor shall be of the same manufacturer unless they are an integral part of the piece of equipment to which they are attached.
- B. Product Data: Provide the following information for each motor:
 - 1. Manufacturer.
 - 2. Rated full load horsepower.
 - 3. Rated volts.
 - 4. Number of Phases.
 - 5. Insulation Class.
 - 6. Frequency in Hertz.
 - 7. Full load amperes (FLA).
 - 8. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
 - 9. Nominal speed at full load (rpm).
 - 10. Service factor.
 - 11. NEMA design letter.
 - 12. NEMA machine type (ODP, WP-I, TEFC, etc.).
- C. For motors one horsepower and larger, include the following additional information:
 - 1. NEMA frame size.
 - 2. NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance for outdoor application.
 - 3. Maximum ambient temperature for which motor is designed.
 - 4. Time rating.
 - 5. Bearing size and type data.
 - 6. Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.
- D. For motors 20 horsepower and larger, include the following additional information:
 - 1. No load amperes.
 - 2. Safe stall time.
 - 3. Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.
 - 4. Motor manufacturers recommended maximum power factor correction capacitor (kvar) that can safely be switched with the motor.
 - 5. Expected value of corrected power factor at no load, 50 percent, 75 percent and full load.
 - 6. Full load amperes with corrected power factor.
 - 7. Maximum guaranteed slip at full load.
- E. Operation and Maintenance Data:
 - 1. Submit operation and maintenance data including assembly Drawings, bearing data including replacement sizes, and lubrication instructions.

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

F. Alternate Motors:

1. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches and other related items at no change in the Contract price.

1.06 WARRANTY

1. Provide minimum one-year manufacturer's warranty including coverage for motors one horsepower and larger.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS:

- A. Motors ½ HP and Larger: Three-phase.
- B. Motors Smaller Than ½ HP: Single-phase.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15.
- F. Duty: Continuous duty at ambient temperature of 40°F and at altitude of 3300 feet (1000 m) above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: NEMA Premium Efficient, as defined in NEMA MG 1.
- C. Stator: Copper windings, unless otherwise indicated.
 1. Multispeed motors shall have separate winding for each speed.
- D. Service Factor: 1.15.

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating, unless otherwise indicated.
- H. Insulation: Class F, unless otherwise indicated.
- I. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motors 7.5 HP and larger; rolled steel for motor frame sizes smaller than 7.5 HP.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:

- A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Bearing Protection: All motors operated on variable frequency drives shall be equipped with maintenance free, 360 degree circumferential conductive micro fiber shaft grounding ring with a minimum two continuous rows of conductive micro fibers completely surrounding the motor shaft to discharge electrical shaft voltages away from the motor's bearings to ground. Note: Friction/spring contact brushes shall not be acceptable.
 - 3. Application Note: Motors up to 100HP shall be provided with a minimum of one shaft grounding ring as described above installed by the manufacturer internally to the motor or externally on the drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.
 - 4. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 5. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

- 6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.
 - 4. Silicone sealants.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. ASTM International (ASTM):
 - a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - b. ASTM C1107/C1107M - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.04 SUBMITTALS:

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

PART 2 - PRODUCTS

2.01 SLEEVES:

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53/A53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 GROUT:

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.03 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC.
- B. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.04 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION:

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch (25 mm) annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, and concrete walls.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 3 inches (76 mm) above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Using waterproof silicone sealant, seal space between sleeve and pipe or insulation.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION:

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and

sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.03 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches (76 mm) above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE:

1. Concrete Slabs-on-Grade:
 - a. Galvanized-steel-pipe sleeves .
2. Concrete Slabs above Grade:
 - a. Galvanized-steel-pipe sleeves.

END OF SECTION 23 05 17

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes:
 - 1. Bronze ball valves.
 - 2. Iron, lug style butterfly valves.
 - 3. Bronze lift check valves.
 - 4. Iron, center-guided check valves.
 - 5. Non-lubricated plug valves
 - 6. Chainwheels.
 - 7. Stainless-steel, high-performance butterfly control valves.
- 1.03 RELATED REQUIREMENTS:
- A. Division 23 - HVAC Piping Sections for specialty valves applicable to those sections only.
- 1.04 REFERENCE STANDARDS:
- A. Applicable Standards (Latest Edition):
 - 1. American Water Works Association (AWWA):
 - a. AWWA C606 - Grooved and Shouldered Joints.
 - 2. ASME International (ASME):
 - a. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
 - b. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 - c. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
 - d. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - e. ASME B16.34 - Valves - Flanged, Threaded, and Welding End.
 - f. ASME B31.1 - Power Piping.
 - g. ASME B31.9 - Building Services Piping.
 - 3. ASTM International (ASTM):
 - a. ASTM A48/A48M - Specification for Gray Iron Castings.
 - b. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. ASTM A536 - Specification for Ductile Iron Castings.
 - d. ASTM B61 - Specification for Steam or Valve Bronze Castings.
 - e. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
 - 4. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
 - a. MSS SP-45 - Bypass and Drain Connections.
 - b. MSS SP-67 - Butterfly Valves.
 - c. MSS SP-68 - High Pressure Butterfly Valves with Offset Design.
 - d. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

- e. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
- f. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
- g. MSS SP-85 - Gray Iron Globe & Angle Valves, Flanged and Threaded Ends.
- h. MSS SP-110 - Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- i. MSS SP-125 - Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves.

1.05 DEFINITIONS:

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. RS: Rising stem.

1.06 SUBMITTALS:

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

1.07 QUALITY ASSURANCE:

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

1.08 DELIVERY, STORAGE, AND HANDLING:

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:

- A. Refer to HVAC valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping, unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - 4. Wrench: For plug valves with square heads. Furnish Owner with one wrench for every five plug valves, for each size square plug-valve head. Provide a minimum of one wrench for every size square plug-valve head.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES:

- A. Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Milwaukee Valve Company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel.
- j. Port: Regular.

2.03 IRON, LUG STYLE BUTTERFLY VALVES:

- A. 250 CWP, Iron, Lug Style Butterfly Valves with EPDM Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Bray Controls; a division of Bray International.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - d. Crane Co.; Crane Valve Group; Center Line.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. DeZurik Water Controls.
 - g. Milwaukee Valve Company.
 - h. Mueller Steam Specialty; a division of SPX Corporation.
 - i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 250 psig (1035 kPa) at 250 °F.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One-piece stainless steel.
 - g. Disc: Nickel-plated ductile iron 304 stainless steel.

2.04 BRONZE LIFT CHECK VALVES:

- A. Class 125, Lift Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).

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- c. Body Design: Vertical flow.
- d. Body Material: ASTM B61 or ASTM B62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.05 IRON, CENTER-GUIDED CHECK VALVES:

- A. Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. DFT Inc.
 - b. Metraflex, Inc.
 - c. Milwaukee Valve Company.
 - d. Mueller Steam Specialty; a division of SPX Corporation.
 - e. Val-Matic Valve & Manufacturing Corp.
 - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Bronze.
- B. D. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. APCO Willamette Valve and Primer Corporation.
 - b. Crispin Valve.
 - c. DFT Inc.
 - d. Milwaukee Valve Company.
 - e. Val-Matic Valve & Manufacturing Corp.
 - 2. Description:
 - a. Standard: MSS SP-125.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - d. Body Material: ASTM A126, gray iron.
 - e. Style: Globe, heavy duty spring loaded.
 - f. Ends: Flanged.
 - g. Seat: Buna-N or EPDM.

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2.06 NON-LUBRICATED PLUG VALVES:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Nordstrom Valves, Inc
 - 2. Engineer approved equivalent.
- B. Description:
 - 1. NPS 2-1/2 to NPS 12 (DN 65 to DN 300).
 - 2. NPS 14 to NPS 24 (DN 350 to DN 600).
 - 3. Body Design: Class 150, Regular Gland, Nonlubricated Plug valves with Flanged Ends.
 - 4. Body Material: A216 WCB, Carbon Steel with bolted bonnet, flanged ends in accordance with ASME B16.5.
 - 5. Pattern: Full bore.
 - 6. Plug: Fully coated EPDM plug, mating seat of no less than 90% pure nickel, raised and welded into the body.

2.07 CARBON STEEL, HIGH-PERFORMANCE BUTTERFLY ACTUATED VALVES

- A. ASME 150, Class IV, 316 SS Disc, RTFE/SS Seats
 - 1. Manufacturers:
 - a. Emerson/Keystone
 - 2. Description
 - a. Pressure Class: ASME 150.
 - b. Body Material: Carbon Steel.
 - c. Style: Butterfly.
 - d. Ends: Flanged.
 - e. Seat: RTFE/SS.
 - f. Stem: Stainless steel.
- B. Actuator
 - 1. Manufacturer/Model:
 - a. Keystone EPI2 Electric Actuator
 - (1) 120 VAC Power, 24VDC Control Contacts
 - (2) For On/Off Valves include the following:
 - (a) Limit Switches: Provide one for valve full open and one for valve full closed unless otherwise noted.
 - 1). Type: Integrated in actuator.
 - (3) Optional Module: OM3
 - (a) Module for local, actuated open/close push buttons for valve control.

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
 - Lift Check Valves: With stem upright and plumb.

3.03 ADJUSTING:

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze center guide lift check valves with bronze disc.
 - b. NPS 2-1/2 (DN 65) and Larger: Iron center-guided, resilient-seat check valves with heavy duty spring.

SECTION 23 05 23 – GENERAL-DUTY VALVES FOR HVAC PIPING

- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.05 CHILLED-WATER VALVE SCHEDULE:

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
 - 1. Iron, Lug style Butterfly Valves, NPS 2-1/2 to NPS 24 (DN 65 to DN 600): 250 CWP, EPDM seat, stainless-steel disc.
 - 2. Iron, Center-Guided Check Valves: Class 125, globe, resilient seat.

3.06 CONDENSER-WATER VALVE SCHEDULE:

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Ball Valves: Two piece, regular port, bronze with stainless-steel trim.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:
 - 1. Iron, Lug style Butterfly Valves, NPS 2-1/2 to NPS 24 (DN 65 to DN 600): 250 CWP, EPDM seat, stainless-steel disc.
 - 2. Iron, Center-Guided Check Valves, NPS 2-1/2 to NPS 24 (DN 65 to DN 600): Class 125, resilient seat.
 - 3. Non-Lubricated Plug Valves: Class 125, regular gland, flanged.

END OF SECTION 23 05 23

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

- A. Contractor shall support pipe as indicated or detailed on contract drawings and schedules. For supports not detailed or scheduled on drawings, contractor shall comply with this Section. Pipe supports in this Section includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Thermal-hanger shield inserts.
 - 4. Fastener systems.

1.02 RELATED REQUIREMENTS:

- 1. DIVISION 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
- 2. SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation devices.
- 3. SECTION 233113 - METAL DUCTS for duct hangers and supports.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 2. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - 3. ASME International (ASME):
 - a. ASME B31.9 - Building Services Piping.
 - b. ASME Boiler and Pressure Vessel Code - Section IX, "Welding and Brazing Qualifications."
 - 4. ASTM International (ASTM):
 - a. ASTM A36/A36M - Specification for Carbon Structural Steel.
 - b. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - c. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - d. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
 - e. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - f. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - 5. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
 - a. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
 - c. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

6. Metal Framing Manufacturers Association, Inc. (MFMA):
 - a. MFMA-4 - Metal Framing Standards Publication.
 - b. MFMA-103 - Guidelines for the Use of Metal Framing.
 7. The Society for Protective Coatings (SSPC):
 - a. SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.
- 1.04 DEFINITIONS:
- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
- 1.05 PERFORMANCE REQUIREMENTS:
- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment.
- 1.06 SUBMITTALS:
- A. Product Data: For each type of product indicated.
 - B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Pipe stands.
 3. Equipment supports.
 - C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.
 - D. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)
- 1.07 QUALITY ASSURANCE:
- A. Structural Steel Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - B. Pipe Welding Qualifications: Weld piping in accordance with qualified procedures using performance qualified welders and welding operators according to ASME Boiler and Pressure Vessel Code.

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - Execution), factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pre-galvanized or hot-dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.02 TRAPEZE PIPE HANGERS:

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 THERMAL-HANGER SHIELD INSERTS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. PHS Industries, Inc.
 - 3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.04 FASTENER SYSTEMS:

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.05 MISCELLANEOUS MATERIALS:

- A. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION:

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, 12, 16, 19, 20, 23, 25, 27, 28, 29, and 30. However, Types 7, 9, 10, 11, 19, and 23 may be used for nonferrous and plastic piping systems 2 inches and smaller.
- C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Do not use in lightweight concrete or in concrete slabs less than 4 inches thick. Powder activated fasteners will not be permitted.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- L. Thread Engagement: all hanger components shall be threaded such that there are a minimum of three rows of threads exposed on the outlet side of the component.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
- 5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 METAL FABRICATIONS:

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with qualified procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.03 ADJUSTING:

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

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- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.04 PAINTING:

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.05 HANGER AND SUPPORT SCHEDULE:

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers or fiberglass pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, and 12. However, Types 7, 9, 10, and 11 may be used for nonferrous and plastic piping systems 2 inches and smaller.
 - 2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 3. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1,050°F (566°C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
 - 4. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - 5. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
 - 6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 7. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

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8. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
9. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
10. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Exception: The following figure type given in Figure 1 of MSS SP-69 will not be acceptable: Type 16.
 2. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 3. Steel Clevises (MSS Type 14): For 120 to 450°F (49 to 232°C) piping installations.
 4. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450°F (49 to 232°C) piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following type:
 1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
 2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 pounds (340 kg).
 - b. Medium (MSS Type 32): 1,500 pounds (680 kg).
 - c. Heavy (MSS Type 33): 3,000 pounds (1360 kg).
 6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes the following:
 - 1. Elastomeric isolation pads.
 - 2. Open-Spring hangers.
- 1.03 RELATED REQUIREMENTS:
- A. SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT.
 - B. SECTION 232113 - HYDRONIC PIPING.
- 1.04 REFERENCE STANDARDS:
- A. Applicable Standards (Latest Edition):
 - 1. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - 2. ASTM International (ASTM):
 - a. ASTM A36/A36M - Specification for Carbon Structural Steel.
 - b. ASTM A492 - Specification for Stainless Steel Rope Wire.
 - c. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
 - d. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - 3. Code of Federal Regulations (CFR):
 - a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
 - 4. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
 - a. MSS SP-127 - Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.
 - 5. Metal Framing Manufacturers Association (MFMA):
 - a. MFMA-3 - Metal Framing Standards Publication.
 - 6. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
 - a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- 1.05 DEFINITIONS:
- A. IBC: International Building Code.
 - B. ICC-ES: ICC-Evaluation Service.
- 1.06 PERFORMANCE REQUIREMENTS:
- A. Wind-Restraint Loading:

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1. Basic Wind Speed: 120 mph (Risk Category III Map)
2. Exposure Category: C
3. Minimum 16 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
 1. Site Class as Defined in the IBC: C.
 2. Assigned Seismic Occupancy Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: Varies by component (See ASCE 7-10, Table 13.6-1)
 3. Component Amplification Factor: Varies by component (See ASCE 7-10, Table 13.6-1)
 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): $S_{DS} = 0.177$
 4. Design Spectral Response Acceleration at 1-Second Period: $S_{D1} = 0.12$
 5. Seismic Design Category: B

1.07 SUBMITTALS:

- A. Product Data: For the following:
 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Qualification Data: For professional engineer and testing agency.
- D. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)
- E. Field quality-control test reports.

1.08 QUALITY ASSURANCE:

- A. Comply with seismic-restraint requirements in the IBC, unless requirements in this Section are more stringent.
- B. Welding: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to

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ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Mountings & Controls, Inc.
- B. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Outside Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50% of the required deflection at rated load.
 - 4. Lateral Stiffness: More than 80% of rated vertical stiffness.
 - 5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
 - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
- C. Elastomeric Isolation Pads: ASHRAE Type 1:
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties.
 - 4. Surface Pattern: Waffle pattern.
 - 5. Infused nonwoven cotton or synthetic fibers.
 - 6. Load-bearing metal plates adhered to pads, where applicable.
 - 7. Sandwich-Core Material: Resilient and/or elastomeric, per manufacturer's recommendation.
 - a. Surface Pattern: Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

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PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SYSTEM DESIGN

- A. Vibration isolation equipment manufacturer shall be responsible for proper selection of spring rates to accomplish the specified minimum static deflections for all spring and pad type isolators, based on weight distribution of equipment to be isolated.

3.03 VIBRATION-CONTROL DEVICE INSTALLATION:

- A. Install cables so they do not bend across edges of adjacent equipment or building structure.
- B. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- C. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- F. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- G. Rigid connections shall not exist between equipment and building structure that will degrade the sound and vibration control system(s) specified herein.
- H. Sound and vibration control equipment and materials manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the sound and vibration control system. Upon completion of equipment installation and after the system is placed into operation, the manufacturer, or his representative, shall make a final inspection and submit a report to Architect in writing, certifying the correctness of the installation and compliance with Drawings and Specifications.
- I. Piping and ductwork to be vibration isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping and ductwork, and maintain a minimum of 3/4 inch and a maximum of 1-1/4 inch clearance around the outside surfaces.
- J. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 INSTALLATION

- A. Install vibration isolators for motor driven equipment, as specified.

3.05 ADJUSTING:

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.06 VIBRATION-CONTROL SCHEDULE:

- A. Centrifugal Chiller: Neoprene pads.
- B. Centrifugal Fans
 1. Up to 22" diameter:
 - a. All floor spans:
 - b. Spring Isolator or Spring Hanger.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.
 - 8. Painting
- 1.03 REFERENCE STANDARDS:
- A. Applicable Standards (Latest Edition):
 - 1. ASME International (ASME):
 - a. ASME A13.1 - Scheme for the Identification of Piping Systems.
 - 2. ASTM International (ASTM):
 - a. ASTM D709 – Standard Specification for Laminated Thermosetting Material
- 1.04 SUBMITTALS:
- A. Product Data: Provide manufacturers catalog literature 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: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- 1.05 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

2.01 IDENTIFICATION APPLICATION

- A. Automatic Controls: Tags. Key to control schematic.
- B. Control Panels: Nameplates.

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- C. Ductwork: Nameplates.
- D. Piping: Markers.
- E. Pumps: Nameplates.
- F. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 EQUIPMENT LABELS:

A. Metal Labels for Equipment:

1. All equipment shall have name plates of metal permanently fastened to the equipment with data engraved or stamped.
 - a. The name plate shall have manufacturer's name, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and essential data.
 - b. Location shall be accessible and visible.
 - c. In case of pumps, the name plates shall include flow rate in gpm and pump head in feet.
2. Material and Thickness: Stainless steel, 0.025 inch or anodized aluminum, 0.032 inch minimum thickness.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inches.
4. 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.
5. Fasteners: Stainless-steel rivets.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers:
 - a. Advanced Graphic Engraving
 - b. Kolbi Pipe Marker Co.
 - c. Seton Identification Products
 - d. Approved Equal.
2. Material ASTM D709.
3. Letter Color: Use following color codes:
 - a. Cooling equipment and components: Green
 - b. Heating equipment and components: Yellow
 - c. Energy reclaim equipment and components: Brown
 - d. Equipment and components that do not meet above criteria: Blue
 - e. Hazardous equipment: Use colors and designs recommended by ASME A13.1.
4. Background Color: Black.
5. Maximum Temperature: Able to withstand temperatures up to 160°F (71°C).
6. Minimum Label Size: 2 1/2" x 4" for control devices and valves and 4 1/2" x 6" for equipment.

Minimum Letter Size: 1/4 inch height or coordinate names, abbreviations and other designations used in mechanical system identification with University Mechanical Engineer assigned to the project and with University Operations.

7. Fasteners: Stainless-steel self-tapping screws.

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- 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: Match schedules as closely as possible. Include the following:
 - 1. Name and plan number
 - 2. Equipment service
 - 3. Design capacity
 - 4. Other design parameters such as pressure drops, entering and leaving conditions, and speed.
- E. Engraved Plastic Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic resin laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine sub-core, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
 - 1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
 - 2. Thickness: 1/16-inch, for units up to 20 sq. in. or 8 inches in length and 1/8-inch for larger units.
 - 3. Fasteners: Self-tapping, stainless steel screws or contact type permanent adhesive.
- F. Access Panel Markers: 1/16-inch thick, engraved plastic laminate markers with abbreviated terms and numbers corresponding to concealed valve/VAV box etc. Provide 1/8-inch center hole for attachment.

2.03 WARNING SIGNS AND LABELS:

- A. Material and Thickness: Preprinted or partially preprinted, accident prevention tags, of plasticized card stock with matte finish suitable for writing.
- B. Letter Color: Yellow with red lettering Follow marker requirement for pipe/duct/equipment labels for material installation.
- C. Maximum Temperature: Able to withstand temperatures up to 160°F.
- D. Minimum Label Size: 3 1/4" x 5 5/8".
- E. Minimum Letter Size: Coordinate names, abbreviations and other designations used in mechanical system identification with University Mechanical Engineer assigned to the project and with University Operations.
- F. Fasteners: Brass grommets and wires.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- H. Label Content: Include caution and warning information, plus emergency notification instructions. Large Size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

2.04 PIPE LABELS:

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com.
 - 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.
 - 3. MIFAB, Inc.: www.mifab.com.
 - 4. Seton Identification Products: www.seton.com.

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5. Approved Equal.
- B. General Requirements for Manufactured Pipe Labels: Manufacturer's standard preprinted captions as selected by the Professional.
- 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:
 - a. Pipes with OD Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degree around pipe at each location.
 - b. Pipes with OD Including Insulation, 6 Inches and Larger: Either full band or strip type pipe markers, at least 3 times letter height and of length required for label.
- E. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, Snap-On type preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed. Include color coding according to ASME A13.1 unless otherwise noted.
- F. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- G. All chilled water, hot water, condenser water, domestic cold and hot water, and coil condensate drain piping shall be provided with identification symbols and color code banding as follows:

Service	Symbol	Color
Chilled Water Supply	CHWS (System No.)	Safety Blue
Chilled Water Return	CHWR (System No.)	Light Blue (Windfall)
Condenser Water Supply	Cond. Sup.	Safety Green
Condenser Water Return	Cond. Ret.	Light Green

Contractor shall refer to University of Pittsburgh Mechanical Design Standards, Division J, Section 230553 – Identification for Mechanical Systems for identification symbols and color code banding to confirm all colors align with standards.

- H. Refrigerant piping shall be provided with the identification symbols and color codes as follows:

Service	Symbol	Color
Refrigerant Liquid	RL-(Refrigerant Type)	Purple
Refrigerant Suction	RS-(Refrigerant Type)	Purple
Refrigerant Hot Gas	RHG-(Refrigerant Type)	Purple

2.05 **STENCILS:**

- A. Manufacturers:
 1. Brady Corporation: www.bradycorp.com.
 2. Kolbi Pipe Marker Co.: www.kolbipipemarkers.com.

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT: continued

3. Seton Identification Products: www.seton.com.
 4. Approved Equal.
 - B. Stencils: With clean cut symbols and letters of following size:
 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8-inch-long color field, 1/2-inch-high letters.
 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8-inch-long color field, 3/4-inch-high letters.
 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12-inch-long color field, 1-1/4-inch-high letters.
 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24-inch-long color field, 2-1/2-inch-high letters.
 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32-inch-long color field, 3-1/2 inch high letters.
 6. Ductwork and Equipment: 2-1/2-inch-high letters.
 7. Stencil Paint: Semi-gloss enamel confirm colors to university standard.
- 2.06 VALVE TAGS:
- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers Include 5/32-inch hole for fastener .
 1. Tag Material: Stainless steel, 0.0375 inch.
 2. Shape: Round
 3. Size: 1 1/2 inch diameter unless otherwise indicated.
 4. Fasteners: Stainless steel, beaded chain; or 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. Frames: Extruded aluminum. Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include screws.
 3. Glazing: ASTM C 1036 Type I, Class 1, glazing quality B, 2.5-mm, single thickness glass.

PART 3 - EXECUTION

- 3.01 PREPARATION:
- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- 3.02 EQUIPMENT LABEL INSTALLATION:
- A. Install or permanently fasten labels on each major item of mechanical equipment that does not have a name plate
 - B. Locate equipment labels where accessible and visible.

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT: continued

3.03 PIPE LABEL INSTALLATION:

- A. Install pipe markers on each system.
- B. Locate pipe markers and color bands where piping is exposed, machine rooms, accessible maintenance spaces such as shafts, tunnels and plenums, and exterior non-concealed locations according to the following:
 - 1. Near each valve and control device.
 - 2. Near each branch connection.
 - 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 ft along each run. Reduce intervals to 20ft. in areas of congested piping and equipment. And at least one per room.
 - 7. Provide identification labels at ceiling tiles to locate valves above removable ceilings.
 - 8. Provide identification labels at access panels to locate concealed valves.

3.04 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 HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: 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. The valve tag schedules shall be framed with glass face and metal frame and mounted in accessible location in each major equipment room. Multiple framed schedules shall be provided on projects with multiple mechanical equipment rooms.
 - 2. A copy of the Valve-tag schedule shall be included in operation and maintenance data.
 - 3. Number shall take existing valve schedules into consideration to prevent multiple instances of same numbers.

3.05 WARNING-TAG INSTALLATION:

- A. Install tags with corrosion resistant chain.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes:
 - 1. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - 2. Other Systems/Equipment:
 - a. Motors.
 - b. Pumps.
 - c. Chillers.
 - d. Cooling towers.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (latest edition):
 - 1. Air Movement and Control Association International Inc. (AMCA):
 - a. 201 - Fans and Systems.
 - 2. American National Standards Institute (ANSI):
 - a. S1.4 - Specification for Sound Level Meters.
 - b. S1.11 - Specification for Octave Band and Fraction Octave Band Analog and Digital Filters.
 - c. S1.13 - Methods for the Measurement of Sound Pressure Levels.
 - d. S1.40 - Specification for Acoustical Calibrators.
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
 - b. 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 4. Associated Air Balance Council (AABC):
 - a. National Standards for Total System Balance.
 - 5. National Environmental Balancing Bureau (NEBB):
 - a. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
 - 6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. HVAC Systems - Duct Design.
 - b. HVAC Systems - Testing, Adjusting, and Balancing.

1.04 DEFINITIONS:

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, Adjusting, and Balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- F. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- G. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- H. 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.
- I. 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 that is normally dissipated.
- J. NC: Noise criteria.
- K. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- L. RC: Room criteria.
- M. Report Forms: Test data sheets for recording test data in logical order.
- N. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- O. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- P. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- Q. 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.
- R. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- S. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- T. 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.
- U. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- V. Test: A procedure to determine quantitative performance of systems or equipment.
- W. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.05 SUBMITTALS:

- A. Submit as specified in Division 23 - Common Work Results for HVAC.
- B. Qualification Data: Within 30days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- C. Contract Documents Examination Report: Within 45days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- D. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- E. Certified TAB reports.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- F. Sample report forms.
- G. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.06 QUALITY ASSURANCE:

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Engineer, Owner, Construction Manager, Commissioning Representative, on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide minimum fourteen days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer & Commissioning.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- 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.

1.07 PROJECT CONDITIONS:

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

1.08 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 fourteen 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.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine Equipment performance data including fan and pump curves.
 - 1. 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.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC Equipment when installed under conditions different from the conditions used to rate Equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC Equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC Equipment.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- O. 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.
- P. 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 in according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked system are operating.

3.02 PREPARATION:

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
- C. Hydronics
 - 1. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - 2. Piping is complete with terminals installed.
 - 3. Water treatment is complete.
 - 4. Systems are flushed, filled, and air purged.
 - 5. Strainers are pulled and cleaned.
 - 6. Control valves are functioning per the sequence of operation.
 - 7. Shutoff and balance valves have been verified to be 100 percent open.
 - 8. Pumps are started and proper rotation is verified.
 - 9. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - 10. Variable-frequency controllers' startup is complete and safeties are verified.
 - 11. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING:

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 - Duct Accessories.
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 00 - Mechanical Insulation.
 - C. Mark Equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
 - D. Take and report testing and balancing measurements in inch-pound (IP) units.
- 3.04 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS:
- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed tolerances outlined in this document.
 - B. Prepare schematic diagrams of systems' "as-built" piping layouts.
 - C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.
- 3.05 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS:
- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.
- 3.06 PROCEDURES FOR MOTORS:
- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase. For fan systems with multiple motors controlled by one VFD, measurement shall be the combined values of all motors.
 6. Nameplate and measured amperage, each phase. For fan systems with multiple motors controlled by one VFD, measurement shall be the combined value of all motors.
 7. Starter thermal-protection-element rating.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.
 - C. Include record of fan/pump and motor submittal performance data with final test reports.
- 3.07 PROCEDURES FOR CHILLERS:
- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 6. Capacity: Calculate in tons of cooling.
 - 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.
- 3.08 PROCEDURES FOR COOLING TOWERS:
- A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
 - 1. Measure condenser-water flow to each cell of the cooling tower.
 - 2. Measure entering- and leaving-water temperatures.
 - 3. Measure wet- and dry-bulb temperatures of entering air.
 - 4. Measure wet- and dry-bulb temperatures of leaving air.
 - 5. Measure condenser-water flow rate recirculating through the cooling tower.
 - 6. Measure cooling-tower spray pump discharge pressure.
 - 7. Adjust water level and feed rate of makeup water system.
 - 8. Measure flow through bypass.
- 3.09 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS:
- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 1. New filters are installed.
 2. Coils are clean and fins combed.
 3. Drain pans are clean.
 4. Fans are clean.
 5. Bearings and other parts are properly lubricated.
 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5%, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5% or less, equipment adjustments are not required.
 4. Balance each air outlet.
- D. Procedures for Temperature Measurements:
 1. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
 2. 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.
 3. Measure outside-air, wet- and dry-bulb temperatures.
- E. Procedures for Space Pressurization Measurements and Adjustments:
 1. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
 2. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
 3. Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - a. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- b. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - c. Test room pressurization first, then zones, and finish with building pressurization.
 - 4. To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
 - 5. For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - a. Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - b. Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.
 - c. For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
 - 6. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
 - 7. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.
- F. Temperature-Control Verification:
 - 1. Verify that controllers are calibrated and commissioned.
 - 2. Check transmitter and controller locations and note conditions that would adversely affect control functions.
 - 3. Record controller settings and note variances between set points and actual measurements.
 - 4. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
 - 5. Check free travel and proper operation of control devices such as damper and valve operators.
 - 6. 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.
 - 7. Check the interaction of electrically operated switch transducers.
 - 8. Check the interaction of interlock and lockout systems.
 - 9. Check main control supply-air pressure and observe compressor and dryer operations.
 - 10. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
 - 11. Note operation of electric actuators using spring return for proper fail-safe operations.

3.10 TOLERANCES:

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Cooling-Water Flow Rate: Plus five percent, minus zero percent.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

3.11 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: Prepare weekly progress 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.

3.12 FINAL REPORT:

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. 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; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- 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.
- D. 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 outdoor, 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. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. 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 number and serial number.
 - f. Water flow rate in gpm (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - 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 (kPa).
 - b. Pump shutoff pressure in feet of head or psig (kPa).
 - c. Actual impeller size in inches (mm).
 - d. Full-open flow rate in gpm (L/s).
 - e. Full-open pressure in feet of head or psig (kPa).
 - f. Final discharge pressure in feet of head or psig (kPa).
 - g. Final suction pressure in feet of head or psig (kPa).
 - h. Final total pressure in feet of head or psig (kPa).
 - i. Final water flow rate in gpm (L/s).

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

- j. Voltage at each connection.
- k. Amperage for each phase.
- F. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.13 INSPECTIONS:

- A. Initial Inspection:
 - 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 - 2. Check the following for each system:
 - a. Verify that balancing devices are marked with final balance position.
 - b. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 - 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer Commissioning Authority.
 - 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer, Owner, Construction Manager, Commissioning Authority.
 - 3. Engineer, Owner, Construction Manager, Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10% of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - 5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB work will be considered defective if it does not pass final inspections. If TAB work fails, proceed as follows:
 - 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 - 2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING: continued

3.14 ADDITIONAL TESTS:

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions identified in seasonal verification from commissioning.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, TAB contractor shall perform additional TAB during near-peak summer and winter conditions. This work shall be executed under a separate contract.

END OF SECTION 23 05 93

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. Chillers.
- B. Chilled-water pumps.

1.03 RELATED REQUIREMENTS:

- A. Section 23 07 19 - HVAC Piping Insulation.

1.04 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. ASTM International (ASTM):
 - a. ASTM A167 - Specification for Stainless- and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - e. ASTM C195 - Specification for Mineral Fiber Thermal Insulating Cement.
 - f. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
 - g. ASTM C449 - Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - h. ASTM C450 - Practice for Fabrication of Thermal Insulation Fitting Covers for NPS Piping, and Vessel Lagging.
 - i. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - j. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - k. ASTM C547 - Specification for Mineral Fiber Pipe Insulation.
 - l. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
 - m. ASTM C553 - Specification for Mineral-Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
 - n. ASTM C585 - Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 - o. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - p. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
 - q. ASTM C656 - Specification for Structural Insulating Board, Calcium Silicate.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

- r. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- s. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
- t. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- u. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- v. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
- w. ASTM C1393 - Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
- x. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
- y. ASTM D1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- z. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- aa. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
- bb. ASTM F1249 - Test Method for Water Vapor Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
- 2. Code of Federal Regulations (CFR):
 - a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.

1.05 SUBMITTALS:

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail removable insulation at equipment connections.
 - 4. Detail application of field-applied jackets.
 - 5. Detail application at linkages of control devices.
 - 6. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality control reports.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

1.06 QUALITY ASSURANCE:

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory-label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.07 DELIVERY, STORAGE, AND HANDLING:

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.08 COORDINATION:

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.09 SCHEDULING:

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

- A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

- a. Aeroflex USA, Inc.; Aerocel.
- b. Armacell, LLC; AP Armaflex.
- c. K-Flex USA; Insul-Sheet and K-FLEX LS.

2.02 ADHESIVES:

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric-Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell, LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.

2.03 MASTICS:

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43 mil (1.09 mm) dry film thick +180°F (-29 to +82°C).
 - 3. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 - 4. Color: White.
- C. Vapor-Retarder Mastic, Water Based: Suitable for indoor and outdoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 2. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).

2.04 LAGGING ADHESIVES:

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
3. Service Temperature Range: 0 to +180°F (-18 to +82°C).
4. Color: White.

2.05 SEALANTS:

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 1. Joint Sealants for Cellular-Glass, and Polyisocyanurate Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: -100 to +300°F (-73 to +149°C).
 5. Color: White or gray.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Engineer approved equal.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: -40 to +250°F (-40 to +121°C).
 5. Color: White.

2.06 FIELD-APPLIED FABRIC-REINFORCING MESH:

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./yd.² (203 g/m²) with a thread count of 5 strands by 5 strands/in.² (2 strands by 2 strands/mm²) for covering equipment.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
- B. Woven Polyester Fabric: Approximately 1 oz./yd.² (34 g/m²) with a thread count of 10 strands by 10 strands/inch² (4 strands by 4 strands/mm²), in a Leno weave, for equipment.
 1. Products: Subject to compliance with requirements, provide products by one of the following:

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

- a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
- b. Vimasco Corporation; Elastafab 894.

2.07 TAPES:

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2. Width: 3 inches (75 mm).
 - 3. Thickness: 11.5 mils (0.29 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2%.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - 2. Width: 3 inches (75 mm).
 - 3. Thickness: 6.5 mils (0.16 mm).
 - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - 5. Elongation: 2%.
 - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.08 SECUREMENTS:

- A. Bands:
 - 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 - 2. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 1/2 inch 13 mmwide with sealor closed seal.
 - 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS:

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch (75-mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.04 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION:

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
 - d. Do not overcompress insulation during installation.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

- e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
- 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
- 7. Stagger joints between insulation layers at least 3 inches (75 mm).
- 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
- 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - 1. Apply 100% coverage of adhesive to surface with manufacturer's recommended adhesive.
 - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
 - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch (10-mm) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - 2. Fabricate boxes from aluminum, at least 0.050 inch (1.3 mm) thick.
 - 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

SECTION 23 07 16 – HVAC EQUIPMENT INSULATION: continued

3.06 EQUIPMENT INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. Acceptable insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials is Contractor's option.

3.07 FINISHES:

- A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09, Painting Sections.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - 2. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field-paint aluminum or stainless-steel jackets.

3.08 FIELD QUALITY CONTROL:

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.
- D. Install new insulation and jackets to replace insulation removed for inspection. Repeat inspection procedures after new materials are installed.

3.09 EQUIPMENT INSULATION SCHEDULE:

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Chilled-water pump insulation shall be the following:
 - 1. Flexible Elastomeric: 1-1/2 inch (38 mm) thick.
- C. Chiller Evaporator insulation shall be the following:
 - 1. Flexible Elastomeric: As Specified by the chiller manufacturer.

END OF SECTION 23 07 16

SECTION 23 07 19 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes requirements for insulating HVAC piping systems:
 - 1. Indoor chilled water piping.

1.03 RELATED REQUIREMENTS:

- 1. Section 23 07 16 - HVAC Equipment Insulation.
- 2. Section 23 21 23 - Hydronic Piping

1.04 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. ASTM International (ASTM):
 - a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate
 - e. ASTM C195 - Specification for Mineral Fiber Thermal Insulating Cement.
 - f. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
 - g. ASTM C449 - Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - h. ASTM C450 - Practice for Fabrication of Thermal Insulation Fitting Covers for NPS Piping, and Vessel Lagging.
 - i. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - j. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - k. ASTM C547 - Specification for Mineral Fiber Pipe Insulation.
 - l. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
 - m. ASTM C553 - Specification for Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
 - n. ASTM C585 - Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
 - o. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - p. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
 - q. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

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- r. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
 - s. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - t. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - u. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
 - v. ASTM C1393 - Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.
 - w. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
 - x. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 - y. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
 - z. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
 - 2. Code of Federal Regulations (CFR):
 - a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings", 2007.
- 1.05 SUBMITTALS:
- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
 - B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
 - C. Qualification Data: For qualified Installer.
 - D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
 - E. Field quality-control reports.
- 1.06 QUALITY ASSURANCE:
- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

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- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- 1.07 DELIVERY, STORAGE, AND HANDLING:
 - A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
 - B. All the insulation materials and accessories covered by this Specification shall be delivered to the Site and stored in a safe, dry place.
 - C. Contractor shall use whatever means necessary to protect the insulation material and accessories before, during, and after installation. No insulation material shall be installed that has been become damaged in any way. Contractor shall also use all means necessary to protect work and materials installed by others.
 - D. If any insulation material has become wet because of transit or Site exposure to moisture or water, Contractor shall not install such material, and shall remove it from the Site.
- 1.08 COORDINATION:
 - A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
 - C. Coordinate installation and testing of heat tracing.
- 1.09 SCHEDULING:
 - A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

- 2.01 INSULATION MATERIALS:
 - A. Comply with requirements in "Piping Insulation Schedule, General" and " Piping Insulation Schedule" articles for where insulating materials shall be applied.
 - B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
 - C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
 - D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

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- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.adhesiv
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Pittsburgh Corning Corporation; Foamglas.
 2. Block Insulation: ASTM C552, Type I.
 3. Special-Shaped Insulation: ASTM C552, Type III.
 4. Board Insulation: ASTM C552, Type IV.
 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C552, Type II, Class 2.
 6. Factory fabricate shapes according to ASTM C450 and ASTM C585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.; Aerocel.
 - b. Armacell, LLC; AP Armaflex.
 - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2.02 ADHESIVES:

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of -100 to +200°F (-73 to +93°C).
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell, LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.

2.03 MASTICS:

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 1. Products: Subject to compliance with requirements, provide products by one of the following:

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- a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
 3. Service Temperature Range: -20 to +180°F (-29 to -82°C).
 4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
 3. Service Temperature Range: -20 to +180°F (-29 to +82°C).
 4. Solids Content: 60% by volume and 66% by weight.
 5. Color: White.

2.04 SEALANTS:

- A. Joint Sealants:
 1. Joint Sealants for Cellular-Glass and Polyisocyanurate Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Permanently flexible, elastomeric sealant.
 4. Service Temperature Range: -100 to +300°F (-73 to +149°C).
 5. Color: White or gray.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FIELD-APPLIED JACKETS:

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: Color-code jackets based on system. Colors to match existing .
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- 2.06 TAPES:
- A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches (50 mm).
 3. Thickness: 6 mils (0.15 mm).
 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 5. Elongation: 500%.
 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- 2.07 SECUREMENTS:
- A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
 2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
 3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
- 2.08 REMOVABLE INSULATION COVERS:
- A. Removable-reusable insulation covers for maintained piping components
1. All piping systems: Provide on any inline piping component requiring regular maintenance including but not limited to Control Valves, Flow Meters, Relief Valves.
- B. Products: Subject to compliance with requirements, provide products by one of the following:
1. HotCaps
 2. Engineer Approved Equal

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PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS:

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

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2. Cover circumferential joints with 3-inch (75-mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4-inches (100-mm) o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches (50-mm) o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 PENETRATION:

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).

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4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated):
Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in DIVISION 07 for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.05 GENERAL PIPE INSULATION INSTALLATION:

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for

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- above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated and any inline piping component requiring regular maintenance including but not limited to Control Valves, Flow Meters, Relief Valves. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF CELLULAR-GLASS INSULATION:

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6-inches (150-mm) o.c.
 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.

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2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
 - C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
 - D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed sections of cellular-glass insulation to valve body.
 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
- 3.07 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION:
- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 3.08 FIELD-APPLIED JACKET INSTALLATION:
- A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive.

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1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- 3.09 FINISHES:
- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 00.
 - B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
 - C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
 - D. Do not field paint aluminum or stainless-steel jackets.
- 3.10 PIPING INSULATION SCHEDULE, GENERAL:
- A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
 - B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
 - C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Drainage piping located in crawl spaces.
 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- 3.11 PIPING INSULATION SCHEDULE:
- A. Indoor and Outdoor Equipment Drains and Water below 60°F (16°C):
 1. All Pipe Sizes up to 24 inch: Flexible Elastomeric: 1.0 inch (25 mm) thick.
 - B. Indoor and Outdoor Chilled Water:
 1. All pipe sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches (50 mm) thick.
 - b. Flexible Elastomeric: 1-1/2 inch (38 mm) thick.
 - C. Refrigerant Suction and Hot-Gas Piping:
 1. NPS 1-1/2 and smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1.0 inch (25 mm) thick.
- 3.12 INDOOR OR OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. If more than one material is listed, selection from materials listed is Contractor's option.
 - C. Piping, Concealed or Exposed:
 1. PVC, Color-Coded by System to Match Existing: 30 mils (0.8 mm) thick.

END OF SECTION 23 07 19

SECTION 23 08 00 – COMMISSIONING OF HVAC

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
 - B. Related Sections:
 - 1. DIVISION 01 for general commissioning process requirements.
- 1.03 DEFINITIONS:
- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
 - B. CxA: Commissioning Authority.
 - C. HVAC&R: Heating, Ventilating, Air-Conditioning, and Refrigeration.
 - D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- 1.04 INFORMATIONAL SUBMITTALS:
- A. Certificates of readiness.
 - B. Certificates of completion of installation, prestart, and startup activities.
- 1.05 CONTRACTOR'S RESPONSIBILITIES:
- A. Perform commissioning tests at the direction of the CxA.
 - B. Attend construction phase controls coordination meeting.
 - C. Attend testing, adjusting, and balancing review and coordination meeting.
 - D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
 - E. Provide information requested by the CxA for final commissioning documentation.
 - F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.
- 1.06 CXA'S RESPONSIBILITIES:
- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
 - B. Direct commissioning testing.
 - C. Verify testing, adjusting, and balancing of Work are complete.
 - D. Provide test data, inspection reports, and certificates in Systems Manual.
- 1.07 COMMISSIONING DOCUMENTATION:
- A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.01 TESTING PREPARATION:

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.02 TESTING AND BALANCING VERIFICATION:

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10%. Failure of more than 10% of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.03 GENERAL TESTING REQUIREMENTS:

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.04 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES:

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 40 91 00 – Common Work for Instrumentation. Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for

each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.
 3. Minimum flushing water velocity.
 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- C. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION 23 08 00

SECTION 23 21 13 – HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Condenser-water piping.
 - 3. Refrigerant relief piping.
 - 4. Transition Couplings
 - 5. Air control devices.
 - 6. Hydronic Piping Specialties.

1.03 RELATED REQUIREMENTS:

- 1. Section 23 21 23 - Hydronic Pumps for pumps, motors, and accessories for hydronic piping.

1.04 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. American Welding Society (AWS):
 - a. A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 - b. D.1/D1.1M - Structural Welding Code - Steel.
 - c. Brazing Handbook.
 - 2. ASME International (ASME):
 - a. B1.20.1 - Pipe Threads, General Purpose, Inch.
 - b. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.
 - c. B16.3 - Malleable Iron Threaded Fittings.
 - d. B16.4 - Cast Iron Threaded Fittings.
 - e. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 to NPS 24.
 - f. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
 - g. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - h. B16.39 - Malleable Iron Threaded Pipe Unions.
 - i. B18.2.1 - Square and Hex Bolts and Screws - Inch Series.
 - j. B31 - Code for Pressure Piping.
 - k. B31.9 - Building Services Piping.
 - l. Boiler and Pressure Vessel Code: Section IV, "Heating Boilers;" Section VIII, "Pressure Vessels," Division 1; Section IX, "Welding and Brazing Qualifications."
 - 3. ASTM International (ASTM):
 - a. A47/A47M - Ferritic Malleable Iron Castings.
 - b. A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
 - d. A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

- e. A234/A234M - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Services.
 - f. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - g. A536 - Ductile Iron Castings.
 - h. A733 - Welded and Seamless Carbon Steel and Austenitic Stainless-Steel Pipe Nipples.
 - i. B32 - Solder Metal.
 - j. B75 - Seamless Copper Tube.
 - k. B75M - Seamless Copper Tube [Metric].
 - l. B88 - Seamless Copper Water Tube.
 - m. B88M - Seamless Copper Water Tube [Metric].
 - n. B306 - Copper Drainage Tube (DWV).
 - o. B584 - Copper Alloy Sand Castings for General Applications.
 - p. B813 - Liquid and Paste Fluxes for Solder Applications of Copper and copper Alloy Tube.
 - q. B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
 - 4. Copper Development Association, Inc. (CDA):
 - a. Copper Tube Handbook.
 - 5. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
 - a. SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
 - b. SP-107 - Transition Union Fittings for Joining Metal and Plastic Products.
 - c. SP-122 - Plastic Industrial Ball Valves.
- 1.05 DEFINITIONS:
- A. PTFE: Polytetrafluoroethylene.
- 1.06 PERFORMANCE REQUIREMENTS:
- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Chilled-Water Piping: 125 psig at 150°F .
 - 2. Condenser-Water Piping: 125 psig at 150°F .
 - 3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.
- 1.07 SUBMITTALS:
- A. Product Data: For each type of the following:
 - 1. Pressure-seal fittings.
 - 2. Air control devices.
 - 3. Hydronic specialties.
 - B. Shop Drawings: Detail, at 1/4 (1:50) scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - C. Qualification Data: For Installer.
 - D. Welding certificates.
 - E. Field quality control test reports.

- F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
- G. Maintenance Material Submittals:
- H. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

1.08 QUALITY ASSURANCE:

- A. Installer Qualifications:
 - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 STEEL PIPE AND FITTINGS:

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Wrought-Steel Fittings; wall thickness as indicated in Part 3 "Piping Applications" Article.
 - 1. 2-Inch Diameter and Smaller: ASTM A 105/A 105M forged steel, 3000 pound in accordance with ASME B16.11.
 - 2. 2-1/2 Inch Diameter and Larger: ASTM A234/A234M, WPB(W) wrought steel, butt weld in accordance with ASME B16.9
- C. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASTM A 105/A 105M, Class 150 in accordance with ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections:
 - (1) 2-Inch Diameter and Smaller: Socket weld or threaded.
 - (2) 2-1/2 Inch Diameter and Larger: Flanged, weld neck.
 - c. Facings: Raised face and flat face. Flat face forged steel flanges shall be used to connect to all classes of cast iron flange.

2.02 JOINING MATERIALS:

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8 inch (3.2 mm) maximum thickness, unless thickness or specific material is indicated.

- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Welding Filler Metals: Comply with ASME Section IX for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- D. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.03 TRANSITION COUPLINGS:

- A. Bolted, sleeve-type, transition couplings for joining plain-end ductile iron pipe to plain-end carbon steel pipe.
- B. Pressure Rating equal to or greater than the pressure rating of the joining pipe systems.
- C. Sleeve and Followers: Ductile iron complying with ASTM A536.
- D. Gaskets: Nitrile (NBR).
- E. Bolts and Nuts: High-strength, Type 304 or 316 Stainless Steel per AWWA Standard C111.
- F. Coating: All ferrous components shall be coated with a fusion-bonded epoxy for corrosion protection. Coating shall meet the requirements of AWWA C213.
- G. Standard: Comply with AWWA C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
- H. The contractor is responsible for verifying the outside diameter (OD) of pipe materials and selecting a coupling rated for the specific transition by the manufacturer.

2.04 VALVES:

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23, Section 23 05 23. Section "General-Duty Valves for HVAC Piping."

2.05 AIR CONTROL DEVICES:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amtrol, Inc.
 - 2. Armstrong Pumps, Inc.
 - 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
 - 4. Taco.
- B. Manual Air Vents:
 - 1. Body: Bronze.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Screwdriver or thumbscrew.
 - 4. Inlet Connection: NPS 1/2 (DN 15).
 - 5. Discharge Connection: NPS 1/8 (DN 6).
 - 6. CWP Rating: 150 psig (1035 kPa).
 - 7. Maximum Operating Temperature: 225°F (107°C).
- C. Automatic Air Vents:
 - 1. Body: Bronze or cast iron.
 - 2. Internal Parts: Nonferrous.
 - 3. Operator: Noncorrosive metal float.
 - 4. Inlet Connection: NPS 1/2 (DN 15).
 - 5. Discharge Connection: NPS 1/4 (DN 8).
 - 6. CWP Rating: 150 psig (1035 kPa).
 - 7. Maximum Operating Temperature: 240°F (116°C).

2.06 HYDRONIC PIPING SPECIALTIES:

- A. Y-Pattern Strainers:
 - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50% free area.
 - 4. CWP Rating: 125 psig (860 kPa).
- B. Stainless-Steel Bellow, Flexible Connectors:
 - 1. Body: Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket.
 - 2. End Connections: Flanged to match equipment connected.
 - 3. Performance: Capable of 3/4 inch (20 mm) misalignment.
 - 4. CWP Rating: 150 psig (1035 kPa).
 - 5. Maximum Operating Temperature: 250°F (121°C).

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS:

- A. Chilled-water and Condenser Water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
 - 1. Schedule 40 steel pipe; Class 150, malleable-iron fittings; and socket welded or threaded joints.
- B. Chilled-water and Condenser Water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded joints with flanges where indicated on drawings or to connect to flanged components.
- C. Refrigerant relief piping, aboveground, NPS 2 (DN 50) and smaller, shall be the following:
 - 1. Standard schedule pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and socket welded and flanged joints.
- D. Refrigerant relief piping, aboveground, NPS 2-1/2 (DN65) and larger, shall be any of the following:
 - 1. Standard schedule pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3.02 VALVE APPLICATIONS:

- A. Install valves in accordance with project construction package. See mechanical detail drawings and equipment schedule for further information.

3.03 PIPING INSTALLATIONS:

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.

- C. Install piping to permit valve servicing.
- D. Install piping at indicated slopes.
- E. Install piping free of sags and bends.
- F. Install fittings for changes in direction and branch connections.
- G. Install piping to allow application of insulation.
- H. Select system components with pressure rating equal to or greater than system operating pressure.
- I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- J. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- K. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- L. Install branch connections to mains using tee fittings in main pipe unless otherwise indicated on drawings, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- M. Install valves according to Section 23 05 23 - General-Duty Valves for HVAC Piping.
- N. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- O. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- P. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
- Q. Identify piping as specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

3.04 HANGERS AND SUPPORTS:

- A. Hanger, support, and anchor devices are specified in Division 23, Section "Hangers and Supports for HVAC Piping and Equipment ". Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 ft. (6 m) long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 ft. (6 m) or longer.
 - 3. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4 (DN 20): Maximum span, 7 ft. (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
 - 2. NPS 1 (DN 25): Maximum span, 7 ft. (2.1 m); minimum rod size, 1/4 inch (6.4 mm).
 - 3. NPS 1-1/2 (DN 40): Maximum span, 9 ft. (2.7 m); minimum rod size, 3/8 inch (10 mm).
 - 4. NPS 2 (DN 50): Maximum span, 10 ft. (3 m); minimum rod size, 3/8 inch (10 mm).
 - 5. NPS 2-1/2 (DN 65): Maximum span, 11 ft. (3.4 m); minimum rod size, 3/8 inch (10 mm).
 - 6. NPS 3 (DN 80): Maximum span, 12 ft. (3.7 m); minimum rod size, 3/8 inch (10 mm).
 - 7. NPS 4 (DN 100): Maximum span, 14 ft. (4.3 m); minimum rod size, 1/2 inch (13 mm).
 - 8. NPS 6 (DN 150): Maximum span, 17 ft. (5.2 m); minimum rod size, 1/2 inch (13 mm).
 - 9. NPS 8 (DN 200): Maximum span, 19 ft. (5.8 m); minimum rod size, 5/8 inch (16 mm).

10. NPS 10 (DN 250): Maximum span, 20 ft. (6.1 m); minimum rod size, 3/4 inch (19 mm).
 11. NPS 12 (DN 300): Maximum span, 23 ft. (7 m); minimum rod size, 7/8 inch (22 mm).
 12. NPS 14 (DN 350): Maximum span, 25 ft. (7.6 m); minimum rod size, 1 inch (25 mm).
 13. NPS 16 (DN 400): Maximum span, 27 ft. (8.2 m); minimum rod size, 1 inch (25 mm).
 14. NPS 18 (DN 450): Maximum span, 28 ft. (8.5 m); minimum rod size, 1-1/4 inches (32 mm).
 15. NPS 20 (DN 500): Maximum span, 30 ft. (9.1 m); minimum rod size, 1-1/4 inches (32 mm).
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4 (DN 20): Maximum span, 5 ft. (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
 2. NPS 1 (DN 25): Maximum span, 6 ft. (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
 3. NPS 1-1/2 (DN 40): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
 4. NPS 2 (DN 50): Maximum span, 8 ft. (2.4 m); minimum rod size, 3/8 inch (10 mm).
 5. NPS 2-1/2 (DN 65): Maximum span, 9 ft. (2.7 m); minimum rod size, 3/8 inch (10 mm).
 6. NPS 3 (DN 80): Maximum span, 10 ft. (3 m); minimum rod size, 3/8 inch (10 mm).
- E. Support vertical runs at roof, at each floor, and at 10 ft. (3 m) intervals between floors.

3.05 PIPE JOINT CONSTRUCTION:

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 HYDRONIC SPECIALTIES INSTALLATION:

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.07 FIELD QUALITY CONTROL:

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 1. Use ambient temperature water as a testing medium, unless there is risk of damage due to freezing.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90% of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 min., examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Post Construction Piping System Flush:
 1. Following construction, all piping shall undergo a flushing sequence to remove all foreign material.
 - a. Water Treatment Vendor to confirm construction flush adequate.
- D. Perform the following before operating the system:
 1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

SECTION 23 21 23 – HYDRONIC PUMPS

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes:
 - 1. Separately coupled, vertically mounted, turbine centrifugal pumps.
- 1.03 REFERENCE STANDARDS:
- A. Applicable Standards (Latest Edition):
 - 1. American National Standards Institute (ANSI):
 - a. ANSI B15.1 - Safety Standard for Mechanical Power Transmission Apparatus.
 - 2. ASME International (ASME):
 - a. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 3. ASTM International (ASTM):
 - a. ASTM A36/A36M - Specification for Carbon Structural Steel.
 - b. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
 - 4. Hydraulic Institute (HI):
 - a. HI 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions (ANSI).
 - b. HI 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application (ANSI).
 - c. HI 1.4 - Centrifugal Pumps for Installation, Operation and Maintenance (ANSI).
 - d. HI 2.1-2.2 - Vertical Pumps for Nomenclature and Definitions (ANSI).
 - e. HI 2.3 - Vertical Pumps for Design and Application (ANSI).
 - f. HI 2.4 - Vertical Pumps for Installation, Operation and Maintenance (ANSI).
 - 5. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - b. IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.
 - 6. NFPA:
 - a. NFPA 70 - National Electrical Code.
 - 7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA MG 1 - Motors and Generators.
 - b. NEMA MG 2 - Safety Standard for Construction, and Guide for Selection, Installation, and Use of Electric Motors and Generators.
 - 8. Occupational Safety & Health Administration (OSHA):
 - a. OSHA 1910.219 - Mechanical Power-Transmission Apparatus.
 - 9. Underwriters Laboratories, Inc. (UL):
 - a. UL 1004 - Standard for Electric Motors.
- 1.04 DEFINITIONS:
- A. Buna-N: Nitrile rubber.

SECTION 23 21 23 – HYDRONIC PUMPS

B. EPT: Ethylene propylene terpolymer.

1.05 SUBMITTALS:

A. Product Data:

1. For each type of pump: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
2. For each motor:
 - a. Outline drawing for each group of identical motors.
 - b. Nameplate data for each group of identical motors rated 460V and below, including the following data:
 - (1) Manufacturer's name and serial number.
 - (2) Manufacturer's type and frame designation.
 - (3) Horsepower output.
 - (4) Time rating.
 - (5) Maximum ambient temperature for which motor is designed.
 - (6) Insulation system designation.
 - (7) Temperature rise and method of measurement.
 - (8) RPM at rated load.
 - (9) Frequency.
 - (10) Number of phases.
 - (11) Rated-load amperes.
 - (12) Voltage.
 - (13) Code letter for locked rotor kVA.
 - (14) Design letter for polyphase integral-horsepower motors.
 - (15) Nominal efficiency.
 - (16) Service factor.
 - (17) For motors equipped with thermal protectors, the words "thermally protected."

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include pump and motor weights.
3. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
4. Include diagrams for power, signal, and control wiring.
5. Provide pump curve for variable speed pump showing efficiencies over operating range.

C. Closeout Submittals:

1. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

SECTION 23 21 23 – HYDRONIC PUMPS

PART 2 - PRODUCTS

2.01 SEPARATELY COUPLED, VERTICALLY MOUNTED, TURBINE CENTRIFUGAL PUMPS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aurora Pump; Division of Pentair Pump Group.
 - 2. Crane Pumps & Systems.
 - 3. Flowserve Corporation.
 - 4. Peerless Pump Company.
 - 5. Pentair Water; Fairbanks Morse.
 - 6. Bell & Gossett
- B. Description: Factory-assembled and -tested, single-stage centrifugal, impeller-between-bearings, end-suction pump as defined in HI 2.1-2.2 and HI 2.3; designed for installation with pump and motor shafts mounted vertically and projecting into a sump.
- C. Pump Construction:
 - 1. Pump Bowl: Cast iron, with basket strainer, replaceable bronze wear ring, and suction bell. Water passages of intermediate bowls shall be coated with porcelain enamel.
 - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel sized according to manufacturer's requirements.
 - 4. Pump Bearings: Water-lubricated bronze and rubber sleeve bearings in cast-iron housing.
 - 5. Pump Column: ASTM A53/A53M, Grade B steel pipe.
 - 6. Seal:
 - a. Systems operating below 200°F: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 - 7. Pump Bearings:
 - a. Systems operating below 160°F: Permanently lubricated ball bearings.
- D. Shaft Coupling: Keyed with locking collets.
- E. Discharge Head: ASME B16.1, Class 125 discharge flange with threaded gage tapping. Top of discharge head shall have a registered fit to accurately locate the driver.
- F. Drive Ratchet: Non-reversing ratchet.
- G. Hollow Shaft Motor: Single speed and secured to discharge head.
 - 1. Rated 460V, 3 phase, 60 hertz.
 - 2. Service factor of 1.15.
 - 3. Shall have squirrel-cage rotors.
 - 4. Shall be indoors and suitable for continuous operation at an ambient temperature of 40 °C.
 - 5. For the motor furnished, the nameplate horsepower rating multiplied by the service factor shall equal or exceed the horsepower required to drive the connected equipment under any operating condition.
 - 6. Stator winding lead terminals of the copper alloy seamless compression type shall be supplied.

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7. Motor Bearings:
 - a. Grease-lubricated ball bearings.
 - b. Shall be insulated when required to prevent bearing or shaft damage due to stray shaft currents.
 8. Motor shall have an inverter grade insulation system consisting of, at a minimum, Class H or better insulation materials with additional phase insulating material, extra end-turn bracing and Class H spike resistant wire. The resulting insulation system shall withstand 2,000V transients without premature motor failure and have no cable limitations in motor application.
 - a. Inverter-duty rated per NEMA MG-1, SECTION IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
 9. The motor's efficiency shall meet or exceed all NEMA Premium Requirements for energy efficiency, or as otherwise required by Federal statute. Efficiency values shall be determined in the manner described by NEMA MG1.12.58.
 10. Motor shall be furnished with an Aegis shaft ground.
- H. Capacities and Characteristics: Refer to equipment schedule on Contract Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PUMP INSTALLATION:

- A. Comply with HI 1.4 for centrifugal pumps.
- B. Comply with HI 2.4 for vertically mounted, turbine centrifugal pumps.
- C. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- F. Equipment mounting:
 1. Pumps Installed on Cast-in-Place Concrete Equipment Bases:
 - a. Pumps without vibration isolation devices:
 - (1) Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in DIVISION 03.
 - (2) Coordinate sizes and locations of concrete bases with actual equipment provided.
 - (3) Construct bases to withstand, without damage to equipment, seismic force required by code.
 - (4) Construct concrete bases 6 inches (150 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of

SECTION 23 21 23 – HYDRONIC PUMPS

base-mounted pumps, unless otherwise indicated or unless required for seismic-anchor support.

(5) Minimum Compressive Strength: 5,000 psi (34.5 MPa) at 28 days.

3.03 ALIGNMENT:

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Comply with pump and coupling manufacturers' written instructions.
- C. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
- D. Pump shall be aligned cold after grout has cured. Alignment of the pump shall be verified after the system is at operating temperature.

3.04 CONNECTIONS:

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- E. Ground equipment according to DIVISION 26.
- F. Connect wiring according to DIVISION 26.

3.05 STARTUP SERVICE:

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.06 DEMONSTRATION:

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes:
 - 1. Single-wall round and flat-oval ducts and fittings.
 - 2. Sheet metal materials.
 - 3. Sealants and gaskets.
 - 4. Hangers and supports.
- 1.03 RELATED REQUIREMENTS:
- A. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.
 - B. Section 23 33 00 - Air Duct Accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
- 1.04 REFERENCE STANDARDS:
- A. Applicable Standards (Latest Edition):
 - 1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
 - a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
 - 4. American Welding Society (AWS):
 - a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
 - b. AWS D1.2/D1.2M - Structural Welding Code - Aluminum.
 - c. AWS D9.1M/D9.1 - Sheet Metal Welding Code.
 - 5. ASTM International (ASTM):
 - a. ASTM A36/A36M - Specification for Carbon Structural Steel.
 - b. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - c. ASTM A492 - Specification for Stainless Steel Rope Wire.
 - d. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
 - e. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - f. ASTM A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - g. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

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- h. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - i. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - j. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
 - k. ASTM C920 - Specification for Elastomeric Joint Sealants.
 - l. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - m. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
 - n. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 - 6. Code of Federal Regulations (CFR):
 - a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings."
 - 7. National Air Duct Cleaners Association (NADCA):
 - a. NADCA 1992 - Mechanical Cleaning of Non-Porous Air Conveyance System Components.
 - b. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.
 - 8. NFPA:
 - a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
 - b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
 - c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations (ANSI).
 - 9. The North American Insulation Manufacturers Association (NAIMA):
 - a. NAIMA AH124 - Fibrous Glass Duct Liner Standard.
 - 10. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - a. HVAC Air Duct Leakage Test Manual.
 - b. HVAC Duct Construction Standards - Metal and Flexible.
 - c. IAQ Guidelines for Occupied Buildings under Construction - Appendix G, Duct Cleanliness for New Construction Guidelines.
 - d. Seismic Restraint Manual: Guidelines for Mechanical Systems.
 - 11. Underwriters Laboratories, Inc. (UL):
 - a. UL 723 - Test for Surface Burning Characteristics of Building Materials.
- 1.05 PERFORMANCE/DESIGN CRITERIA:
- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
 - B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

SECTION 23 31 13 – METAL DUCTS

1. Refer to Section 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for design criteria.
- 1.06 SUBMITTALS:
- A. Product Data: For each type of the following products:
 1. Liners and adhesives.
 2. Sealants and gaskets.
 - B. Delegated-Design Submittal:
 1. Sheet metal thicknesses.
 2. Joint and seam construction and sealing.
 3. Reinforcement details and spacing.
 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 5. Design Calculations: Calculations for selecting hangers and supports.
 - C. Field quality-control reports.

PART 2 - PRODUCTS

- 2.01 SINGLE-WALL ROUND DUCTS AND FITTINGS:
- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class, unless otherwise indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lindab, Inc.
 - b. McGill AirFlow, LLC.
 - c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
 - B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 - D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

SECTION 23 31 13 – METAL DUCTS

2.02 SHEET METAL MATERIALS:

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- D. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- E. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.03 SEALANT AND GASKETS:

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches (102 mm).
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: -40 to +200°F (-40 to +93°C).
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65%.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. VOC: Maximum 75 g/L (less water).
 - 7. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.

SECTION 23 31 13 – METAL DUCTS

- 8. Service: Indoor or outdoor.
- 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Flanged Joint Sealant: Comply with ASTM C920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- F. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch w.g. (2500 Pa) static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.04 HANGERS AND SUPPORTS:

- A. Hanger Rods for Indoor: Zinc-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Hot-dipped galvanized, all-thread rods..
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:

- A. Coordinate duct layout and duct accessory arrangement with Drawings. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated, unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," unless otherwise indicated.

SECTION 23 31 13 – METAL DUCTS

- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 - Air Duct Accessories for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.02 INSTALLATION OF EXPOSED DUCTWORK:

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Exhaust Ducts: Seal Class A.
 - 3. Conditioned Space, Exhaust Ducts: Seal Class B.

SECTION 23 31 13 – METAL DUCTS

3.04 HANGER AND SUPPORT INSTALLATION:

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick. These fasteners shall not be used to support ductwork larger than 24 inches square.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS:

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00 - Air Duct Accessories.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING:

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in DIVISION 09 Painting Sections.

3.07 START UP:

- A. Air Balance: Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.08 DUCT SCHEDULE:

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch w.g. (500 Pa).

SECTION 23 31 13 – METAL DUCTS

- b. Minimum SMACNA Seal Class: B if negative pressure.
 - c. SMACNA Leakage Class for Round and Flat Oval: 6
- C. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
- D. Elbow Configuration:
 - 1. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - (1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 inches (305 mm) and Smaller in Diameter: Stamped or pleated.

END OF SECTION 23 31 13

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes:
 - 1. Backdraft dampers.
 - 2. Manual volume dampers.
 - 3. Control dampers.
 - 4. Flange connectors.
 - 5. Flexible connectors.
 - 6. Flexible ducts.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. Air Movement and Control Association International, Inc. (AMCA):
 - a. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating (ANSI).
 - 2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
 - a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
 - 4. ASTM International (ASTM):
 - a. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - b. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - c. ASTM B209-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - d. ASTM B209M-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
 - e. ASTM B221-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - f. ASTM B221M-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
 - g. ASTM E84-09a - Test Method for Surface Burning Characteristics of Building Materials.
 - h. ASTM E477-06a - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
 - 5. NFPA:
 - a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
 - b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

SECTION 23 33 00 – AIR DUCT ACCESSORIES

- c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
 - 6. North American Insulation Manufacturers Association (The) (NAIMA):
 - a. NAIMA AH116 - Fibrous Glass Duct Construction Standards.
 - 7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - a. HVAC Duct Construction Standards - Metal and Flexible
 - 8. Underwriters Laboratories, Inc. (UL):
 - a. UL 181 - Factory-Made Air Ducts and Air Connectors.
 - b. UL 555 - Fire Dampers.
 - c. UL 555C - Ceiling Dampers.
 - d. UL 555S - Smoke Dampers.
 - e. UL 1978 - Standard for Grease Ducts.
 - f. Fire Resistance Directory.
- 1.04 SUBMITTALS:
- A. Product Data: For each type of product.
 - B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Wiring Diagrams: For power, signal, and control wiring.
 - C. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

- 2.01 ASSEMBLY DESCRIPTION:
- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
 - B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- 2.02 MATERIALS:
- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Exposed-Surface Finish: Mill phosphatized.
 - B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
 - C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

SECTION 23 33 00 – AIR DUCT ACCESSORIES

2.03 BACKDRAFT DAMPERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. Nailor Industries Inc.
 - 4. Pottorff.
 - 5. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1,250 fpm (6.4 m/s).
- D. Maximum System Pressure: 2-inch w.g. (0.5 kPa >).
- E. Frame: Hat-shaped, 0.063 inch (1.6 mm) thick extruded aluminum with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, off-center pivoted with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Extruded vinyl, mechanically locked.
- I. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20 inch (5 mm).
- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball.
- M. Accessories:
 - 1. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage (1.0 mm) minimum.
 - b. Sleeve Length: 6 inches (152 mm) minimum.
 - 2. Screen Mounting: Rear mounted.
 - 3. Screen Material: Aluminum.
 - 4. Screen Type: Bird.
 - 5. 90-degree stops.

2.04 MANUAL VOLUME DAMPERS:

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a division of Mestek, Inc.
 - b. McGill AirFlow, LLC.
 - c. Nailor Industries, Inc.
 - d. Pottorff.
 - e. Ruskin Company.
 - 2. Standard leakage rating.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Frame: Hat-shaped, 0.094 inch (2.4 mm) thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:

SECTION 23 33 00 – AIR DUCT ACCESSORIES

- a. Multiple or single blade.
- b. Opposed-blade design.
- c. Stiffen damper blades for stability.
- d. Galvanized-steel, 0.064 inch (1.62 mm) thick.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Oil-impregnated bronze or Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Galvanized steel.

2.05 FLANGE CONNECTORS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Nexus PDQ; Division of Shilco Holdings, Inc.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.06 DUCT-MOUNTED ACCESS DOORS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. McGill AirFlow, LLC.
 - 5. Nailor Industries, Inc.
 - 6. Pottorff.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1- by 1-inch (25- by 25-mm) butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.

SECTION 23 33 00 – AIR DUCT ACCESSORIES

- b. Access Doors up to [18 Inches (460 mm)] Square: [Two hinges] [Continuous] and two sash locks.
- c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches.

2.07 FLEXIBLE CONNECTORS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne, Inc.
 - 3. Elgen Manufacturing.
 - 4. Ventfabrics, Inc.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4 inches (70 mm) wide, 0.028 inch (0.7 mm) thick, galvanized sheet steel or 0.032 inch (0.8 mm) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3. Service Temperature: -40 to +200°F (-40 to +93°C).

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 2. At each change in direction and at maximum 50-foot (15-m) spacing.

SECTION 23 33 00 – AIR DUCT ACCESSORIES

- 3. Control devices requiring inspection.
 - 4. Elsewhere as indicated.
 - H. Install access doors with swing against duct static pressure.
 - I. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
 - 2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - 3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - 4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - 5. Body Access: 25 by 14 inches (635 by 355 mm).
 - 6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
 - J. Label access doors according to Section 230553 - Identification for HVAC Piping and Equipment to indicate the purpose of access door.
 - K. Install flexible connectors to connect ducts to equipment.
 - L. For fans developing static pressures of 5-inch w.g. (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
 - M. Install duct test holes where required for testing and balancing purposes.
- 3.02 FIELD QUALITY CONTROL:
- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

SECTION 23 34 23 – HVAC POWER VENTILATORS

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes:
 - 1. In-line centrifugal fans.
- 1.03 REFERENCE STANDARDS:
- A. American Bearing Manufacturers Association (ABMA):
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings (ANSI).
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
 - B. Air Movement and Control Association International, Inc. (AMCA):
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 3. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data (ANSI).
 - C. Air Movement and Control Association International, Inc./American Society of Heating, Refrigerating and Air-Conditioning Engineers (AMCA/ASHRAE):
 - 1. AMCA 210/ASHRAE 51 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI).
 - D. NFPA:
 - 1. NFPA 70 - National Electrical Code.
 - E. Underwriters Laboratories, Inc. (UL):
 - 1. UL 705 - Power Ventilators.
 - 2. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances.
- 1.04 PERFORMANCE REQUIREMENTS:
- A. Project Altitude: Base fan-performance ratings on actual Project Site elevations.
 - B. Operating Limits: Classify according to AMCA 99.
- 1.05 SUBMITTALS:
- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

SECTION 23 34 23 – HVAC POWER VENTILATORS

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
 - C. Field quality-control reports.
 - D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.
- 1.06 QUALITY ASSURANCE:
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
 - C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.
- 1.07 COORDINATION:
- A. Coordinate sizes and locations of equipment supports, and penetrations with actual equipment provided.

PART 2 - PRODUCTS

- 2.01 IN-LINE CENTRIFUGAL FANS:
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation.
 2. Hartzell Fan, Incorporated.
 3. Loren Cook Company.
 4. PennBarry.
 - B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
 - C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
 - D. Fan Wheels: Aluminum centrifugal.
 - E. Accessories:
 1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
 2. Companion Flanges: For inlet and outlet duct connections.
 3. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
 - F. Capacities and Characteristics: Refer to Fan Schedule on Drawings.
- 2.02 MOTORS:
- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

SECTION 23 34 23 – HVAC POWER VENTILATORS

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.03 SOURCE QUALITY CONTROL:

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install power ventilators level and plumb.
- B. Support units using spring isolators having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- E. Install units with clearances for service and maintenance.
- F. Label units according to requirements specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

3.02 CONNECTIONS:

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 - Air Duct Accessories.
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26.
- D. Connect wiring according to Division 26.

3.03 FIELD QUALITY CONTROL:

- A. Perform tests and inspections.
- B. Tests and Inspections:

SECTION 23 34 23 – HVAC POWER VENTILATORS

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system and install guards.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.04 ADJUSTING:

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing procedures.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION 23 34 23

SECTION 23 64 16 – CHILLER INSTALLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract apply to this Section.

1.02 SUMMARY:

- A. This specification includes the installation of packaged, water-cooled, electric-motor-driven centrifugal chillers.
- B. It is intended to be utilized in conjunction with the chiller pre-purchase specification package and equipment provided by that package.
- C. This specification is intended to document the installation requirements specific to the contractor. It is the contractor's responsibility to ensure that all aspects of chiller installation, including those provided under this specification and the pre-purchase specification package, are complied with and completed.
- D. Related Section:
 - 1. Section 28 44 00 - Refrigerant Detection and Alarm for refrigerant monitors, alarms, supplemental breathing apparatus, and ventilation equipment interlocks.

1.03 REFERENCES:

- A. Applicable Standards (Latest Edition):
 - 1. Air-Conditioning & Refrigeration Institute (ARI):
 - a. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.
 - b. ARI 575 - Method of Measuring Machinery Sound within an Equipment Space.
 - c. ARI 580 - Standard for Non-Condensable Gas Purge Equipment for Use with Low-Pressure Liquid Centrifugal Chillers.
 - 2. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
 - a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
 - 3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ASHRAE 15 - Safety Standard for Refrigeration Systems.
 - b. ASHRAE 34 - Designation and Safety Classifications of Refrigerants.
 - c. ASHRAE 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks (ANSI).
 - d. ASHRAE 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems (ANSI).
 - 4. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
 - a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
 - 5. ASME International (ASME):
 - a. ASME B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 to NPS 24.
 - b. ASME Boiler and Pressure Vessel Code - Section VIII, "Pressure Vessels," Division 01.
 - 6. ASTM International (ASTM):
 - a. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

SECTION 23 64 16 – CHILLER INSTALLATION

7. Green Seal (GS):
 - a. GS-31 - Environmental Standard for Electric Chillers.
 8. International Electrotechnical Commission (IEC):
 - a. IEC 60947-4-1 - Part 4: "Contactors and Motor Starters"; Section 1, "Electromechanical Contactors and Motor Starters" (with Amendment 1, dated 2002).
 9. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosure for Electrical Equipment (1,000V Maximum).
 - b. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - c. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated 600V.
 - d. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
 - e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600V Maximum).
 10. NFPA:
 - a. NFPA 70 - National Electrical Code.
 11. Underwriters Laboratories, Inc. (UL):
 - a. UL 1995 - Heating and Cooling Equipment.
- 1.04 DEFINITIONS:
- A. BAS: Building automation system.
 - B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
 - C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/hr. to the total power input given in terms of watts at any given set of rating conditions.
 - D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and referenced to ARI standard rating conditions.
 - E. kW/Ton (kW/kW): The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons (kW) at any given set of rating conditions.
 - F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit calculated per the method defined by ARI 550/590 and intended for operating conditions other than the ARI standard rating conditions.
- 1.05 DELIVERY, STORAGE, AND HANDLING:
- A. Contractor is responsible for receiving, storing, and installing the chiller.
- 1.06 COORDINATION:
- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor bolt inserts into bases.

SECTION 23 64 16 – CHILLER INSTALLATION

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine chillers before installation. Reject chillers that are damaged.
- B. Examine roughing-in for equipment support, anchor bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.
 - 1. Final chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 CHILLER INSTALLATION:

- A. Equipment Mounting: Install chiller on concrete bases using elastomeric pads. Comply with requirements for concrete bases specified in Division 03. Comply with requirements for vibration isolation devices specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 1. Secure to foundation following manufacturer's installation documentation.
- B. Maintain manufacturer's recommended clearances for service and maintenance.
- C. Charge chiller with refrigerant and fill with oil if not factory installed.
- D. Install separate devices furnished by manufacturer and not factory installed.
- E. Do not flush piping system through the chiller; bypass the chiller for system flush, pressure test, and passivation.
- F. Insulate all surfaces capable of condensing. Insulate using vendor recommended insulation materials, thicknesses, and installation instructions.
- G. Touch up and repair any paint damaged during shipping or installation.

3.03 CONNECTIONS:

- A. Comply with requirements for piping specified in Section 23 21 13 - Hydronic Piping and Section 23 23 00 - Refrigerant Piping. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to chiller to allow service and maintenance.
- C. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, flow meter, pressure differential indicator, drain connection with valve and other appurtenances as indicated on P&ID. Make connections to chiller with a flange.
- D. Condenser Fluid Connections: Connect to condenser inlet with shutoff valve, strainer, thermometer, and plugged tee with pressure gage. Connect to condenser outlet with shutoff valve, flow switch, thermometer, plugged tee with shutoff valve and pressure gage, drain connection with valve and other appurtenances as indicated on P&ID. Make connections to chiller with a flange.
- E. Refrigerant Pressure Relief Device Connections: For chillers installed indoors, extend separate vent piping for each chiller to the outdoors without valves or restrictions. Comply with

SECTION 23 64 16 – CHILLER INSTALLATION

- ASHRAE 15. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.
- F. For chillers equipped with a purge system, extend separate purge vent piping for each chiller to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.
- G. Connect each chiller drain connection with a union and drain pipe, and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection.
- H. Electrical connections: install electrical and controls connections as indicated in drawings and chiller installation documentation.
- 3.04 VENDOR SERVICES:
- A. Coordinate with and support factory-authorized service representatives in their scope (as provided by chiller procurement package.)
- B. Note that chiller assembly and startup is under the direction of and supervision of the factory authorized service representative.
- C. This includes but is not limited to:
1. Communicating construction schedule of equipment on site.
 2. Allowing job site access.
 3. Coordinating equipment schedule with factory-authorized service representative.
- 3.05 STARTUP SERVICE:
- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
 3. Verify that pumps are installed and functional.
 4. Verify that thermometers and gages are installed.
 5. Operate chiller for run-in period.
 6. Check bearing lubrication and oil levels.
 7. Verify that refrigerant pressure relief device is vented outside.
 8. Verify proper motor rotation.
 9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
 10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
 11. Verify and record performance of chiller protection devices.
 12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
- C. Prepare test and inspection startup reports.
- 3.06 DEMONSTRATION:
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chillers.

END OF SECTION 23 64 16

SECTION 23 65 00 – COOLING TOWERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes: Open-circuit, induced-draft, crossflow cooling towers.

1.03 REFERENCES:

1. Applicable Standards (Latest Edition):
 - a. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
 - b. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
2. ASME International (ASME):
 - a. ASME B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 to NPS 24.
 - b. ASME PTC 23 - ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment (ANSI).
 - c. ASME Boiler and Pressure Vessel Code - Section VIII, "Pressure Vessels," Division 01.
3. ASTM International (ASTM):
 - a. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - b. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
4. Code of Federal Regulations (CFR):
 - a. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory."
 - b. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart D - "Walking-Working Surfaces," Section 1910.23 - "Guarding Floor and Wall Openings and Holes."
 - c. 29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart D - "Walking-Working Surfaces," Section 1910.27 - "Fixed Ladders."
5. Cooling Technology Institute (CTI):
 - a. CTI ATC 105 - Acceptance Test Code for Water Cooling Towers.
 - b. CTI ATC 128 - Code for Measurement of Sound from Water Cooling Towers.
 - c. CTI STD 111 - Gear Speed Reducers.
 - d. CTI STD 201 - Certification Standard for Commercial Water-Cooling Towers Thermal Performance.

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6. FM Global (FM):
 - a. Approval Guide.
 7. National Electrical Manufacturers Association (NEMA):
 - a. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).
 - b. NEMA MG-1 (Rev. 1) - Motors and Generators.
 8. NFPA:
 - a. NFPA 70 - National Electrical Code.
 9. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
 - a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- 1.04 DEFINITIONS:
- A. BMS: Building management system.
 - B. FRP: Fiber-reinforced polyester.
- 1.05 PERFORMANCE REQUIREMENTS:
- A. Structural Performance: Cooling tower support structure shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
- 1.06 ACTION SUBMITTALS:
- A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.
 1. Maximum flow rate.
 2. Minimum flow rate.
 3. Drift loss as percent of design flow rate.
 4. Sound power levels in eight (8) octave bands for operation with fans off, fans at minimum, and design speed.
 5. Performance curves for the following:
 - a. Varying entering-water temperatures from design to minimum.
 - b. Varying ambient wet-bulb temperatures from design to minimum.
 - c. Varying water flow rates from design to minimum.
 - d. Varying fan operation (off, minimum, and design speed).
 6. Fan airflow, brake horsepower, and drive losses.
 7. Pump flow rate, head, brake horsepower, and efficiency.
 8. Fan motor Nameplate Data:
 - a. Manufacturer's name and serial number.
 - b. Manufacturer's type and frame designation.
 - c. Horsepower output.
 - d. Time rating.
 - e. Maximum ambient temperature for which motor is designed.
 - f. Insulation system designation.
 - g. Temperature rise and method of measurement.
 - h. RPM at rated load.
 - i. Frequency.

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- j. Number of phases.
 - k. Rated-load amperes.
 - l. Voltage.
 - m. Code letter for locked rotor kVA.
 - n. Design letter for polyphase integral-horsepower motors.
 - o. Nominal efficiency.
 - p. Service factor.
 - q. For motors equipped with thermal protectors, the words "thermally protected."
 - 9. Motor power factor at 100, 75, 50, and 25% of nameplate horsepower.
 - 10. Electrical power requirements for each cooling tower component requiring power.
 - B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:
 - 1. Assembled unit dimensions.
 - 2. Weight and load distribution.
 - 3. Required clearances for maintenance and operation.
 - 4. Sizes and locations of piping and wiring connections.
 - 5. Wiring Diagrams: For power, signal, and control wiring.
- 1.07 INFORMATIONAL SUBMITTALS:
- A. Certificates: For certification required in "Quality Assurance" Article.
 - B. Source quality-control reports.
 - C. Field quality control reports.
 - D. Startup service reports.
 - E. Warranty: Sample of special warranty.
- 1.08 CLOSEOUT SUBMITTALS:
- A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.
- 1.09 QUALITY ASSURANCE:
- A. Testing Agency Qualifications: Certified by CTI.
 - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 06, "Heating, Ventilating, and Air-Conditioning."
 - D. CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to plan. If, because of a suspected thermal performance deficiency, the owner chooses to conduct an on-site thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI or ASME standards during the first year of operation; and if the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to the owner to compensate for the performance deficiency.
 - E. FM approval required.

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1.10 COORDINATION:

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

1.11 WARRANTY:

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:
 - 1. Fan assembly including fan, drive, and motor.
 - 2. All components of cooling tower.
 - 3. Warranty Period: Five (5) years from date of delivery.

PART 2 - PRODUCTS

2.01 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Baltimore Aircoil Company.
 - 2. Marley Cooling Technologies; an SPX Corporation.
 - 3. Evapco, Inc.
- B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.
- C. Cooling tower designed to resist wind load of 120 mph per ASCE 7.
- D. Casing and Frame:
 - 1. Casing and Frame Material: Stainless steel.
 - 2. Fasteners: Stainless steel.
 - 3. Joints and Seams: Sealed watertight.
 - 4. Welded Connections: Continuous and watertight.
- E. Collection Basin:
 - 1. Material: 304 Stainless steel.
 - 2. Removable stainless-steel strainer with openings smaller than nozzle orifices.
 - 3. Overflow and drain connections.
 - 4. Outlet Connection: ASME B16.5, Class 150 flange.
- F. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.
 - 1. Material: Stainless steel.
 - 2. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
 - 3. Inlet Connection: ASME B16.5, Class 150 flange.
 - 4. Joints and Seams: Sealed watertight.
 - 5. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.

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6. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable stainless-steel hardware.
9. Single-Inlet, Field Pipe Connection: PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves. Pipe each cooling tower cell internally to a single, field connection suitable for mating to ASME B16.5, Class 150 flange and located on the bottom, unless otherwise indicated.
- G. Fill:
 1. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E84.
 2. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
 3. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120°F (49°C).
- H. Drift Eliminator:
 1. Material: PVC; with maximum flame-spread index of 5 according to ASTM E84.
 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
- I. Air-Intake Louvers:
 1. Material: PVC.
 2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 3. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
- J. Air-Intake Screens: Stainless-steel wire mesh.
- K. Axial Fan: Balanced at the factory after assembly.
 1. Blade Material: Aluminum.
 2. Hub Material: Aluminum.
 3. Blade Pitch: Field adjustable.
 4. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
 5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between -20 and +300°F (29 and +149°C). Bearings designed for an L-10 life of 50,000 hours.
 6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
- L. Direct Drive: Fan hub directly connected and properly secured to motor shaft with flexible composite disc coupling.
- M. Fan Motor:
 1. General Requirements for Fan Motors: Rated 460V, 3 phase, 60 hertz.
 2. Motor Rotor Type: Permanent magnet.
 3. Energy Efficiency: The motor's efficiency shall meet or exceed all NEMA Premium Requirements for energy efficiency, or as otherwise required by Federal statute. Efficiency values shall be determined in the manner described by NEMA MG1.12.58.
 4. Service Factor: 1.15.
 5. Motor shall have an inverter grade insulation system consisting of, at a minimum, Class H or better insulation materials with additional phase insulating material, extra end-turn

SECTION 23 65 00 – COOLING TOWERS

- bracing and Class H spike resistant wire. The resulting insulation system shall withstand 2,000V transients without premature motor failure and have no cable limitations in motor application.
- a. Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors.
6. Severe-duty rating with the following features:
 - a. TEAO motor type if located in airstream.
 - b. Rotor and stator protected with corrosion-inhibiting epoxy resin.
 - c. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between -20 and +300°F (-29 and +149°C).
 - d. Internal heater automatically energized when motor is de-energized.
 - N. Fan Discharge Stack: Material shall match casing, manufacturer's standard velocity recovery design.
 1. Stack Extension: Fabricated to extend above fan deck 4 feet, unless otherwise indicated.
 2. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.
 - O. Vibration Switch: For each fan drive.
 1. Enclosure: NEMA 250, Type 4X.
 2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3,000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
 3. Provide switch with manual-reset button for hardwired connection to fan motor electrical circuit.
 4. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.
 - P. Controls: Comply with requirements in Division 40.
 1. NEMA 250, Type 4X enclosure with removable internally mounted backplate.
 2. Control-circuit transformer with primary and secondary side fuses.
 3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
 4. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
 5. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquid-tight conduit.
 6. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:
 - a. Operational status of each motor.
 - b. Cooling tower leaving-fluid temperature.
 - c. Fan vibration alarm.
 7. Building Management System (BMS) Interface:
 - a. Hardwired Interface Signals:
 - (1) Run Command: 24 VDC
 - (2) Running Feedback: 24 VDC
 - (3) Common Alarm: 24 VDC

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- b. Network interface:
 - (1) Provide Ethernet IP, BACnet/IP, or Modbus TCP, if available, to provide additional monitoring and control of internal cooling tower VFD parameters.
 - (2) Provide complete listing of all available software points.
 - c. Any instrumentation by vendor shall be brought to junction box with clear field wiring requirements.
 - Q. Personnel Access Components:
 - 1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
 - 2. External Ladders/Platforms: Galvanized- or stainless-steel fixed ladder providing access to platform at the motor access door of the unit. Platform shall have at least 36 in of walking surface and have galvanized steel grating. Platform and ladder shall comply with 29 CFR 1910.27 and OSHA standards.
 - 3. Upper Platform: Upper Platform shall be designed so that personnel can access all sides of all three cooling tower cells from a single ladder provide with the tower.
 - a. Access to upper platform by hinged and latched access door.
 - b. Provide davit with base mounted on upper platform to aid in maintenance activities from upper platforms. Davit crane shall be capable of listing, extending and lowering equipment up to 1000lbs to grade.
 - 4. Handrail: Galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
 - 5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.
 - a. Shall provide easy access to the fans, motors, sheaves, bearings, all mechanical equipment and complete water distribution system. The fill shall be acceptable means of accessing these components.
 - R. Capacities and Characteristics:
 - 1. Refer to drawing schedules.
- 2.02 SOURCE QUALITY CONTROL:
- A. Verification of Performance: Test and certify cooling tower performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

PART 3 - EXECUTION

- 3.01 EXAMINATION:
- A. Before cooling tower installation, examine roughing-in for tower support, anchor bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.
 - 1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
 - B. Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.02 INSTALLATION:
- A. Install cooling towers on support structure indicated in Contract Documents.

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3.03 CONNECTIONS:

- A. Piping installation requirements are specified in other Division 23 Sections. Contract Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to cooling towers to allow service and maintenance.
- C. Provide drain piping with valve at cooling tower drain connections and at low points in piping. Supply and Return Piping: Comply with applicable requirements in Section 23 21 13 - Hydronic Piping. Connect to entering cooling tower connections with shutoff valve, pressure transmitter, on/off control valve, balancing valve, thermometer, and drain connection with valve.

3.04 FIELD QUALITY CONTROL:

- A. Testing Agency Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.
- C. Perform tests and inspections and prepare test reports per Part D below.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections: Comply with ASME PTC 23, "ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment."
- E. Piping systems shall be hydrostatically or pneumatically pressure tested at one and one-half times the maximum operating pressure.
- F. Cooling towers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.05 STARTUP SERVICE:

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Obtain performance data from manufacturer.
 - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Clean entire unit including basins.
 - b. Verify that accessories are properly installed.
 - c. Verify clearances for airflow and for cooling tower servicing.
 - d. Check for vibration isolation and structural support.
 - e. Lubricate bearings.
 - f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
 - g. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
 - h. Check vibration switch setting. Verify operation.
 - i. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.

SECTION 23 65 00 – COOLING TOWERS

- j. Replace defective and malfunctioning units.
 - D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
 - E. Prepare a written startup report that records the results of tests and inspections.
- 3.06 ADJUSTING:
- A. Set and balance water flow to each tower inlet.
 - B. Adjust water-level control for proper operating level.
- 3.07 DEMONSTRATION:
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 23 65 00

SECTION 26 00 00 – GENERAL REQUIREMENTS

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section applies to the complete installation of power, control, instrumentation, communication wiring, equipment accessories, lighting, and other electrical systems specified in all other Section(s) of Division 26. In general, work includes, but is not limited to, the following:
 - 1. Installation of wiring connections to Equipment specified in Division 26 and all other Divisions of these Specifications unless indicated otherwise.
 - 2. Installation of all interconnections wiring and equipment furnished by Owner: Chillers, USS2.
 - 3. Testing of installed cabling and wiring, electrical equipment, lighting and power systems, and other electrical devices and components associated with equipment and equipment packages.
- 1.03 RELATED REQUIREMENTS:
- A. All other Sections of Division 26.
 - B. Submittals shall be complete, featuring clear identification of all selected items. Highlight or mark applicable ratings, model/part numbers, and corresponding options.
 - C. All submittals must clearly identify the corresponding equipment schedule ID, equipment, or component tag in the title for distinct identification.
- 1.04 REFERENCE STANDARDS:
- A. Publication Dates: Comply with latest standards in effect as of date of the Contract Documents unless otherwise indicated.
 - B. As specified in each applicable Section, Division 26.
 - C. National Fire Protection Association (NFPA):
 - 1. 70 - National Electrical Code (NEC).
 - D. Underwriter's Laboratories, Inc. (UL) standards.
- 1.05 SUBMITTALS:
- A. As specified in each applicable Section(s), Division 26, Division 01.

PART 2 - PRODUCTS

- 2.01 GENERAL:
- A. All Equipment and Materials shall be in accordance with the National Electrical Code (NEC).
 - B. All cable conductor terminations shall be UL listed for 90°C conductors, unless specified otherwise in other Sections of Division 26. All terminations supplied by the Equipment manufacturer shall be UL listed at a temperature rating that is not less than the Equipment temperature rating.

2.02 SYSTEMS TO BE INSTALLED:

- A. 12.47kV, 3-phase, 3-wire, 60Hz systems.
- B. 480V, 3 phase, 60 hertz, 3 wire systems.
- C. Grounding systems.
- D. Control systems.
- E. Convenience power facilities during construction.
- F. Alarm and Instrumentation systems.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. As specified in each applicable Section(s), Division 26.
- B. All work shall be in accordance with the National Electrical Code (NEC).
- C. Install systems, materials, and equipment level, plumb, parallel, and perpendicular to other building systems and components, where installed in finished spaces.
- D. Where Equipment motor horsepower sizes and/or kilowatt sizes are indicated as approximate for Equipment furnished and installed by this Contract and a different size is installed, Contractor shall furnish and install the following at no additional cost to Owner.
 - 1. The proper size of motor starter or contactor and appurtenances.
 - 2. Fuses or circuit breakers as indicated.
 - 3. Wire and conduit sized for the Equipment.
 - 4. Any code enforced local disconnecting means labeling.

3.02 WORK ON EXISTING EQUIPMENT:

- A. Do not remove any equipment from service without obtaining permission from Owner and Engineer.
- B. Perform work that requires taking equipment out of service at times designated by Owner to cause minimum interruption in plant operation.
- C. Continue work with as many workmen as can be efficiently utilized from the time any equipment is removed from service until equipment is tested and back in service.
- D. Connect electrical Equipment to provide same phasing as existing equipment, unless otherwise specified or indicated.

3.03 TESTING:

- A. Test all electrical Equipment upon completion of installation to ensure that the Equipment operates satisfactorily and to conform to Contract Documents.
- B. Furnish temporary power sources of proper type for testing purposes when normal supply is not available at the time of testing.

3.04 COORDINATION AND SCHEDULING:

- A. Coordinate with Owner and all other Divisions.
- B. Coordinate Electrical installation with other trades to avoid interference with exposed conduit, lighting fixtures, or other Equipment until all piping, pipe hangers, ducts, and Equipment which is located above or behind has been installed, unless release is given in specific cases by Engineer.
- C. Coordinate installation of Equipment and wiring with the established construction schedule.
- D. Contractor must coordinate receiving, storing and handling of Owner furnished equipment and be responsible for setting, installing, interconnecting, and testing equipment and all associated parts and accessories.

- E. Provide temporary platforms, lighting and handrails as required to allow installation of electrical components and raceway systems.
- F. Contractor must be responsible for overall site safety, coordinating with all parties on site for hazards and associated work being performed each day.
- G. Provide temporary safety signage, barriers, fencing, covers, etc. for all site hazards throughout the duration of construction.

END OF SECTION 26 00 00

SECTION 26 05 04 – WIRE, CABLE AND ACCESSORIES

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes all electrical wire, cable, and accessories including terminations.
 - B. Definition:
 - 1. Burns & McDonnell type designations such as "PRN1," "CEN1" and "SEN2," indicated or specified are for identification purposes only and are not intended to correspond to any trade designation.
- 1.03 RELATED REQUIREMENTS:
- A. Section 26 00 00 – General Requirements.
 - B. Section 26 05 26 - Grounding.
 - C. Section 26 08 00 - Field Testing.
- 1.04 REFERENCE STANDARDS:
- A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - B. Applicable Standards:
 - 1. National Fire Protection Association (NFPA):
 - a. 70 – National Electrical Code (NEC).
 - b. 262 – Standard Development for Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
 - 2. Underwriter's Laboratories, Inc. (UL):
 - a. 44 – UL Standard for Safety Thermoset-Insulated Wires and Cables.
 - b. 83 – UL Standard for Safety Thermoplastic-Insulated Wires and Cables.
 - c. 854 – UL Standard for Service-Entrance Cables.
 - d. 1277 – UL Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
 - 3. Insulated Cable Engineer's Association (ICEA):
 - a. ICEA S-73-532 (NEMA WC57) – Standard for Control, Thermocouple Extension, and Instrumentation Cables.
 - b. ICEA S-93-639 (NEMA WC74) – 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
 - c. ICEA S-95-658 (NEMA WC70) – Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
 - d. ICEA S-97-682 – Standard for Utility Shielded Power Cables Rated 5 through 46kV.
 - e. ICEA S-104-696 – Standard for Indoor-Outdoor Optical Fiber Cable.
 - f. ICEA T-33-655 – Low-Smoke Halogen-Free (LSHF) Polymeric Cable Jackets.
 - 4. Institute of Electrical and Electronic Engineers (IEEE):
 - a. 48 – Test Procedures and Requirements for Alternating-Current Cable Terminations Used On Shielded Cables Having Laminated Insulation Rated 2.5kV through 765kV or Extruded Insulation Rated 2.5kV through 500kV.
 - b. 82 – Test Procedures for Impulse Voltage Tests On Insulated Conductors.

- c. 404 – Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5kV to 500kV.
- d. 1185 – Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities.
- e. 1202 – Standard for Flame-Propagation Testing of Wire and Cable.
- f. 1210 – Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable.
- 5. American Society for Testing and Materials (ASTM):
 - a. B3 – Standard Specification for Soft or Annealed Copper Wire.
 - b. B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - c. B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
 - d. B172 – Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors.
 - e. B189 – Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.
- 6. Fiber-Optic Cable (In addition to the above Reference Standards):
 - a. Telecommunications Industry Association (TIA):
 - (1) TIA-455-25 – FOTP- 25 Impact Testing of Optical Fiber Cables.
 - (2) TIA-455-204 – FOTP-204 Measurement of Bandwidth on Multimode Fiber.
 - (3) TIA-455-33 – FOTP-33 Optical Fiber Cable Tensile Loading and Bending Test.
 - (4) TIA-455-41 – FOTP- 41 Compressive Loading Resistance of Optical Fiber Cables.
 - (5) TIA-455-78 – Measurement Methods and Test Procedure – Attenuation.
 - (6) TIA-455-177 – FOTP-177 IEC-60793-1-43 Optical Fibers – Part 1-43: Measurement Methods and Test Procedures – Numerical Aperture - REPLACES TIA/EIA-455-7 AND TIA/EIA-455-47.
 - (7) TIA-455-104 – FOTP-104 Fiber Optic Cable Cyclic Flexing Test.

1.05 SUBMITTALS:

- A. Submit as specified in DIVISION 01.
- B. Includes, but not limited to, the following:
 - 1. Data sheets for each wire and cable type specified.
 - 2. Data sheets for wire and cable accessories.
 - 3. Cable manufacturer's approval of splicing and terminating materials.
 - 4. Cable manufacturer's approval of pulling compounds.
 - 5. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, etc.
 - 6. Other equipment and materials to be used.
 - 7. Unpriced wire and cable purchase orders.
 - 8. Two 3-foot samples of fiber-optic cable.
 - 9. Factory test results of each fiber-optic cable reel provided.

1.06 QUALITY ASSURANCE:

- A. Factory Tests:
 - 1. Factory tests shall be conducted on wire and cable as specified on each individual wire and cable type specification sheet contained in this Section.

2. Wire and cable certification sheets shall be submitted to the Engineer as specified on each individual wire and cable specification sheet and in accordance with requirements in DIVISION 01.
3. In addition to the above requirements, fiber-optic cable shall be tested as follows:
 - a. Quality Control Test Protocol: The manufacturer shall conduct tests according to industry standard requirements. Tests shall be performed routinely on sample sizes sufficient to verify quality and continuity or as specified.
 - b. The end-to-end attenuation of each reel of cable supplied shall be tested. Each fiber in a cable shall be tested. The results shall be recorded and provided with the cable when shipped. A copy of these test reports shall be submitted to the Engineer.
 - c. Tensile Strength: Tensile performance shall be tested on samples of the actual cable furnished. The tests shall include cable stress versus cable and fiber strain, and breaking strength. The tests shall verify that the cable supplied will not experience fiber strain under the specified environmental conditions when installed at the manufacturer's stated nominal axial load. Certified test reports shall be submitted and shall show that the requirements of this Section have been met.
 - d. Tests shall be performed on this or similar cable construction and the cables shall meet or exceed the requirements of the standard specified. Copies of test reports shall be submitted for the following tests:
 - (1) Crush Resistance: Tests with acceptable results shall be performed on similar cable types in accordance with TIA-455-41. The cable shall have a compressive strength of 1,350 lbs., at 20°C.
 - (2) Impact Resistance: The impact test specified in TIA-455-25 will show that no significant attenuation will result from 25 impacts of the specified impact at a sample temperature of -30°C or +25°C.
 - (3) Cyclic Flex Resistance (Test Conditions I and III): No significant attenuation results after 25 flex cycles when tested in accordance with TIA-455-104 using a bend radius of 5 times the cable outside diameter.
 - (4) Temperature Cycling: Conduct in accordance with TIA-455-3, the results of which shall show no attenuation increase at -40°C and +70°C.
 - (5) High and Low Temperature Bend Resistance (Test Level 1): No significant attenuation shall result from testing in accordance with TIA-455-37 at test temperatures of -30°C or +60°C.
 - (6) Water Penetration: The cable shall meet the requirements of TIA-455-82.
 - (7) Compound Flow (Drip) Resistance: Test results shall indicate compliance with the requirements of TIA-455-81 at a test temperature of +60°C.
 - (8) Vibration Characteristics: Vibration tests shall be carried out in accordance with standard industry practices for aeolian vibration and galloping conditions. The cable shall have self-damping properties in the entire frequency range and shall be unaffected mechanically or optically after 100 million vibration cycles of each condition.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Wire and Cable:

1. Aetna/ Rockbestos-Suprenant/ Marmon Engineered Wire & Cable/ Dekoron Wire.
2. Belden.

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26 05 04 WIRE, CABLE AND ACCESSORIES

3. Cerro Wire.
 4. Corning Cable.
 5. Lake Cable.
 6. Okonite.
 7. Optical Cable Corporation.
 8. Prysmian Group/ Encore/ General Cable.
 9. Service Wire.
 10. Southwire/ Coleman Wire.
- B. Wire and Cable Accessories:
1. Cable Connectors for Control and Instrument Cable:
 - a. AMP Special Industries.
 - b. Panduit Corporation.
 - c. Thomas and Betts Company, Inc.
 - d. Minnesota Mining and Manufacturing (3M).
 2. Cable Connectors for Power Cable:
 - a. AMP Special Industries.
 - b. Thomas and Betts Company, Inc.
 - c. Panduit Corporation.
 - d. Minnesota Mining and Manufacturing (3M).
 - e. Burndy.
 3. Pin Reducers for Power Cable:
 - a. Burndy.
 4. Termination and Splice Kits:
 - a. Minnesota Mining and Manufacturing (3M).
 - b. Raychem.
 5. Tape and Insulation Putty:
 - a. Minnesota Mining and Manufacturing (3M).
 6. Cable Pulling Lubricants:
 - a. American Polywater Corp.
 - b. CRC Industries.
 - c. Blackburn.
 - d. Ideal.
 - e. Greenlee.
 - f. 3M/Electrical Products Division.
 7. Cable Ties:
 - a. AMP Special Industries.
 - b. Dennison Manufacturing Company.
 - c. Panduit Corporation.
 - d. Thomas and Betts Company, Inc. (T&B).
 - e. Minnesota Mining and Manufacturing (3M).
 8. Cable Supports:
 - a. O. Z. Gedney Company.
 9. Terminal Blocks:
 - a. States Company.
 - b. General Electric.
 - c. Phoenix Contact (PLC enclosures and cabinets).
 - d. Weidmueller.

2.02 WIRE AND CABLE:

- A. The Cable Schedule defines the type, size, end points, and routing of each wire or cable excluding lighting, intercom, receptacle power, and grounding cables.
- B. All cable installed in cable tray shall be rated for exposed run and shall be labeled as type TC-ER. For any cable not rated type TC-ER shall not be exposed and shall be installed in raceway for the entire route per the NEC.
- C. Cable Packaging:
 - 1. Each cable reel will hold only one continuous cable.
 - 2. Reel Identification Numbers:
 - a. Each cable reel shall have a unique identification number.
 - b. Reel identification shall be placed on one of the end flanges and using one of the following methods:
 - (1) Permanently stenciled 1/2-inch letters.
 - (2) Corrosion-resistant metal tag, minimum size shall be 3 inches by 5 inches with 1/4-inch stamped letters.
 - c. Reel identification shall include the following:
 - (1) Project name.
 - (2) Contract name.
 - (3) Contract number.
 - (4) Engineer's type designation such as "PRN1," "CEN1," etc., and wire size and number of conductors such as "250/1/C," or 14-7/C.
 - (5) Starting and ending cable footage marker number.
 - (6) Reel identification number (unique for each reel).
 - 3. Cable End Preparations:
 - a. Each cable end, except for medium voltage cables, shall be sealed with a rubber cap or other approved method to prevent moisture entry.
 - 4. Manufacturer shall provide, as a minimum, a two-layer pressed fiberboard cover with two metal bands around the outside of the cable for each cable reel.
- D. Lighting, intercom, receptacle power, and grounding cable requirements are indicated on the plan drawings or on miscellaneous schedules included with the plan drawings.
- E. Wire and cable shall be furnished in accordance with the specification sheets at the end of this Section.
- F. Multi-conductor power cables shall include a grounding conductor as part of the assembly.
- G. Multiple unit structures such as motor control centers, power centers, load centers, digital and analog termination cabinets, excitation switchgear, and all equipment in the control equipment rooms require cable termination in the individual cubicles. These unit numbers will be added to the Cable Schedule at a later date. Base bid shall account for these later unit designations and Contractor shall adjust his final cable lengths at no price to the Contract.
- H. Specific duct bank assignments will be added prior to start of construction.
- I. Wire or cables listed in the Cable Schedule with insufficient information for determining length shall be included in the Bid as a 150-foot length of the type of wire or cable indicated. The Contract price will be adjusted up or down using unit prices after actual wire or cable length is determined.
- J. Wire or cables listed in the Cable Schedule without cable type or size information shall be included in bid as type 1-7/C#14 CRN. The Contract price will be adjusted up or down using unit prices after actual cable type or size or both is determined.
- K. Fiber-Optic Cable Design Requirements:

1. Each cable shall contain six fibers and shall be finished in sufficient lengths as required to maintain one continuous circuit without splices.
 2. The cable shall have a circular cross-section so that installation is performed with standard sheaves and tensioning equipment.
 3. The cable shall be an all-dielectric, self-supporting fiber optic cable.
 4. The cable shall be manufactured such that no fiber strain will be caused by the cable itself.
 5. The cable shall not contain metals or conductive materials.
 6. Each reel shall be accompanied by OTDR attenuation test data on each fiber. Copies of these test results shall be submitted to the Owner and Engineer after manufacturing.
- L. Flat cable constructions will not be accepted. Provide 3/C cable in lieu of 2/C where round 2/C cable cannot be obtained.

2.03 CONNECTORS:

- A. General Requirements:
1. Designed and sized for specific cable being connected.
 2. Solderless, pressure-type connectors constructed of non-corrodible tin-plated copper.
 3. Rated current-carrying capacity equal to or greater than the cable being connected.
 4. Application tooling for connectors shall contain die or piston stops to prevent over-crimping and cycling or pressure relief to prevent under-crimping. Dies of all application tooling shall provide dot or wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.
- B. Power Connectors (sizes 12-4 AWG) 600V and Below:
1. Non-insulated ring-tongue type.
 2. Ring tongue sized to match terminal stud size.
 3. Brazed barrel seam.
 4. Application tooling designed to crimp the wire barrel (conductor grip) with a one-step crimp.
 5. Acceptable manufacturers' cross-reference chart is listed at end of this Article.
- C. Power Connectors (sizes 2 AWG - 750 kcmil) 600V and Below:
1. Non-insulated one-hole rectangular tongue for sizes 2 AWG through 3/0 AWG and NEMA two-hole rectangular tongue for 4/0 AWG through 750 kcmil.
 2. Connectors for DLO type cable (fine stranding) shall be specifically made for use with fine stranded cables. Barrels shall be funneled to facilitate wire insertion and prevent turned-back strands.
 3. Application tooling shall be hydraulic operated.
 4. Voltage rating equal or greater than that of the cable being used.
 5. Reducing pins may be used if required and where approved by engineer.
 6. Acceptable manufacturers' cross-reference chart is listed at end of this Article.
- D. Power Connectors (sizes 2 AWG - 750 kcmil) above 600V:
1. Non-insulated one-hole rectangular tongue for sizes 2 AWG through 3/0 AWG and NEMA two-hole rectangular tongue for 4/0 AWG through 750 kcmil.
 2. Connectors for DLO type cable (fine stranding) shall be specifically made for use with fine stranded cables. Barrels shall be funneled to facilitate wire insertion and prevent turned-back strands.
 3. Voltage rating equal or greater than that of the cable being used.
 4. Application tooling shall be hydraulic operated.
 5. Acceptable manufacturers' cross-reference chart is listed at end of this Article.
- E. Control, Instrument and Specialty Cable Connectors:

1. All terminations shall have pre-insulated ring-tongue type or pre-insulated ferrule type except for fiberoptic and thermocouple conductors. Spade lugs will not be permitted.
 2. Vinyl or nylon pre-insulated ring-tongue type for non-PLC terminations unless Equipment cannot accept a ring tongue connector.
 3. Polypropylene pre-insulated ferrules for DCS, PLC, or any other termination with screw connection type terminal block. Terminations are subject to the review and approval of the Owner and Engineer.
 - a. Provide ferrules as manufactured by Phoenix Contact, AI series, color coded in accordance with DIN 46228-4 or Engineer approved equal.
 - b. Crimp tool shall be Phoenix Contact Crimpfox 6H, catalog number 1212046 or Engineer approved equal.
 - c. The un-insulated portion of the ferrule shall correspond with the length required to fully engage the terminal portion of the terminal block.
 - d. Two-conductor or twin ferrules will not be permitted. For installations where single ferrules cannot be installed, twin ferrules or no ferrule may be used upon Engineer approval.
 4. Sized to match terminal stud size.
 5. Have insulation grip sleeve to firmly hold to cable insulation.
 6. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned-back strands.
 7. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve or ring with a one-step crimp.
 8. Acceptable manufacturers' cross-reference chart is listed at end of this Article.
- F. Fiber-Optic Cable Connectors:
1. Provide appropriate mechanical or fusion type connectors for 62.5/125µm fiber.
 2. Provide Kellum's Fiber Optic Pull Grips Part No. 033-29-XXXX or Engineer-approved equal for pulling fiber-optic cables.
 3. Acceptable manufacturer's cross-reference chart is listed at end of this Article.

Acceptable Connector Manufacturers' Cross-Reference Chart

<u>Type</u>	<u>Size (AWG or MCM)</u>	<u>Amp Special Industries</u>	<u>Thomas & Betts</u>	<u>Panduit Corp.</u>	<u>3-M</u>
Control	22-18	PIDG	RA18	PN18	MNG-18
	16-14	PIDG	RB14	PN14	MNG-14
	12-10	PIDG	RC10	PN10	MNG-10
Power (600V and Below)	12-10	Solistrand	C10	P10	M10
	8	Solistrand	D8	P8	M8
	6	Solistrand	E6	P6	M6
	4	Solistrand	F4	P4	M4
	2-2/0	Ampower	54100 Series	LCA	30000 Series
	3/0-750	Ampower	54200 Series	LCC	31100 Series
Power (Above 600V)	2-3/0	Ampower*	54400 Series	LCA*	30000 Series

	4/0-750	Ampower*	54400 Series	LCC*	31100 Series
Fiber-optic	All	N/A	N/A	N/A	ST6100
- *Rated for 5 kV and below.
- 2.04 STORAGE:
A. This Contract will establish a crushed rock laydown area for cable storage. All reels shall be stored off the ground on timbers.
- 2.05 MOTOR LEAD TERMINATION/SPLICE (LOW-VOLTAGE, 600V AND BELOW, POWER CABLE):
A. Splices shall be made using compression-type connectors bolted together. The compression-type connectors shall be properly sized for the cables. Reference acceptable connector manufacturer's cross-reference chart.
B. Splice to be covered with heat-shrinkable or cold-shrink tubing connector insulators.
C. Splicing shall be done in accordance with the instructions provided with the Minnesota Mining and Manufacturing (3M) 5300 Series Motor Connector Kit, Raychem brand MCK or RVC Motor Connector Kit.
- 2.06 CABLE SUPPORTS:
A. Cable supports for cables in vertical conduit risers shall be O. Z. Gedney Type "R" wedging plug type or approved equal.
- 2.07 CABLE TIES:
A. Nylon self-locking type.
B. Normal service temperature range of -40 to 85°C.
C. Weather-resistant, UV-resistant, type for outdoor use.
D. Conforms to SAE testing requirements of SAE-AS23190.
E. AMP Special Industries "AMP-TY," Dennison Manufacturing Company "BAR-LOK," Panduit Corporation "PAN-TY" and "BARB-TY", Thomas & Betts "TY-RAP," or Minnesota Mining and Manufacturing 3M Brand cable ties.
- 2.08 TERMINAL BLOCKS:
A. For Mounting in Terminal Boxes (TBs):
1. No adhesive back mounting clips will be allowed.
2. Designed and sized for the cables being terminated.
3. Allow for 20% spare terminals.
4. Block insulation rated 600V.
5. Binding screw-type terminals for power cables and straight-strap stud terminals for control and instrument cables.
6. Rated current carrying capacity equal to or greater than the cable being terminated.
7. Marking strip.
8. Phoenix Contact RT Bolt Connection series for power, control and instrument cables. Weidmueller Screw Connection with Stud series for power, control and instrument cables. States Company Type NT Model M-251 for control and instrument cables.
B. For Mounting in Cabinets, Panels, Control Boards, Etc.:
1. No adhesive back mounting clips will be allowed.
2. Designed and sized for the cables being terminated.

3. Allow for 20% spare terminals.
4. Block insulation rated 600V.
5. Binding screw type terminals for power cables and current transformer circuits and sliding link stud type terminals for control and instrument cables.
6. Rated current carrying capacity equal to or greater than the cable being terminated.
7. Marking strip on blocks for power cables and control and instrument cables.
8. Short-circuit strips with one shorting screw for each terminal for current transformer circuits.
9. Phoenix Contact RT Bolt Connection series for power, control and instrument cables. Weidmueller Screw Connection with Stud series for power, control and instrument cables. States Company Type NT Model M-250 or Stanwick Type SLS for control and instrument cables. General Electric Type EB-27 for current transformer circuits.

2.09 CABLE IDENTIFICATION TAGS:

- A. Designed to provide a permanent wire and cable identification system.
- B. Show complete cable number. Cable numbers are defined in the Contract Drawings.
- C. Cable numbers shall be machine stamped or typed and shall be legible and permanent.
- D. Character size for cable numbers shall be a minimum of 1/8 inch.
- E. Material shall be nonmetallic and impervious to moisture.
- F. Be securely attached to cables and accessible for inspection.
- G. Cable identification tags, marking and attachment methods shall be subject to approval of the Engineer.
- H. All multi conductor cables shall have a wire identification tag at each termination point. This tag shall be typed, legible and permanent. The wire identification tag shall include the cable circuit number.
- I. Phase and Polarity Conductor Identification:
 1. Cables with insulation colors per ICEA Method 1, Table E-2, shall be identified with colored tape on the insulation at each end of the cable termination as indicated below:
 - a. 480Vac:
 - (1) Phase A – Black conductor taped Brown
 - (2) Phase B – Red conductor taped Orange
 - (3) Phase C – Blue conductor taped Yellow
 - (4) Ground – Orange conductor taped Green
 - (5) Neutral – Yellow conductor taped gray (for 277/480VAC)
 - b. 208Vac:
 - (1) Phase A – Black conductor
 - (2) Phase B – Red conductor
 - (3) Phase C – Blue conductor
 - (4) Ground – Orange conductor taped Green
 - c. 240Vac, 208Vac, & 120Vac single phase:
 - (1) Hot – Black conductor
 - (2) Neutral – Red conductor taped White
 - (3) Ground – Blue conductor taped Green
 - d. 125Vdc:
 - (1) Positive – Red conductor
 - (2) Negative – Black conductor
 - (3) Ground – Blue conductor taped Green

2. Cables with insulation colors per ICEA Method 4 shall be identified with colored tape on the insulation at each end of the cable termination as indicated below:
 - a. 480Vac:
 - (1) Phase A – Brown
 - (2) Phase B – Orange
 - (3) Phase C – Yellow
 - (4) Ground – Green
 - (5) Neutral – Gray (for 277/480VAC)
 - b. 208Vac:
 - (1) Phase A – Black
 - (2) Phase B – Red
 - (3) Phase C – Blue
 - (4) Ground – Green
 - c. 240Vac, 208Vac, & 120Vac single phase:
 - (1) Hot – Black
 - (2) Neutral – White
 - (3) Ground – Green
 - d. 125Vdc:
 - (1) Positive – Red
 - (2) Negative – Black
 - (3) Ground – Green

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Wire and Cable:

1. General Requirements:
 - a. Install in conduit, cable tray or duct system as indicated.
 - b. Do not subject cable to pulling tensions or sidewall pressures more than manufacturer's recommendations.
 - c. Attach pulling grips over the cable sheath to prevent slipping of the insulation.
 - d. Do not subject cable to bending radius less than those recommended by the cable manufacturer or as noted below (whichever is greater) during or after installation:
 - (1) Eight times the cable outside diameter for 600V or lower rated cables.
 - e. Install intermediate splices only as indicated or as required to avoid subjecting cable to excessive pulling tension or sidewall pressures. Cable splicing locations shall be approved by Engineer prior to cable installation.
 - f. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.
 - g. Install cable supports in vertical and angular runs of tray or conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of National Electrical Code (NEC).
 - h. All pulling compounds shall be approved by wire and cable manufacturer as being compatible with cable materials according to IEEE 1210.
 - i. Attach a cable identification tag to each cable at all termination or end points.
 - j. Contractor shall provide a load cell tension monitoring device to aid the Contractor in assuring that cable pulling tension limits are not being exceeded. In addition, the Contractor shall monitor, and record individual cable pulls as requested by the

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resident project representative to assure compliance with the cable limitations as published by the cable manufacturer.

- k. All wire and cable installation shall comply with the applicable parts of the National Electrical Code (NEC).
 - l. Contractor shall test each wire for ground or shorts after installation but before any connections are made.
 - m. There shall be at least 12 inches of excess control or low-voltage wire remaining at all terminal blocks to allow connections or splices to be made.
2. Power (600V and Below), Control, Instrument, and Specialty Cable:
- a. Install metallic barrier in all cable tray and boxes to separate from each other, power, control and instrumentation from low-level signal (50V or less) instrumentation circuits where run in the same cable tray or box.
 - b. Secure with cable ties in cable tray risers at intervals not to exceed 3 feet.
 - c. Tie together with cable ties all single conductor cable on each individual circuit in each junction box, equipment or manhole, and in cable tray, at intervals not to exceed 6 feet.
 - d. At PLC (DCS) cabinets, strip the cable jackets back to within 6 inches of cabinet entry point (to allow cable number label to be affixed) and insulate all cable shields. Provide enough excess cable to allow all conductors to reach any terminal point within the cabinet following an orthogonal route. (No diagonal routing allowed.)
 - e. Control and instrument cable splices shall be as follows:
 - (1) Made only in junction or terminal boxes.
 - (2) Made on terminal blocks.
 - (3) Conductor color coding shall be maintained.
 - (4) For shielded cables, shield continuity, and isolation shall be maintained.
 - (5) Wire identification markers shall be installed at each splice.
 - f. Power cable (600V or below) splices and motor terminations shall be as follows:
 - (1) Made only in junction or terminal boxes.
 - (2) Splices shall be made using compression type connectors bolted together.
 - (3) Splice to be covered with a cold-shrink connector insulator.
 - (4) Wire identification markers shall be installed at each splice.
 - g. Terminate and ground control, instrument, and specialty cable shields as indicated and recommended by the manufacturer of the equipment being connected.
 - h. Ground Cable: Install as specified in Section 26 05 26.
 - i. Fiber-Optic Cable:
 - (1) Follow manufacturer's recommendations regarding:
 - (a) Maximum tensile load.
 - (b) Maximum static tensile.
 - (c) Minimum bending radius.
 - (d) Maximum crushing force.
 - (e) Maximum impact.
 - (f) Harmful liquids and/or gases.
 - (g) Temperature and humidity limitations.
 - (2) Install pull boxes not to exceed 300 feet apart in long runs to reduce the amount of cable that needs to be pulled at any one time.
 - (3) Use elbow fittings for right-angle bends.

- (4) Pull box openings shall be at least four times the minimum bend radius of the cable.
 - (5) All fiber optic cable shall be protected with inner duct. After installation, inner ducts are to be permanently labeled as containing fiber optic cable.
 - (6) All fiber optic cable and inner duct shall be fully supported throughout its entire run.
 - (7) At no time shall more than the manufacturer's recommended pulling tension be placed on any fiber optic cable while it is being pulled through cable tray or conduit. It is preferred that all fiber optic cable be pulled with hand power only. If power winches or mechanical advantage devices are used to pull cable, a tensionometer must be used to ensure that maximum tension is not exceeded. Alternatively, a "mechanical fuse," rated at the manufacturer's maximum recommended pulling tension may be included in the linkage. Torsion shall be avoided by use of a swivel at the cable end. While under tension, a minimum bend radius of 20 times the outside cable diameter shall be maintained through use of pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.
 - (8) Terminate each individual strand of fiber optic cable.
 - (9) Install connectors on each spare strand of fiber optic cable.
3. Cable Connections and Terminations:
- a. Make up clean and tight to assure a low-resistance joint.
 - b. Make only in terminal boxes, equipment or other accepted enclosures and not in conduit or cable tray.
 - c. No more than two wires shall be terminated on one screw.
 - d. Install all connectors with tooling UL approved for use on connectors installed.

END OF SECTION 26 05 04

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	BC2 B&McD TYPE:	NEC TYPE:
BARE COPPER GROUND CABLE <u>GENERAL REQUIREMENTS:</u> CONDUCTOR Annealed, coated (tinned), bare copper (ASTM B33). <u>SPECIFIC REQUIREMENTS:</u> 1. Solid in sizes 4 AWG and smaller. 2. Class B stranded in sizes 2 AWG and larger (ASTM B8).		

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	CEV1 B&McD TYPE:	TC NEC TYPE:
600 VOLT - MULTI-CONDUCTOR CONTROL CABLE		
<u>GENERAL REQUIREMENTS:</u>		
CONDUCTOR:	Class B stranded annealed copper per ASTM B8.	
INSULATION:	30 mils of flame retardant cross-linked polyethylene "XLPE" and rated as Type XHHW-2 per UL 44.	
COLOR CODE:	Per ICEA S-73-532, Appendix E, Method 1, Table E-2.	
CABLE JACKET:	Lead free, flame retardant, polyvinyl chloride "PVC" (ICEA S-73-532/NEMA WC57 and UL1277).	
IDENTIFICATION:	Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number and size of conductors, voltage rating, and numbered footage markers.	
<u>SPECIFIC REQUIREMENTS:</u>		
TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 90°C --- Continuous, wet and dry locations	
FACTORY TESTS:	1. All cable shall be tested in accordance with requirements of ICEA S-73-532/NEMA WC57. 2. The cable shall meet the requirements of IEEE 1202. 3. The singles of the multi conductor cables shall meet the requirements of UL 44 VW-1 flame test.	
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57, UL44 XHHW-2, and UL 1277 TYPE TC-ER	

	WIRE AND CABLE SPECIFICATION SHEET	
	CRN(*) B&McD TYPE:	TC-ER NEC TYPE:

600 VOLT - MULTI-CONDUCTOR CONTROL CABLE

GENERAL REQUIREMENTS:

CONDUCTOR: 10AWG, 12AWG or 14AWG Class B tinned stranded annealed tinned copper per ASTM B8, B33.

INSULATION: 30 mils of flame retardant Ethylene-Propylene "EP" (ICEA S-73-532/NEMA WC57).

COLOR CODE: Per ICEA S-73-532, Appendix E, Method 1, colors per Cable Type Table below.

SHIELD: Per Cable Type Table below.

CABLE JACKET: Lead free, flame retardant, thermoplastic chlorinated polyethylene "CPE" (ICEA S-73-532/ NEMA WC57).

IDENTIFICATION: Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number and size of conductors, voltage rating, and numbered footage markers.

Cable Type Table

*B&McD Type	SHIELD	COLOR CODE (ICEA S-73-532 Table)
CRN1	None	E-2
CRN1A	None	E-1
CRN2	Aluminized polyester tape and tinned copper drain wire.	E-2
CRN2A	Aluminized polyester tape and tinned copper drain wire.	E-1
CRN3	5 mil tinned Cu tape applied helically over the core assembly w/ 20% min overlap.	E-2
CRN3A	5 mil tinned Cu tape applied helically over the core assembly w/ 20% min overlap.	E-1

SPECIFIC REQUIREMENTS:

TEMP. RATING: Cable shall be suitable for operation under the following maximum conductor temperature:
90°C --- Continuous, wet or dry locations

FACTORY TESTS:

1. All cable shall be tested in accordance with requirements of ICEA S-73-532/NEMA WC57.
2. The cable shall meet the requirements of IEEE 1202.
3. The singles of the multi conductor cables shall meet the requirements of UL 44 VW-1 flame test.

CERTIFICATION: Cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57, UL44 XHHW-2, and UL 1277 TYPE TC-ER

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	DAT6P B&McD TYPE:	NEC TYPE:
CATEGORY 6 – PLENUM-RATED COMMUNICATIONS CABLE <u>GENERAL REQUIREMENTS:</u> CONDUCTORS: Bare solid copper conductors, 23 AWG. 4 unshielded twisted pairs. INSULATION: Thermoplastic. CABLE JACKET: Flame Retardant Polyvinyl Chloride (PVC). IDENTIFICATION: TIA Category 6 cable. FLAME RATING: Cable should have a plenum rating that meets all requirements described in NFPA 262. <u>SPECIFIC REQUIREMENTS:</u> TEMP. RATING: Operating range of -20°C to +75°C. BANDWIDTH: Up to 250 MHZ. APPLICATIONS: IEEE 802.3: 10BASE-T, 100BASE-TX, 1000BASE-T. FACTORY TESTS: All cable shall be tested in accordance with requirements of ANSI/TIA 568-C.2. CERTIFICATION: Cables shall be certified to be in compliance with all applicable requirements of ANSI/TIA 568-C.2.		

		WIRE AND CABLE SPECIFICATION SHEET	
		HRL1 B&McD TYPE:	MV105 NEC TYPE:
15,000 VOLT - SINGLE CONDUCTOR - SHIELED - POWER CABLE			
GENERAL REQUIREMENTS:			
CONDUCTOR:	Class B compact (Per ASTM B496) or compressed (Per ASTM B8) annealed bare copper strand.		
STRAND SHIELD:	Extruded layer of semi-conducting thermoset compound.		
INSULATION:	Ethylene-propylene “EPR”, 133%, Nominal Insulation Thickness 220 mils. It shall be triple extruded with the conductor and insulation shield.		
INSULATION SHIELD:	Extruded layer of semi-conducting thermoset compound.		
METALLIC SHIELD:	Helically applied 5 mil bare copper tape with a minimum 25% overlap.		
CONDUCTOR JACKET:	Black, low smoke, low halogen, oil-resistant polymeric jacket conforming to the requirements of ICEA T-33-655.		
IDENTIFICATION:	Surface printing on the cable shall show manufacturer’s name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers.		
SPECIFIC REQUIREMENTS:			
TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 105°C --- Continuous, wet or dry locations 140°C --- Emergency 250°C --- Short Circuit		
LISTINGS:	UL 1072 Type MV-105 ICEA S-93-639 / NEMA WC74. ICEA T-33-655. AEIC CS8 SUN RES, FOR CT USE		
FLAME TESTS:	UL 1685 Vertical Flame Test IEEE 1202 / CSA FT-4 (70,000 BTU Flame Test)		

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	IEV1 B&McD TYPE:	TC NEC TYPE:

600 VOLT - SHIELDED INSTRUMENT CABLE
(WITH SHIELDED TWISTED PAIRS)

GENERAL REQUIREMENTS:

CONDUCTOR: Class B stranded annealed copper per ASTM B3, B8.

INSULATION: Cross-linked polyethylene "XLPE" (ICEA S-73-532/NEMA WC57) and rated as UL 44 Type XHHW-2.

COLOR CODE: Per ICEA S-73-532 Appendix E, Method 9 per Cable Type Table below and Note 1.

PAIR/TRIAD SHIELD: Per Cable Type Table below.

CABLE SHIELD: Per Cable Type Table below.

CABLE JACKET: Lead free, flame retardant, polyvinyl chloride "PVC" (ICEA S-73-532/NEMA WC57 and UL1277).

IDENTIFICATION: Surface printing on the cable shall show manufacturer's name, insulation type, jacket type, number and size of conductors, voltage rating, and numbered footage markers.

Cable Type Table

*BMcD Type	Size (AWG)	Pair shield	Cable shield	Color Code (ICEA S-73-532)
IEV1	16PR	Aluminized polyester tape and tinned Cu drain wire.	Aluminized polyester tape and tinned Cu drain wire.	Note 1 below

Note 1: Pairs shall be colored black & white. Multiple pairs shall be numbered per Method 9.

SPECIFIC REQUIREMENTS:

TEMP. RATING: 90°C --- Continuous, wet or dry locations

JACKET THICKNESS: Jacket thickness shall be in accordance with ICEA S-73-532/NEMA WC57.

CABLING: Pairs twisted per ICEA S-73-532/NEMA WC57.

FACTORY TESTS:

1. All cable shall be tested in accordance with requirements of ICEA S-73-532/NEMA WC57.
2. All cables and singles of multi-conductor cables supplied shall meet the requirements of UL 1277.

CERTIFICATION: Cables shall be certified to be in conformance with all applicable requirements of ICEA S-73-532/NEMA WC57.

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	SEV1 B&McD TYPE:	XHHW-2 NEC TYPE:
600 VOLT – SINGLE CONDUCTOR POWER CABLE		
GENERAL REQUIREMENTS:		
CONDUCTOR:	Class B or C stranded annealed copper per ASTM B8.	
INSULATION:	Cross-linked polyethylene “XLPE” (UL44) rated as Type XHHW-2.	
CABLE JACKET:	Polyvinyl chloride “PVC” (UL44) and rated for outdoor use.	
IDENTIFICATION:	Surface printing on the cable shall show manufacturer’s name, cable type, insulation type (XHHW-2), number and size of conductors, voltage rating and Underwriters Laboratories label (UL).	
SPECIFIC REQUIREMENTS:		
TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 90°C --- Continuous, wet or dry locations	
INSULATION THICKNESS:	Insulation thickness shall be in accordance with UL 44 Type XHHW-2 and ICEA S-95-658/NEMA WC70.	
JACKET THICKNESS:	Jacket thickness shall be in accordance with UL 44 and ICEA S-95-658/NEMA WC70.	
FACTORY TESTS:	All cable shall be tested in accordance with requirements of UL 44.	
CERTIFICATION:	1. Cables shall be certified to be in conformance with all applicable requirements of UL44. 2. Sizes 1/0 and larger shall meet the flame test requirements of UL 1685 and shall be marked “FOR CT USE”.	

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	SEV2 B&McD TYPE:	TC-ER NEC TYPE:
600 VOLT - MULTI-CONDUCTOR POWER CABLE		
GENERAL REQUIREMENTS:		
CONDUCTOR:	Class B or C bare stranded annealed copper per ASTM B8.	
INSULATION:	Cross-linked polyethylene “XLPE” (UL44) and rated as Type XHHW-2. Color coding shall be Method 1 (ICEA S-73-532) using pigmented compounds with colors as designated by Table E-2.	
CABLE JACKET:	Lead Free, Flame Retardant, Polyvinyl chloride “PVC” (UL1277) and rated for outdoor use.	
IDENTIFICATION:	Surface printing on the cable shall show manufacturer’s name, cable type (TC-ER), insulation type (XHHW-2) number and size of conductors, voltage rating and Underwriters Laboratories label (UL).	
SPECIFIC REQUIREMENTS:		
TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 90°C --- Continuous, wet or dry locations	
INSULATION THICKNESS:	Insulation thickness shall be in accordance with UL 44 Type XHHW-2 and ICEA S-95-658/NEMA WC70.	
JACKET THICKNESS:	Jacket thickness shall be in accordance with UL 1277 and ICEA S-95-658/NEMA WC70.	
FACTORY TESTS:	All cable shall be tested in accordance with requirements of ICEA S-95-658 and of UL 1277. a) All cables shall meet the flame test requirements of IEEE1202. b) All single conductors shall pass the UL44 VW-1 flame test.	
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of UL44, UL 1277 TYPE TC-ER, ICEA S-95-658/NEMA WC70.	

Burns & McDonnell Engineering Company Engineers - Architects - Consultants Kansas City, Missouri	WIRE AND CABLE SPECIFICATION SHEET	
	VFD B&McD TYPE:	TC-ER NEC TYPE:
600 VOLT - 3 CONDUCTOR POWER CABLE WITH 3 SYMMETRICAL GROUNDS		
<u>GENERAL REQUIREMENTS:</u>		
CONDUCTOR:	Class B stranded annealed copper per ASTM B8.	
INSULATION:	Cross-linked polyethylene “XLPE” (ICEA S-95-658) and color coded per ICEA Method 4.	
CABLE JACKET:	Lead Free, Flame Retardant, Polyvinyl chloride “PVC” (UL1277).	
GROUND WIRE:	3 symmetrical uninsulated Class B stranded annealed copper.	
TAPE SHIELD:	Helically applied 5 mil bare copper tape with a minimum 25% overlap.	
FILLER:	Cable with non-hygroscopic, fillers where necessary to assure roundness.	
IDENTIFICATION:	Surface printing on the cable shall show manufacturer’s name, cable type (XHHW-2), insulation type, jacket type, number and size of conductor, voltage rating, and Underwriters Laboratories label (UL).	
<u>SPECIFIC REQUIREMENTS:</u>		
TEMP. RATING:	Cable shall be suitable for operation under the following maximum conductor temperatures: 90°C --- Continuous, wet or dry locations 130° --- Emergency 250° --- Short Circuit	
INSULATION THICKNESS:	Insulation thickness shall be in accordance with UL 44 Type XHHW-2 and ICEA S-95-658/NEMA WC70.	
GROUND WIRE SIZE:	Ground wires shall be stranded copper per ASTM B8 sized in accordance with UL 1277.	
JACKET THICKNESS:	Jacket thickness shall be in accordance with UL 1277 and ICEA S-95-658/NEMA WC70.	
FACTORY TESTS:	All cable shall be tested in accordance with requirements of ICEA S-95-658 and of UL 1277. 1. All cables shall meet the flame test requirements of IEEE1202. 2. All single conductors shall pass the UL44 VW-1 flame test.	
CERTIFICATION:	Cables shall be certified to be in conformance with all applicable requirements of UL44, UL 1277 TYPE TC-ER, ICEA S-95-658/NEMA WC70.	

POWER CONTROL & INSTRUMENT CABLE

VOLTAGE CLASS OR USE

H - 15-KV POWER
P - 5-KV POWER
S - 600-V POWER
C - CONTROL
I - INSTRUMENT

SPECIFIC CONSTRUCTION

1 - BASIC CONSTRUCTION TYPE
2 - A VARIATION OF THE BASIC CONSTRUCTION TYPE
3 - ANOTHER VARIATION OF THE BASIC CONSTRUCTION TYPE
4 - ETC.

SEV1

CONDUCTOR INSULATION

E - CROSS-LINKED POLYETHYLENE
P - POLYETHYLENE
R - ETHYLENE PROPYLENE OR SILICON RUBBER
T - POLYESTER TABLE
V - POLYVINYL CHLORIDE
F - FLUOROPOLYMER OR FLUOROCARBON RESINS

CABLE OVERALL JACKET

N - NEOPRENE, HYPALON OR CHLORINATED POLYETHYLENE
P - POLYETHYLENE
V - POLYVINYL CHLORIDE
F - FLUOROPOLYMER OR FLUOROCARBON RESINS
L - LOW SMOKE, ZERO HALOGEN

SPECIALTY CABLE

BC2

CLASS OR USE

BC - BARE COPPER
PF - PREFABRICATED ASSEMBLY
HT - HIGH TEMPERATURE
IC - INTERCOM
ME - MINERAL INSULATED
SW - SWITCHBOARD WIRE

SPECIFIC CONSTRUCTION

1 - BASIC CONSTRUCTION TYPE
2 - A VARIATION OF THE BASIC CONSTRUCTION TYPE
3 - ANOTHER VARIATION OF THE BASIC CONSTRUCTION TYPE
4 - ETC.

TCE

TC - THERMOCOUPLE EXTENSION WIRE

J - IRON/CONSTANTAN
K - CHROMEL/ALUMEL
T - COPPER/CONSTANTAN
E - CHROMEL/CONSTANTAN

RG8

RG - COAXIAL CABLE

NUMBER FOLLOWING RG PREFIX DESIGNATES SPECIFIC RG TYPE



date 04/10/26

designed J. BAYER

PROJECT NAME

SECTION 26 05 00 EXHIBIT A
CABLE TYPE
DESIGNATIONS
(SHEET 1 OF 2)

project

XXXXX

contract

5.XXXX

dwg. no.

rev.

EXHIBIT 26 05 00-A — 0

FIBER OPTICS CABLE

CLASS OR USE

FIB - FIBER OPTIC
DAT - DATA CABLE

SPECIFIC CONSTRUCTION

- 1 - BASIC CONSTRUCTION TYPE
- 2 - A VARIATION OF THE BASIC CONSTRUCTION TYPE
- 3 - ANOTHER VARIATION OF THE BASIC CONSTRUCTION TYPE
- 4 - ETC.

FIB1



date 03/06/26

designed J. BAYER

PROJECT NAME

**SECTION 26 05 00 EXHIBIT A
CABLE TYPE
DESIGNATIONS
(SHEET 2 OF 2)**

project

XXXXX

contract

5.XXXX

dwg. no.

rev.

EXHIBIT 26 05 00-A — 0

SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

- 1.01 RELATED DOCUMENTS:
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- 1.02 SUMMARY:
- A. This Section includes the following:
 - 1. Buried ground grids and ground rods for the main plant, chimney, miscellaneous yard structures, manholes, and duct banks, including ground risers coiled above grade from the grids. Maximum acceptable resistance of grid shall be between 1 and 5 Ohms.
 - 2. Connection of ground risers from the buried ground grid to structures and equipment at grade level.
 - 3. Extension and connection of ground risers to structures, equipment, raceways, and grounding systems above grade level.
- 1.03 RELATED REQUIREMENTS:
- A. Section 26 05 04 - Wire, Cable, and Accessories.
 - B. Section 26 08 00 - Field Testing.
- 1.04 REFERENCE STANDARDS:
- A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
 - B. Applicable Standards:
 - 1. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
 - 2. American Society for Testing and Materials (ASTM):
 - a. B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 3. Underwriters Laboratories (UL).
 - a. 467 – UL Standard for Safety Grounding and Bonding Equipment.
 - 4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. IEEE C2 - National Electrical Safety Code.
- 1.05 SUBMITTALS:
- A. Submit as specified in Division 01.
 - B. Includes, but not limited to, catalog cuts for the following:
 - 1. Cable.
 - 2. Ground Rods.
 - 3. Connection Materials.
 - 4. Miscellaneous Grounding Equipment.

PART 2 - PRODUCTS

- 2.01 ACCEPTABLE MANUFACTURERS:
- A. Ground Rods:
 - 1. Erico.

2. Thomas & Betts.
 3. Hubbell.
 - B. Connection Materials:
 1. Exothermic-Type Welding Process:
 - a. Erico (Cadweld).
 - b. Tectoweld.
 2. Compression-Type Connectors:
 - a. AMP.
 - b. Burndy.
 - c. Thomas & Betts.
 3. Cable-to-Equipment Ground Lugs and hardware.
 - a. Burndy.
 - b. O-Z/Gedney.
 - C. Ground Bus Bars and Cast Ground Plates:
 1. Burndy.
 2. Erico.
 - D. Static Grounding Reel:
 1. Appleton Electric Company.
 2. Hubbel-Gleason
- 2.02 WIRE AND CABLE:
- A. Type BC2 and/or other, as specified in Section 26 05 04.
 - B. Conductor Sizes:
 1. As specified for specific connections.
 2. For connections specified but sizes not indicated, use conductor sizes which conform to NEC, except use minimum 1/0 AWG if buried in earth or cast in concrete, and minimum No. 6 AWG at other locations.
- 2.03 GROUND RODS:
- A. Copper-clad steel or copper-alloy sectional-type rods.
 - B. One end pointed to facilitate driving.
 - C. 3/4-inch diameter and furnished in 10-foot sections with diameter and total length stamped near top of rod.
 - D. Provide 10-foot ground rods except where otherwise indicated.
- 2.04 CONNECTION MATERIALS:
- A. Cable-to-cable, cable-to-rod, and cable-to-steel connections.
 1. Exothermic-type welding process.
 - B. Cable-To-Equipment Ground Lugs:
 1. Bolted Type:
 - a. Copper alloy terminal with twin clamping element.
 - b. Bolted to equipment housing with silicon bronze bolts and lock washers.
 - c. Burndy "QIKLUG" type QQA.
 2. Split-Bolt Type:
 - a. Only where indicated, or where approved by the Resident Project representative.
- 2.05 MISCELLANEOUS GROUNDING EQUIPMENT:
- A. Structural Steel Column Ground Pad: If indicated.

2.06 COAL TAR EPOXY COATING:

- A. Carboline Bitumastic No. 300M.
- B. Tnemec Tneme-Tar 46H-413.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Wire and Cable:
 - 1. General:
 - a. Install using as few joints as possible.
 - b. Protect against unraveling, caging, and abrasion by several wrappings of plastic tape on all ends, where cable leaves concrete, and at necessary intermediate points.
 - c. Install so as not to be entirely encircled or closely encircled by magnetic material.
 - d. Suitably protect against damage during construction. Replace or suitably repair cable at Owner's discretion if cable is damaged by anyone before final acceptance.
 - 2. In Exposed Installations:
 - a. Route runs as indicated, or as required by the NEC.
 - b. Route along the webs of columns and beams, and in corners where possible for maximum physical protection.
 - c. Support at intervals of 3 feet or less with metallic nonmagnetic clamp-type supports; clamps of magnetic material may be used provided they do not completely encircle the conductor.
 - 3. In Buried Installations:
 - a. Exothermic-type welded connection, unless otherwise indicated.
 - b. Install at the depths specified or indicated. Otherwise install at least 30 inches below finished grade or deeper if necessary, in order to be in contact with earth.
 - c. Maintain clearance of at least 3 feet from all underground metal piping or structures where possible, otherwise tape all ground conductors within this clearance.
 - d. Backfill with excavated earth free from frozen material, rocks, or stones. Thoroughly compact backfill.
- B. Ground Rods:
 - 1. Install rods where indicated by driving and not by drilling or jetting.
 - 2. Drive rods into unexcavated earth wherever possible.
 - 3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
 - 4. Drive to a depth such that top of rods will be approximately 30 inches below final grade, or subgrade, and connect to the buried grid ground conductors.
- C. Connections:
 - 1. Conform to manufacturer's instructions.
 - 2. Chemically degrease and dry completely before welding.
 - 3. Apply coal tar epoxy coating to all exothermic-welded connections to be buried after checking of connections by the Resident Project Representative.
 - 4. Make up bolted connections clean and tight.
 - 5. Low-resistance connections with resistance drop not exceeding 1 ohm.
 - 6. Do not cover up connections before they are inspected by the Resident Project Representative.
 - 7. For ground pads and plates, clean mating surface and apply water resistant electrical contact grease.
- D. Buried Ground Grid:

1. Install where indicated and as specified.
 2. Use 4/0 AWG ground conductor, unless otherwise indicated.
 3. Install beneath a minimum of 30 inches of earth cover or deeper if necessary in order to avoid structures such as foundations, caissons, and buried piping.
- E. Equipment Grounds (except motors):
1. Ground major electrical equipment as specified or indicated.
 2. Use 4/0 AWG ground conductor, unless otherwise indicated.
 3. Ground other equipment wired by this Contract as specified, indicated, or as required by the NEC.
 4. Connect ground risers where indicated.
 5. Provide direct copper connections to the buried ground grid via nearest accessible copper ground conductor; i.e., cable tray grounds or other equipment grounds.
 6. Ground electrical system neutrals using 4/0 AWG ground conductor unless otherwise indicated.
 7. Install so as not to be susceptible to mechanical damage during operation or maintenance of equipment.
- F. Isolated Instrument Grounds:
1. For enclosures containing shielded instrument signals, provide a separate insulated instrument ground cable riser.
 2. The instrument ground cable shall be electrically isolated from the equipment safety ground except for a single split-bolt connection to the buried ground grid, external to the enclosure.
 3. Ground all instrument shields to the instrument ground bus within the enclosure(s).
- G. Motor Grounds:
1. Ground motors as specified, indicated, or as required by the NEC.
 2. Connect ground risers where indicated.
 3.

<u>Motor Rating</u>	<u>Ground Conductor</u>
10 horsepower and less	Conduit (including flexible conduit at motor-flexible conduit shall be 1-1/4 inches or smaller, length 6 feet or less and fittings approved for grounding equipment).
15 horsepower to 60 horsepower	Conduit (including flexible conduit at motor, with external No. 6 AWG ground jumper).
75 horsepower to 3,000 horsepower	Minimum 2/0 copper conductor (usually riser from buried ground grid of same size as grid).
- H. Structural Steel Grounds:
1. Ground risers to structural steel shall be the same conductor size as the buried ground grid.
 2. Use exothermic-type welding process for connections and install as indicated.
 3. Install No. 2 AWG bonding jumpers where stairways, handrails, and metal grating are not effectively grounded through the building structural steel. Comply with UL 467.
 4. Utilize structural steel column ground pad if indicated.

- I. Metallic Conduit Grounds:
 - 1. Ground at all terminal points.
 - 2. When a conduit contains a power cable, ground conduit to cable tray using a UL approved grounding bushing connected to the ground conductor on the cable tray.
 - 3. When a conduit contains a control or instrumentation cable, ground conduit to cable tray by a tight, mechanical, UL approved connector.
 - 4. Where extending into floor-mounted equipment from below, connect to equipment ground bus or frame.
 - 5. Where extending into a manhole, handhole, cable trench, or nonmetallic box, connect to the ground conductor at that location using grounding bushings.
 - 6. At locations where a pull box is installed on a conduit riser, install insulated grounding bushings and make proper connections to the ground grid for all conduits.
- J. Cable Tray Grounds:
 - 1. Ground with a continuous No. 2 AWG ground conductor clamped to the tray at one point in each prefabricated length of tray, at intervals not to exceed 20 feet.
 - 2. Connect tray ground conductor to the power station ground grid at a minimum of two locations using No. 2 AWG ground conductor, at intervals not to exceed 100 feet.
- K. Box Grounds: Unless grounded by conduit system, ground all boxes by direct copper connection to the buried ground grid system. All duct bank riser pull boxes shall have a direct bolted ground cable connection to the duct bank ground cable system.

3.02 FIELD QUALITY CONTROL - Specified in Section 26 08 00.

END OF SECTION 26 05 26

SECTION 26 05 33 – CONDUIT AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes all conduit, fittings, boxes, and accessories as specified or indicated.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM A123 - Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products.
 - b. ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - d. ASTM A668 - Steel Forgings, Carbon and Alloy, for General Industrial Use.
 - e. ASTM B241 - Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
 - f. ASTM F512 - Smooth-Wall, Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
 - 2. Federal Specifications (FS):
 - a. W-C-1094 - Conduit and Conduit Fittings, Plastic, Rigid.
 - b. WW-C-00540 - Conduit, Metal, Rigid and Coupling Elbow and Nipple, Electrical Conduit, Aluminum.
 - c. WW-C-566 - Conduit, Metal, Flexible.
 - d. WW-C-581E - Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit, Steel, Zinc Coated.
 - 3. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code (NEC).
 - 4. National Electrical Manufacturers' Association (NEMA):
 - a. NEMA C80.1 - Electrical Rigid Steel Conduit.
 - b. NEMA C80.3 - Steel Electrical Metallic Tubing.
 - c. NEMA C80.5 - Electrical Rigid Aluminum Conduit.
 - d. NEMA C80.6 - Electrical Intermediate Metal Conduit.
 - e. NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable Assemblies.
 - f. NEMA TC2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40) and (EPC-80).
 - g. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - h. NEMA TC6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
 - i. NEMA TC9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
 - j. NEMA TC14 - Filament Wound Reinforced Thermosetting Resin Conduit and Fittings.
 - k. NEMA RN1 - PolyVinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 5. Underwriters' Laboratories, Inc. (UL):
 - a. UL 1 - Flexible Metal Conduit.

- b. UL 6 - Electrical Rigid Metal Conduit - Steel.
- c. UL 467 - Grounding and Bonding Equipment.
- d. UL 514A - Metallic Outlet Boxes.
- e. UL 514B - Conduit, Tubing, and Cable Fittings.
- f. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
- g. UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
- h. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.
- i. UL 797 - Electrical Metallic Tubing - Steel.
- j. UL 886 - Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
- k. UL 2420 - Belowground Reinforce Thermosetting Resin Conduit (RTRC) and Fittings.
- l. UL 2515 - Aboveground Reinforce Thermosetting Resin Conduit (RTRC) and Fittings.

1.04 SUBMITTALS:

- A. Submit as specified in Division 01.
- B. Includes, but not limited to, the following:
 - 1. Catalog cuts.
 - 2. Reproducible "Record Drawings" showing installation details (conduit size and location dimensions) for all conduits which are concealed, cast-in-concrete, buried, and home run circuits.

1.05 JOB CONDITIONS:

- A. Consider all other locations to be nonhazardous unless otherwise required by NEC or other applicable standards or as indicated.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Rigid Steel Conduit:
 - 1. Allied Tube and Conduit Corporation.
 - 2. Triangle Wire and Cable.
 - 3. Republic Conduit.
 - 4. Wheatland Tube Company.
 - 5. Western Tube and Conduit Corp.
 - 6. OCAL, Inc.
- B. Intermediate Metal Conduit:
 - 1. Allied Tube and Conduit Corporation.
 - 2. Republic Conduit.
 - 3. Triangle Wire and Cable.
 - 4. Wheatland Tube Company.
- C. Rigid Steel Conduit with Bonded Polyvinyl Chloride (PVC) Jacket:
 - 1. Robroy Industries.
 - 2. OCAL, Inc.
- D. Rigid Aluminum Conduit:
 - 1. Consolidated Aluminum Corporation (CONALCO).
 - 2. V.A.W. of America, Inc.
 - 3. New Jersey Aluminum Company.
 - 4. Phelps Dodge Cable and Wire Company.

- E. Electrical Metallic Tubing:
 - 1. Allied Tube and Conduit Corporation.
 - 2. Triangle Wire and Cable.
 - 3. Republic Conduit.
 - 4. Wheatland Tube Company.
 - 5. Western Tube and Conduit Corp.
- F. Rigid Nonmetallic Conduit:
 - 1. Polyvinyl Chloride (PVC) Conduit
 - a. Carlon Products Division, Continental Oil Company.
 - b. Certain-Teed Products Corporation.
 - c. FRE Composites.
 - d. Allied Tube and Conduit.
 - 2. Reinforced Thermosetting Resin Conduit (RTRC)
 - a. Champion Fiberglass
 - b. FRE Composites
 - c. United Fiberglass
- G. Flexible Steel Conduit:
 - 1. Flexible Technology Corp.
 - 2. Electri-flex Company.
 - 3. International Metal Hose Company.
- H. Conduit Fittings for Rigid Metallic Conduit:
 - 1. Heavy-duty Fittings:
 - a. Appleton Electric Company.
 - b. Crouse-Hinds Company.
 - c. O. Z. Gedney Company.
 - 2. Conduit Expansion and Deflection Fittings:
 - a. O. Z. Gedney Company.
 - 3. Wall Entrance Seals:
 - a. O. Z. Gedney Company.
 - b. Spring City Electrical Mfg. Co.
- I. Conduit Boxes for Rigid Metallic Conduit:
 - 1. Hoffman Engineering Company.
 - 2. E. M. Wiegmann and Company.
- J. Hazardous Enclosures and Junction Boxes:
 - 1. Killark Electrical Manufacturing Co.
 - 2. Akron Electric, Inc.
 - 3. Crouse-Hinds Company.
 - 4. Appleton Electric Company.
 - 5. O.Z. Gedney Company.
- K. Supports:
 - 1. OCAL, Inc.
 - 2. Unistrut Products Corporation.
 - 3. Van-Huffel Tube Corporation, Power-Strut.
 - 4. Super Strut, Inc.
- L. Conduit Identification Tags:
 - 1. KC Plastic Laminating Company, Kansas City, Missouri.
 - 2. W. H. Brady Co.
 - 3. Electromark Company.

2.02 DESIGN REQUIREMENTS:

- A. Each length of conduit furnished with coupling on one end and metal or plastic thread protector on other end.
- B. UL listed and labeled on each conduit length, fitting, and accessory.
- C. Sizes of conduit, fittings, and accessories as indicated, specified, or as required by applicable standards.

2.03 RIGID STEEL CONDUIT:

- A. Mild ductile steel, circular in cross section with uniform wall thickness sufficiently accurate to cut clean threads.
- B. Each length threaded on both ends and threads protected by same process as used on each length.
- C. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
- D. Galvanized by the hot-dip process as follows:
 - 1. Interior and exterior surfaces coated with a solid, unbroken layer of 99% virgin zinc by dipping.
 - 2. Coating not to show fixed deposits of copper after four 1-minute immersions in a standard copper sulfate solution.
 - 3. One coat of zinc chromate finish on inside and outside surfaces to prevent oxidation and white rust.
- E. Couplings and elbows fabricated, coated, and finished by the same process as conduit.

2.04 INTERMEDIATE METAL CONDUIT:

- A. Lightweight rigid steel conduit.
- B. Fabricated from Grade 1010 steel and formed on an electric weld line.
- C. Each length threaded on both ends with threads protected.
- D. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
- E. Galvanized by the hot-dip process as described for rigid steel conduit.
- F. Compatible with standard rigid steel conduit fittings.
- G. For products used, special equipment shall not be required for field installation, standard bending, cutting or threading equipment, or hanging devices.

2.05 RIGID ALUMINUM CONDUIT:

- A. Fabricated from ASTM B241 alloy GS 10A, identical to Aluminum Association Alloy 6063.
- B. All scale, dirt, grease, burrs, and other foreign matter removed prior to applying coating.
- C. Entire length coated with a special silicone lubricating compound, compatible with wire and cable coverings, to minimize wire drag.
- D. Each length threaded at both ends.
- E. Threads protected with a homogenized zinc dust petroleum lubricating compound to prevent seizure.
- F. Coupling and elbows fabricated from the same material as conduit and each treated as required for conduit.
- G. Couplings may utilize Aluminum Association Alloy 3003 in lieu of Aluminum Association Alloy 6063.

2.06 ELECTRICAL METALLIC TUBING:

- A. High-grade steel manufactured to standards which assure maximum ductility.
- B. Exterior protected by electro-galvanizing process.
- C. Interior surface uniformly coated with aluminum lacquer or enamel.
- D. Final treatment of chromic acid to form a corrosion-resistant coating of zinc chromate on galvanized surfaces.
- E. Watertight compression-type fittings throughout.

2.07 RIGID NONMETALLIC CONDUIT:

- A. Polyvinyl Chloride (PVC):
 - 1. Fabricated from self-extinguishing high-impact polyvinyl chloride.
 - 2. Fittings and accessories fabricated from same material as conduit.
 - 3. Solvent-cement-type joints as recommended by manufacturer.
 - 4. Inside diameter no less than that of rigid steel conduit.
 - 5. Dielectric strength a minimum of 400V per mil.
 - 6. Rated and labeled for use with 90°C rated conductors.
- B. Reinforced Thermosetting Resin Conduit (RTRC):
 - 1. Conduit, fittings, and accessories shall consist of continuous E-glass roving encapsulated in a high temperature cured, corrosion resistant epoxy resin.
 - 2. Conduits, fittings and accessories shall be filament wound.
 - 3. All components shall be pigmented for UV resistance.
 - 4. All components shall be fire resistant to UL 94.
 - 5. Suitable for use at temperatures from -40°C (-40°F) to +110°C (+230°F).
 - 6. Solvent-cement type joints as recommended by the manufacture or integral urethane tri-seal gasket.

2.08 FLEXIBLE STEEL CONDUIT:

- A. Liquid-tight conduit with flexible galvanized-steel core and a polyvinyl chloride covering.
- B. For use in all areas except boiler front and high temperature area.
 - 1. Suitable for use in -20°C through 60°C.
 - 2. Suitable for oil-resistant applications.
- C. For use at the boiler front and high temperature areas (exceeding 60°C).
 - 1. Suitable for use in -17°C to +105°C, intermitting to +120°C.
 - 2. Suitable for oil-resistant applications.

2.09 CONDUIT FITTINGS FOR RIGID METALLIC CONDUIT:

- A. Heavy-Duty Cast Malleable Iron or Aluminum for All Types of Fittings:
 - 1. Mogul type for conduit sizes 1-1/2 inches and larger.
 - 2. LBD or roller action type LB for right angle fittings for conduit sizes 2 inches and larger.
 - 3. Full-threaded hubs and rubber-gasketed covers.
 - 4. Zinc, cadmium-plated, or bronze hardware bolts, screws, and bushings for assembly.
 - 5. Iron type fittings to be cadmium-plated or galvanized.
 - 6. Standard, junction fittings, couplings, and elbows fabricated from the same material as conduit, and each treated and coated as required for the conduit.
 - 7. All fittings and couplings shall be full-threaded type. Split or set screw types are not allowed.
- B. Conduit Expansion and Deflection Fittings:
 - 1. Expansion Fittings:
 - a. Galvanized expansion fittings for conduit movement up to 4 inches.

- b. Insulated metal bushing on ends of the conduit, bonding jumper, and with expansion head sealed with a high-grade graphite packing.
2. Deflection Fittings:
- a. Fitting shall provide for a movement of 3/4 inch from the normal in all directions. When used for angular movement, fitting shall allow for a deflection of 30 degrees from the normal in any direction.
- b. Fitting shall have copper alloy coupling at both ends, a neoprene sleeve with stainless-steel bands, and a tinned flexible copper braid bonding jumper internal to the neoprene sleeve and terminating on the copper alloy couplings.
- C. Wall Entrance Seals:
1. Type WSK for sealing around conduit passing through a wall.
- 2.10 CONDUIT BOXES FOR RIGID METALLIC CONDUIT:
- A. Steel Boxes:
1. Electrogalvanized steel boxes.
2. Galvanized steel covers.
3. Cadmium-plated or bronze screws and bolts.
- B. Aluminum boxes shall be self-oxidizing, self-renewing aluminum alloy that is "copper-free" (less than 0.3 of 1%) to assure resistance to corrosion.
- C. Stainless-steel boxes shall be of type 316 stainless steel.
- D. Minimum gauge requirements:
- | No surface
<u>area exceeds</u> | No single
<u>dimension exceeds</u> | <u>Steel (MSG)</u> | <u>Aluminum (B&S)</u> |
|-----------------------------------|---------------------------------------|--------------------|---------------------------|
| 360 sq. inches | 24 inches | 16 | 12 |
| 1,000 sq. inches | 40 inches | 14 | 10 |
| 1,500 sq. inches | 60 inches | 12 | 8 |
| over 1,500 sq. inches | over 60 inches | 10 | 6 |
- E. Provide threaded conduit entrances or waterproof hubs outdoors and in other areas subject to moisture.
- F. Include provisions for mounting cable supports where indicated, specified, or as required by NEC.
- 2.11 HAZARDOUS ENCLOSURES AND JUNCTION BOXES:
- A. Enclosures and junction boxes shall be suitable for the area classification where installed.
- B. Provide drains and breathers rated for the area classification.
- C. Include provisions for mounting cable supports where indicated, specified, or as required by the NEC.
- 2.12 SUPPORT SYSTEM:
- A. Use galvanized steel conduit clamps to support all exposed metallic conduit.
- B. Use nonmagnetic clamps to support nonmetallic conduits.
- C. Fabricate from structural steel or manufactured framing members equal to "Unistrut" P-1000 series as manufactured by Unistrut Corporation unless otherwise indicated.
- D. Provide all necessary rods, anchors, inserts, clamps, spacers, shims, bolts, and miscellaneous steel.

- E. Provide galvanized or cadmium-plated members.
- F. Use noncorrodible metal, galvanized metal, or cadmium-plated metal for nuts, bolts, washers, shims, and other small accessories.

2.13 CONDUIT IDENTIFICATION TAGS:

- A. Made by KC Plastic Laminating Company:
 - 1. Gothic, 3/4-inch, black characters on white background.
 - 2. Made of white flame-retardant PVC.
 - 3. "Permastick" adhesive and peel-off backing.
- B. Made by W.H. Brady Company:
 - 1. Numbers generated by the "Bintab Labeling System" with each conduit number on a continuous white background strip.
 - 2. Black letters on white background of 4-mil vinyl.
 - 3. Label size of 0.9 inches high and 4 inches wide.
 - 4. Text size of 0.7 inches high with 3 characters per inch.
 - 5. Furnish with outdoor numbers and letters:
 - a. B927 over-laminated for long lasting performance in all environments.
 - b. V826 permanent adhesive for cold weather installation.
 - c. UV resistant ink.
- C. Made by Electromark Company:
 - 1. Each conduit number generated on a continuous white background strip.
 - 2. C-1003 series with black letters on a white background of 6-mil polyester film.
 - 3. Label size of 1 inch high and 4 inches wide.
 - 4. Text size of 0.75 inches high with 3 characters per inch.
 - 5. Suitable for outdoor installation in all environments.
 - a. Long lasting performance in all environments.
 - b. Permanent adhesive for cold weather installation.
 - c. UV resistant ink.
 - d. Furnish with wrap around bands to ensure that the identification tags will not lift off.
- D. Engineer shall provide raceway numbers in an Excel database, if requested by Contractor.
- E. All raceways shall be labeled with the unique number included in the cable schedule.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. General Requirements:
 - 1. Location:
 - a. Install conduit as near as possible to the routing indicated.
 - b. Shift locations as required to avoid interference with other equipment and piping being installed.
 - 2. Furnish conduit in sizes indicated. Where sizes are not indicated, do not use conduit smaller than 3/4 inch, except 1/2 inch may be used for connection to control devices, thermocouple, and light fixture stem hangers where necessary.
 - 3. Size conduit in accordance with NEC requirements.
 - 4. Size conduit seal fittings as required by NEC so that cable fill shall not exceed 25% of the area of the fitting.
 - 5. Do not route conduits through cable tray openings in walls, floors, and similar openings.
 - 6. Holes and Sleeves:

- a. Unless indicated as being provided by others, provide through floors, walls, ceilings, and roofs as necessary for conduit runs, including weatherproofing at outside walls and on roofs.
 - b. Furnish sleeves for all holes and forms for all openings in new work.
 - c. Core drill all holes in existing work using a dustless method. All core drilling locations shall be approved by the Resident Project Representative or Owner before Work commences.
 - d. For sealing conduit penetrations, refer to Section 26 05 06.
 - e. Provide air seals for holes and openings in floors, walls, ceilings, and roofs between interior and exterior areas, and between temperature controlled and nontemperature controlled areas. Refer to Section 26 05 06.
 - f. Provide and install banding at all holes cut through existing or new openings in grating.
7. Make connections including any required punching to boxes, panels, and other equipment as follows:
 - a. Indoors: Double locknuts, one inside and outside.
 - b. Outdoors: Use threaded conduit fittings or waterproof hubs.
 - c. Due to wire sizing requirements, conduit sizes indicated may be larger than attachment means provided on equipment. In those instances, furnish necessary reducing fittings or boxes.
 8. Drill and tap motor main and auxiliary terminal boxes as required, and make connections as follows:
 - a. Indoors: Double locknuts, one inside and one outside.
 - b. Outdoors: Use threaded conduit fittings or waterproof hubs.
 9. Make connections to cable trays as follows:
 - a. Attach to tray with cable tray conduit clamps specifically designed for this application (UL Approved).
 - b. Attach to top of tray where tray covers are not required and to bottom of tray where covers are required.
 - c. Do not cut or punch tray side rails to install conduit.
 - d. Seal conduits at tray. Use IlSCO Duct Seal catalog # DS-1 or DS-5.
 - e. All transitions between conduit and cable tray shall provide the cables with continuous support using conduit fittings, cable tray fittings, or conduit elbows. Bending radii of the fitting or elbow shall meet or exceed the minimum cable bending radius as specified in Section 26 05 04.
 10. Terminate all conduit runs with insulated bushings.
 11. Running threads will not be permitted.
 12. Coat all field cut threads, scars, or wrench abrasions in galvanized conduit with an organic zinc rich primer.
 13. Do not exceed the following number of bends between cable pulling points:

<u>Max. Length of Run in Feet</u>	<u>Max. No. of 90-degree Bends</u>
0-49	4
50-99	3
100-149	2
150-199	1

14. Place drainage fittings for conduits or weep holes for junction boxes, pull boxes, panels, and other boxes and enclosures at low points where moisture can collect, except in hazardous areas.
 15. Metallic conduit systems shall be electrically continuous in their entirety, with bonding jumpers provided as required by NEC.
 16. Provide suitable protection for conduit risers against damage during construction.
 17. Cap all conduits after cleaning where conduits are to be left empty by this contract.
 18. Carefully ream ends of all conduit lengths after cutting to eliminate sharp burrs.
 19. Clean out all conduit before pulling wire.
 20. Provide all fittings necessary for a complete installation.
 21. The routing of conduits shall be per the NEC.
 22. Provide boxes, sized per the NEC, which are suitable for the area classification as defined by the NEC for conduit runs as follows:
 - a. Where cable pulling tension exceeds the manufacturer's recommended allowable tension.
 - b. The number of bends exceeds the allowable.
 - c. Where splice or termination boxes are required.
- B. Exposed Installation:
1. Install in building interior spaces where specified or indicated.
 2. Install above grade outdoors.
 3. Install horizontal runs as high above floor as possible, and in no case lower than 7 feet above floor, walkway, or platform in passage area.
 4. Run conduit parallel or perpendicular to walls, ceilings, beams, and columns unless indicated otherwise.
 5. Route to clear all doors, windows, access wells, and openings.
 6. Group parallel runs in neatly aligned banks where possible with minimum of 1-inch clearance between conduits.
 7. Maintain 6-inch clearance between conduit and coverings on all hot lines such as steam, hot water, or other hot lines.
 8. Do not exceed a distance of 8 feet between supports on horizontal or vertical runs.
- C. Rigid Steel Conduit:
1. Install as specified or indicated.
 2. Permitted for exposed, concealed, and cast-in-concrete applications.
 3. Permitted for buried applications if encased with a minimum of 3 inches of concrete.
- D. Intermediate Metal Conduit:
1. Do not install in hazardous locations.
 2. Install same as rigid steel conduit as specified in INSTALLATION, this Section.
- E. Rigid Steel Conduit with Bonded Polyvinyl Chloride (PVC) Jacket:
1. Install as specified or indicated.
 2. Permitted for cast-in-concrete and buried applications.
 3. Use bender per manufacturer's instructions.
 4. Tighten conduit with strap wrench and repair any damaged coating with a liquid patching compound as recommended by manufacturer.
- F. Rigid Aluminum Conduit:
1. Install as specified or indicated.
 2. Permitted for exposed applications.
 3. Do not install underground or cast-in-concrete.
 4. Use anti-seize compound on conduit threads.

5. Use bender per manufacturer's instructions.
- G. Electrical Metallic Tubing:
 1. Install as specified or indicated.
 2. Permitted for exposed, concealed, and cast-in-concrete applications with the following restrictions:
 - a. Use only for lighting, intercommunication, and convenience power circuits.
 - b. For exposed applications, use indoors only and only where protected by flanges of columns, beams, or other protective structures.
 - c. Install concealed in walls, floors, and above suspended ceilings where possible.
 - d. Do not use where conduit passes through floors or to support light fixtures.
 - e. Do not install in hazardous locations.
- H. Rigid Nonmetallic Conduit:
 1. Install as specified or indicated.
 2. PVC conduit.
 - a. Type Schedule 40 conduit for exposed applications.
 3. Fiberglass conduit.
 - a. For use in exposed applications.
- I. Flexible Steel Conduit:
 1. Install as specified or indicated.
 2. Permitted for exposed and concealed applications.
 3. Do not install underground or cast-in-concrete.
 4. Use between rigid conduit and motor terminal boxes.
 5. Place between rigid conduit or conduit box and control or instrument device cases and where direct connection is not desirable for reasons of equipment movement, vibration, or for ease of installation and maintenance. (Example: Connections between building steel and turbine or turbine foundation and between boiler steel and boiler.)
 6. Install at all points of connection to Equipment mounted on supports to allow for expansion and contraction.
 7. Install at locations where rigid conduit connections are impractical.
 8. Maximum length shall be 6 feet.
 9. Install an external bonding jumper to conform to NEC on all conduit sizes.
 10. Use for conduit expansion joints where practical.
 11. Use type suitable for the environment, i.e., high temperature or oil.
- J. Conduit Fittings:
 1. Install as specified, indicated, or as required by NEC.
 2. Install conduit seals in all conduit penetrating hazardous areas, at Equipment located therein, and at locations required by the NEC.
 3. Install explosion-proof fittings in the rigid steel conduit system as required by the NEC and other applicable standards.
 4. Install insulated grounding bushings on all conduit risers.
- K. Expansion Fittings, Deflection Fittings, and Flexible Couplings:
 1. Install conduit expansion fittings as required in underground conduit runs to provide protection against ground settling, in conduit runs in concrete pours between sections of concrete, in embedded or underground conduit runs between fixed structures, and along bridges, trestles, and conveyor structures.
 2. Install expansion fittings in long, straight, continuous runs at a maximum of 200-foot intervals.
 3. Use weatherproof tape with internal bonding assembly in all nonhazardous areas.

4. Use flexible couplings in hazardous areas.
- L. Boxes:
 1. Install boxes as specified, indicated, or as required by NEC.
 2. Provide with 1/4-inch drain holes where installed at indoor termination of duct banks or outdoor conduit run.
 3. Indoors, conform to NEMA Type 1 enclosure in all nonhazardous locations.
 4. Outdoors, conform to NEMA Type 3R except in manholes and handholes conform to NEMA Type 4.
5. Metallic Barriers:
 - a. Design not to separate phases of a power circuit.
 - b. Provide as necessary for the isolation of power circuits from other type circuits. Refer to Section 26 05 04.
- M. Supports:
 1. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
 2. Design to provide 1/4-inch space between Equipment housings and walls or columns upon which they are mounted.
 3. Do not exceed load requirements in NEC and NEMA standards.
 4. Paint all field cuts or welding of supports with an organic zinc rich primer.
 5. Use electrogalvanized steel conduit clamps and nonmagnetic conduit clamps to support electrogalvanized steel conduit and nonmagnetic conduit respectively.
- N. Conduit Identification Tags:
 1. Install on all scheduled conduit at time of installation.
 2. Clean the conduit surface and install a tag at each conduit termination in such a manner that the tag is readable from the floor, platform, or other vantage point.
 3. Provide temporary conduit identification until the permanent conduit identification can be installed. An acceptable method is the usage of a broad-tipped permanent ink type of marker.
- O. Home Runs: Where routing of conduit is not indicated, such as for lighting, convenience power, intercom circuits, and other systems, field route conduit as specified in this Section.

END OF SECTION 26 05 33

SECTION 26 05 73 – OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. Contractor must perform the system studies outlined in this specification and must be coordinated and approved by the Owner.
- B. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Contractor to coordinate with the Owner on any existing model available. Contractor may have to build a model if an existing one is not available. Contractor must perform a coordination and arc flash analysis using a computer-based simulating software approved by Owner. Protective devices shall be set based on results of the protective device coordination study.
 - 1. Coordination of series-rated devices is permitted.

1.03 REFERENCE STANDARDS:

- A. Code of Federal Regulations (CFR):
 - 1. 29 CFR 1910.7 - National Recognized Testing Laboratories.
- B. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 - Recommended Practice for Electric Power Distribution for Industrial Plants (the Red Book)
 - 2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (the Buff Book).
 - 3. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis (the Brown Book) (ANSI).
 - 4. IEEE 551 - Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.
 - 5. IEEE 620 - Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
 - 6. IEEE C37.40 - Standard Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories.
 - 7. IEEE C57.12.00 - General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers (ANSI).
 - 8. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers (ANSI).
- C. Insulated Cable Engineers Association, Inc. (ICEA):
 - 1. ICEA P-32-382 - Short-Circuit Characteristics of Insulated Cables.
 - 2. ICEA P-45-482 - Short-Circuit Performance of Metallic Shielding & Sheaths.
- D. International Electrical Testing Association (NETA):
 - 1. NETA Acceptance Testing Specification - Acceptance Testing Specifications.
 - 2. NETA ETT-2000 - Standard for Certification of Electrical Testing Technicians (ANSI).
- E. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA MG 1 - Motors and Generators.

- F. NFPA:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 70E - Standard for Electrical Safety in the Workplace.
- G. Underwriters Laboratories Inc. (UL):
 - 1. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.

1.04 SUBMITTALS:

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 242, IEEE 399, and IEEE 1584 (2018).
- C. Submit comprehensive report, result summary, TCC's and Arc flash label results.

1.05 QUALITY ASSURANCE:

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional Engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of Engineer.
- C. Comply with IEEE 399 for general study procedures.
- D. Comply with IEEE 242 for methodology.
- E. Comply with IEEE 1584 for arc flash.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS:

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Provide the coordination study by one of the following products. Coordinate with Owner and follow the same product as the existing model.
 - 1. SKM Systems Analysis, Inc.
 - 2. ETAP
 - 3. Easy Power

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS:

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA:

- A. Gather and tabulate the following input data to support coordination study:
 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Impedance of utility service entrance.
 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.

- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY:

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Distribution panelboard.
 - 4. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
 - 2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.
- F. Equipment Evaluation Report:
 - 1. For 600V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY:

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

- H. Arc Flash Analysis: Following the coordination study and determining the recommended trip settings of overcurrent devices, prepare an arc flash analysis of each bus and determine the following:
1. Calculate available arc flash energy.
 2. Category and corresponding level PPE.
 3. Generate and apply arc flash labels.

END OF SECTION 26 05 73

SECTION 26 08 00 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. The purpose of this section is to specify the Contractor's responsibilities and participation in the commissioning process.
- B. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Commissioning is primarily the responsibility of the Commissioning Authority, with start-up, testing and support for commissioning the responsibility of Division 26. The commissioning process does not relieve the Contractor from participation in the process or diminish the role and obligations to complete all portions of work in a satisfactory and fully operational manner.
- C. Work of Division 26 includes:
 - 1. Testing and start-up of the electrical equipment.
 - 2. Assistance in functional testing to verify equipment/system performance.
 - 3. Providing qualified personnel to assist in commissioning tests required after the initial commissioning.
 - 4. Completion and endorsement of Pre-functional Construction Checklists provided by the Commissioning Authority to assure that Division 26 equipment and systems are fully operational and ready for functional testing.
 - 5. Providing equipment, materials and labor necessary to correct deficiencies found during the commissioning process which fulfill contract and warranty requirements.
 - 6. Providing operation and maintenance information and as-built drawings to the Commissioning Authority for review verification and organization prior to distribution.
 - 7. Providing assistance to the Commissioning Authority to develop, edit and document system operation descriptions.
 - 8. Provide a detailed start up plan for Engineer's and Owner's review, comments and recommendations.
 - 9. Provide at the end of the job the following items for inclusion in the systems manual.
 - a. Control drawings, sequences of control
 - b. A table of all set points
 - c. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
 - d. A list of all manufacture recommended preventive maintenance procedures for all equipment and systems.
 - 10. Use web-based Facility Grid Commissioning application to fill out Construction Checklist and to track issues resolutions. Attendance at one training class is required for all Contractors. This training will take place at the construction Cx kick off.
 - 11. Providing training for the systems specified in this Division.

1.02 RELATED WORK:

- A. All installation, testing and start-up procedures and documentation requirements specified within Division 26 and related portions of this project.
- B. Section 019113 – Commissioning
Section 260801 – Field Testing
- C. Commissioning Functional Test Procedures that required participation of the Division 26 Contractors.
- D. Cooperate with the Commissioning Authority in the following manner:

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1. Provide all testing and start-up procedures and documentation requirements specified within Division 1 and Division 26 and related portions of this project.
2. Allow sufficient time before final completion dates so electrical systems start-up and commissioning can be accomplished.
3. Provide labor, specialty equipment and material to make required connections, circuitry and delay.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT:

- A. Standard test equipment for commissioning will be provided by the Contractor.
- B. Division 26 Contractor or 3rd party NETA certified agency shall provide and operate standard and specialized test equipment as necessary to test and start up the electrical systems.
- C. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment through the installing Contractor. Manufacturer shall provide the test equipment, demonstrate its use and assist the Commissioning Authority in the commissioning process.
- D. The Contractor shall provide all labor, equipment, software and all test programming support as necessary to start up, calibrate, debug and verify proper function of the control/facility management system. This equipment and software shall be provided for use by both the testing Contractor and the Commissioning Authority.

PART 3 - EXECUTION

3.01 WORK PRIOR TO COMMISSIONING:

- A. Complete all phases of work so the systems can be energized, started, tested and otherwise commissioned. Division 26 has primary start-up responsibilities with obligations to complete systems, including all sub-systems, so they are functional. This includes the complete installation of all equipment materials, raceways, wire, terminations, controls, etc., per the Contract Documents and related directives, clarifications, change orders, etc.
- B. A Commissioning Plan will be developed by the Commissioning Authority. Upon request of the Commissioning Authority, the Contractor shall provide assistance and consultation. The Commissioning Plan will be developed prior to completion of the installation. The Contractor is obligated to assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If Contractor-initiated system changes have been made that alter the commissioning process, the Commissioning Authority will notify the Engineer and the Contractor may be obligated to compensate the Commissioning Authority to test the revised product or confirm the suitability/unsuitability of the substitution or revision.
- C. Specific pre-commissioning responsibilities of Division 26 are as follows:
 1. Normal start-up services required bringing each system into a fully operational state. This includes electrical rotational check, motor rotational check, cleaning, lug and termination torqueing, insulation resistance testing for wiring, electrical phasing check, control sequences of operation, etc. The Commissioning Authority will not begin the commissioning process until each system is complete, including normal Contractor start-up and debugging.
 2. The Contractor shall perform pre-functional construction checklists on the systems to be commissioned to verify that all aspects of the work are complete in compliance with the

- plans and Specifications. Contractor start-up forms may be substituted for the pre-functional test forms with prior approval by the Commissioning Authority.
3. Factory start-up services will be provided for key equipment and systems specified in Division 26. Factory start-up activities to be documented and submitted. The Contractor shall coordinate this work with the manufacturer and the Commissioning Authority.
 4. Notify Construction Manager and Commissioning Authority when systems are ready for functional testing.
- D. Commissioning is intended to begin upon completion of a system. Commissioning may proceed prior to the completion of systems and/or sub-systems, if expediting this work is in the best interests of the Owner. Commissioning activities and schedule will be coordinated with the Contractor. Start of commissioning before system completion will not relieve the Contractor from completing those systems as per the schedule.

3.02 PARTICIPATION IN COMMISSIONING:

- A. Commissioning testing shall be performed by this division Contractor and documented by the Commissioning Authority. Provide skilled technicians to start up and debug all systems within this division of work. These same technicians shall be made available to assist the Commissioning Authority in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested by the Commissioning Authority and coordinated by the Contractor. Contractor will ensure the qualified technician(s) are available and present during the agreed-upon schedules and of sufficient duration to complete the necessary tests, adjustments and/or problem resolutions.
- B. System problems and discrepancies may require additional technician time, Commissioning Authority time, redesign and/or reconstruction of systems and system components. The additional technician time shall be made available for the subsequent commissioning periods until the required system performance is obtained.
- C. The Commissioning Authority reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment, system and/or sub-system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service/commission the equipment and an attitude/willingness to work with the Commissioning Authority to get the job done. A liaison or intermediary between the Commissioning Authority and qualified factory representatives does not constitute the availability of a qualified technician for purpose of this work.

3.03 WORK TO RESOLVE DEFICIENCIES:

- A. A. In some systems, maladjustments, misapplied equipment, and/or deficient performance under varying loads will result in a system that does not meet the original design intent. Correction of work will be completed under direction of the Architect, with input from the Contractor, equipment supplier and Commissioning Authority. Whereas all members will have input and the opportunity to discuss, debate and work out problems, the Architect/Engineer of Record will have final jurisdiction on the necessary work to be done to achieve performance.

3.04 ADDITIONAL COMMISSIONING:

- A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The Contractor, suppliers and Commissioning Authority shall include a reasonable reserve to complete this work as part of their standard contractual obligations.
- B. The cost of compensation of the Commissioning Authority for repeat testing or troubleshooting due to systems that do not meet specified performance shall be borne by the Contractor.

- C. Corrective work shall be completed in a timely fashion to permit the timely completion of the commissioning process.

3.05 SYSTEMS TO BE COMMISSIONED

- A. Refer to specification section 01 91 13.

3.06 TRAINING

- A. This Contractor will be required to participate in the training of the Owner's engineering and maintenance staff for each system and the related components. Training may be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids, or in the field with the specific equipment. The type of training will be per the Owner's option.

3.07 SYSTEMS DOCUMENTATION

- A. Maintain as-built red-lines on the job site as required in Division 1. Red-lining of the drawings at completion of construction based on memory of key personnel is satisfactory.
- B. In addition to the stated requirements for operation and maintenance data, provide one (1) copy of equipment technical literature, operation and maintenance literature and shop drawings to the Commissioning Authority as soon as they are available. This requirement is for review of these documents prior to distribution of multiple copies for the Owner's final use.
- C. Schedules, instructions for operation of each piece of equipment for emergencies, seasonal adjustment, startup and shutdown
- D. A list of all manufacturer recommended preventive maintenance procedures for all equipment and systems.

3.08 COORDINATION:

- A. The contractor and commissioning agent must coordinate with Owner on required operational tests and procedures prior to testing and commissioning any systems that may impact plant or system operations at least 1 week in advance. Any required outages must be coordinated and approved by Owner at least 4 weeks prior.

END OF SECTION 26 08 00

SECTION 26 08 01 – FIELD TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 26 00 88- Commissioning of Electrical Systems.

1.02 SUMMARY:

- A. This Section covers field testing of all wire, cable, and electrical equipment. This Contract shall obtain the services of a testing subcontractor as described herein. Testing shall be performed under the supervision of the testing supervisor furnished by the testing subcontractor.

1.03 REFERENCE STANDARDS:

- A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- B. Applicable Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM D1816 – Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
 - 2. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
 - 3. National Electrical Manufacturers Association (NEMA):
 - a. WC 74 - 5-46kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy (ICEA S-93-639)
 - 4. National Electrical Testing Association (NETA):
 - a. ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
 - 5. Institute of Electrical and Electronic Engineers (IEEE):
 - a. C2 - National Electrical Safety Code (NESC).
 - b. C37.20.1 - Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
 - c. C37.20.2 - Metal-Clad Switchgear.
 - d. C37.20.3 - Metal-Enclosed Interrupter Switchgear (1 kV–38 kV).
 - e. C37.23 - Metal-Enclosed Bus
 - f. C57.12.91-2020- Standard Test Code for Dry-Type Distribution and Power Transformers.
 - g. 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - h. 62.2 - Guide for Diagnostic Field Testing of Electric Power Apparatus - Electrical Machinery.
 - i. 450 - Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
 - j. 3004.8-2016- Recommended Practice for Motor Protection in Industrial and Commercial Power Systems
 - k. IEEE Guide for Motor Control Centers Rated up to and including 600V AC or 1000V DC with Recommendations Intended to Help reduce Electrical Hazards.

- C. Test Reports:
1. Submit as specified in Division 01.
 2. Maintain a written record of all tests showing date, testing equipment, personnel making test, equipment or material tested, tests performed, and results, including deficiencies found. Test reports should include nameplate data of equipment being tested.
 3. Complete test forms supplied by the Commissioning agent. In cases where specific types of forms are unavailable, Contractor may use his standard forms.
 4. All Contract Drawings used by the testing subcontractor shall be returned to Engineer as a prerequisite for final payment. As each schematic diagram is tested, testing subcontractor shall mark it with the initials of the person testing and the date testing was completed.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT:

- A. Provide all necessary testing equipment as applicable, which includes but not limited to, the following:
1. Wet and dry bulb thermometer.
 2. 500, 1,000 and 2,000V insulation test sets, meggers.
 3. Battery-powered portable telephone sets.
 4. Battery-powered ringing set.
 5. Ac high potential test set, adjustable up to 38 kV, 60 cycles (if required).
 6. Dc high potential test set, adjustable up to 90 kV.
 7. Very Low Frequency (VLF) AC Hipot Tester.
 8. Apparatus for measuring dielectric breakdown voltage of insulating oils per ASTM Method D1816.
 9. 125/250/500Vac voltmeters, and three 0- to 5-amp, ac ammeters 0.5% accuracy.
 10. Three Simpson Model 260 volt-ohm-millimeters (or Engineer-approved equal).
 11. Phase rotation meters, 60 cycle.
 12. Phase angle meter, 60 cycle.
 13. Two sets of portable synchronizing lights.
 14. Relay test set (Multi-Amp SR-76) with the following accessories:
 - a. Variac or potentiometer.
 - b. Cycle timer.
 - c. Load box.
 - d. Potential transformers.
 - e. Directional distance relay test box.
 - f. Phase shifter.
 - g. Test rectifiers.
 15. Ac high current test set rated at least 45,000 amperes, 60 cycles (Multi-Amp Model CB-7745 or equal).
 16. Commercial model four-point earth/ground resistance and soil resistivity test set, Megger® (James G. Biddle Company) type DET4TCR2.
 17. One transformer ratio tester, Megger® (James G. Biddle) type TTR.
 18. Miscellaneous test leads, jumpers, cable, switches, receptacles, plugs, and other equipment as necessary.
 19. Provide dual-frequency FM radio communication for each test crew with two additional radios for Resident Project Representative. Motorola or approved equal.
 20. Motor rotation indicator (AR Model 50 or equal).

21. Signal source for control loops (4 to 20 mA, 1 to 5Vdc, etc.).
22. Thermocouple measuring equipment.
23. Oscilloscope (if required).

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. Conform to requirements as specified in Division 01.
- B. Furnish labor, testing contractor, test equipment, and materials as follows:
 1. For specified inspections and tests.
 2. For assisting each manufacturer's field service representative specified.
 3. For assisting other unspecified manufacturers' field service representatives if requested by them or by Resident Project Representative. Negotiate with the requesting party.
- C. Inspect, test, and repair if necessary, all equipment and materials furnished by this Contract.
- D. Perform specified inspections and tests and report all deficiencies in equipment and materials to Resident Project Representative. Where applicable, perform Work under the direction of the equipment manufacturer's field service representative. Minor, easily correctable deficiencies shall be corrected and reported to Resident Project Representative.
- E. Repair equipment and materials furnished by others if requested by Resident Project Representative or by manufacturer's field service representative. Negotiate with the requesting party.
- F. Be responsible for any damage to equipment or material due to improper test procedures or test apparatus handling and replace or restore to original condition at Owner's option any damaged equipment or material.
- G. Furnish and use safety devices such as rubber gloves and blankets, protective screens and barriers, yellow tape, danger signs, and related items to adequately protect and warn all personnel in the vicinity of the tests.
- H. Furnish personnel acceptable to Owner Appointed Representative.
- I. Certain inspections and tests specified to be performed by this Contract may also be performed by others. This overlapping and duplication is necessary and intentional.
- J. Resident Project Representative will approve the testing schedule of all electrical testing and inspections. Cooperate and work closely with Resident Project Representative during all phases of construction, especially with respect to the following:
 1. Sequence and priorities of construction and start-up.
 2. Testing and testing methods.
 3. Control scheme checkout and procedures.
 4. Equipment start-up.
 5. Testing and control scheme checkout records.
 6. Tagging procedures for personnel and equipment safety.
 7. Releasing tested equipment to Owner for operation.
- K. Owner reserves the option to assign their own personnel to assist Contractor in checking out certain control schemes where Owner concludes such assistance is necessary to meet the Project schedule. If Owner should exercise this option, Contractor will be furnished a notice, in writing, specifying the extent of Owner's involvement.
- L. After completing testing and checkout of equipment, wiring, control schemes, and other items associated with individual systems, and believing a system to be ready for operation, notify Resident Project Representative who, along with Owner, will witness a final operational test of each individual system to be conducted by this Contractor.

- M. Once testing activity begins, Contractor shall establish a permanent testing crew of experienced electricians preferably with a background in controls and basic testing procedures. Testing subcontractor supervisor shall attend jobsite meetings as requested by Resident Project Representative.
- N. Contractor shall cooperate fully with the testing subcontractor and Owner in performing all testing activities and shall add personnel to the testing crew as required to have all testing completed in accordance with the dates listed in the construction and systems operations schedule requirements of Division 01.
- O. It is anticipated there will be frequent occasions when testing will have to be performed outside regular working hours. This testing would primarily be related to work during start-up testing and checkout of equipment and systems and during initial energization of each unit. Other possible work of this nature would be under critical situations where the safety of men or equipment and progress of the overall Project Work is concerned.
- P. Provide office facilities for the testing subcontractor to include, but not limited to, the following: separate office space; file cabinet, desks, test benches, and similar items; telephone service; photocopying; and clerical service.

3.02 TESTING CONTRACTOR:

- A. Obtain the services of a testing subcontractor listed in PART 1.
- B. Testing subcontractor personnel shall have the following qualifications:
 - 1. Shall be thoroughly familiar with control scheme checkout, large power plant control systems, and test equipment; and be expert in setting, calibrating and testing protective relays.
 - 2. Shall have proven ability in the above-mentioned areas of work with a minimum of five years' experience with a utility, a major electrical equipment manufacturer, a consulting engineering firm, or with an independent testing contractor. For each person furnished by the testing subcontractor with the above experience, a testing assistant may be furnished with a minimum of two years of similar experience.
 - 3. Shall be able to supply references and proof of experience and ability to keep good test records on recent projects.
 - 4. Shall be cooperative and willing to work with Resident Project Representative in developing testing and start-up priorities and schedules. It is essential that testing subcontractor and Resident Project Representative maintain a good communicative working relationship at all times.
- C. Responsibilities:
 - 1. Perform inspections and tests.
 - 2. Prepare reports.
 - 3. Furnish personnel as required to maintain Project schedule.

3.03 INDIVIDUAL DEVICE AND EQUIPMENT INSPECTIONS AND TESTS:

- A. Medium-Voltage Power Cables:
 - 1. Perform inspection and testing of medium-voltage cables in accordance with Section 7.3.3 of InterNational Electrical Testing Association ANSI/NETA ATS, latest edition.
 - 2. Tests shall include, but not be limited to, insulation integrity, continuity, phasing, and dielectric withstand as defined in the referenced standard.
 - 3. Test voltages, methods, and acceptance criteria shall be in strict accordance with referenced NETA ATS section and cable manufacturer's recommendations.
 - 4. Submit complete test reports documenting compliance with the above requirements prior to energization.

- B. Medium-Voltage Fuses:
1. Perform visual inspection, continuity/open check, confirmation of rating/class, and inspection of fuse clips/holders.
- C. Low-Voltage Drawout Air Circuit Breakers:
1. High-potential test each breaker in accordance with IEEE C37.20.1, Table 1, "Voltage and insulation levels for LV ac switchgear," and part 6.5, "Field dielectric tests." Apply test voltage to each pole of the breaker for one minute. Voltages to be used are as follows:
dc test value 2.32 kV
 2. Adjust and set trip units to values furnished by Engineer, including the following as applicable:
 - a. Instantaneous overcurrent trip.
 - b. Long time and short time pickup.
 - c. Long time delay and short time delay.
 - d. Ground pickup and delay.
 3. Additional tests will be performed by the manufacturer's field service representative.
- D. 600V Molded-Case Breakers:
1. Set adjustable magnetic trips to values furnished by Engineer.
 2. Megger each pole for freedom from grounds.
 3. Check for proper current rating for circuit to which connected.
 4. A sample no greater than 5% of the total molded-case breakers shall be checked for proper operation. Engineer will make selection of breakers to be tested.
- E. Motors:
1. Check equipment ground to assure continuity of connections.
 2. Before applying voltage, measure and record the one-minute insulation resistance of the stator winding as follows:

<u>Motor Voltage</u>	<u>Megger Voltage</u>	<u>Minimum Acceptable Insulation Resistance</u>
460	500	10 Megohms
4,000	1,000	50
6,600	2,000	75

If measured resistance values are lower than these, record room temperature and humidity and submit readings to Resident Project Representative.

3. Check lubrication, starter, and control circuits. Check that motor is free of dirt and dust. Rotate rotor by hand to determine that rotor turns freely. Apply voltage momentarily and note direction of rotation. If direction of rotation is reversed, interchange two of the primary leads at the motor. Reconnect motor to driven equipment.
4. Motors 100 horsepower and above shall have a one-hour "run in" while uncoupled. Winding and bearing temperatures shall be monitored noting any high temperature levels or rapid variation. If the motor appears to be running hot, notify Resident Project Representative.
5. On large motors with an insulated bearing, measure the shaft-to-bearing and bearing-to-ground voltages with a high-resistance (5,000 ohms per volt or more) 0 to 5V scale ac voltmeter while the motor is running under load to check the integrity of the bearing

- insulation. If shaft-to-bearing voltage is present, notify the Resident Project Representative.
6. Motor shall be closely monitored during initial operation for any high temperatures or abnormal conditions.
 7. After motor has reached steady-state temperature, move RTD monitoring circuit to hottest RTD.
- F. Motor Starters and Contactors:
1. Check equipment ground to assure continuity of connections.
 2. Remove all blocking used for shipment.
 3. Check magnetic coil for proper rating.
 4. Clean all contacts and magnetic surfaces (as required).
 5. Check all auxiliary contacts for correct arrangement with coil de-energized; i.e., normally open or normally closed.
 6. Check all fuses or air circuit breakers for proper rating.
 7. Check field connections for tightness.
 8. Check secondary fuses on motor starter control power transformer supply.
- G. Switches:
1. Power Switches (disconnects, safety, etc.):
 - a. Inspect contacts and clean if necessary.
 - b. Inspect arc chutes.
 - c. Inspect fuses for proper rating.
- H. Wire and Cable:
1. Verify that all conductors of every cable are terminated at the proper terminals as indicated by the Contract Drawings and manufacturer's drawings, and properly tagged.
 2. 600V Power Cable: With cable disconnected at both ends, megger each cable with a 1,000V megger for one minute. Values must be approximately as follows:

<u>Conductor Size (AWG OR MCM)</u>	<u>Resistance (Megohms-1,000 ft.)</u>
14-8	200
6-2/0	100
3/0-1,000	50

If cable is meggered with one end connected to a motor or transformer, megger values must meet acceptable limits for that equipment, as described previously.
 3. 600V Control Cable:
 - a. Megger the specific control cables selected by Resident Project Representative. The quantity of cables required to be meggered will not exceed 10% of the control cable installed by this Contract. Megger as described for 600V power cable after installation, but with cables disconnected from control panels and other equipment.
 - b. All control cables shall have a continuity check performed on each conductor to ensure the conductance of each wire before the wires are terminated. Cables with conductors failing this test shall be removed and replaced.
 4. 300V Instrument Cable:
 - a. All instrument cables shall have a continuity check performed on each conductor and shield to ensure the conductance of each wire and shield before the wires are terminated. Cables with conductors or shields failing this test shall be removed and replaced.

- I. Miscellaneous Equipment Tests: Test all other miscellaneous equipment furnished under this Contract for which specific tests are not specified as recommended by the respective equipment manufacturers.
 - J. Dampers and Valves:
 - 1. Set limit switches for proper damper or valve operation.
 - 2. Verify operation damper or valve such that it is free from binding and travels within the proper limits.
- 3.04 START-UP AND SYSTEM TESTS: The following is a list of system tests to be performed by this Contract. Many of the individual tests will be duplicated, and the final scope of testing will be confirmed by the Owner. Some of the system tests will be performed after normal working hours.
- A. Auxiliary Power System Start-up Power:
 - 1. Verify the phase rotation and sequence upon initial energization of any electrical distribution apparatus.
 - 2. A very detailed written procedure (furnished by Engineer) shall be used for initial energization of all switchgear and load centers. This test will verify proper phasing and synchronizing for the main electrical distribution system energized from the start-up source. The procedure will consist of the following general elements for each electrical bus:
 - a. Verify proper phase rotation and sequence.
 - b. Verify proper operation of sync-check relays and synchronizing system.
 - c. Verify proper source for each synchronizing potential.
 - d. Verify proper operation of synchronizing scope and associated voltmeters.
 - e. Verify proper operation of breaker controls.
 - f. Verify proper phasing through start-up and load center transformers.
 - 3. Prior to the initial energization of any equipment (or re-energization of any equipment), megger for grounds or shorts as follows:
 - a. Megger between each phase and ground and between all phases and record.
 - b. Tests showing lower values than expected should be investigated and corrected prior to energization.
 - c. Tests may be waived by Resident Project Representative where equipment has been de-energized for only a short period of time and no work has taken place on the equipment.
 - B. Auxiliary Power System Station Loop:
 - 1. This procedure will verify proper phasing of the station loop. The loop consists of the substation, main transformer(s), auxiliary transformers, switchgear busses, and start-up transformer. A very detailed procedure will be provided by Resident Project Representative. The procedure will consist of the following general elements for each electrical bus:
 - a. Verify proper phase rotation and sequence.
 - b. Verify proper operation of sync-check relays and synchronizing system.
 - c. Verify proper source for each synchronizing potential.
 - d. Verify proper operation of sync-scope and associated voltmeters.
 - e. Verify proper operation of breaker controls.
 - f. Verify proper phasing through main step-up transformers and unit auxiliary transformers.

2. The above tests will be repeated for each switchgear bus energized from each different source.
- C. Generator and Auxiliary Power System Protective Relays and Metering:
 1. Prior to initial energization of any relay, verify that relay operates correct device and the proper sequence is executed (i.e., relay starts timer, timer trips breaker, alarm, and other sequential operations). Proper sequence of relay will be verified against one-lines and turbine-generator protective relay logic diagrams.
 2. Upon initial energization of relay, measure current and voltages at relay to verify proper magnitude and direction.
 3. Verify proper currents and voltages for all metering equipment.
 4. Verify metering equipment has the proper scale.
 5. Calibrate metering equipment if requested by Resident Project Representative.
 6. Verify correct operation of metering system to include the following:
 - a. Proper output of all transducers.
 - b. Proper operation of any demand recorders.
 - c. Proper direction for watt-hour meter.
 - d. Proper outputs of doubling relays, demand recorders, and related items.
 - e. Proper inputs to recorders, remote telemetering scheme, and related items.
- D. Control Schemes:
 1. De-energized Functional Check: Each scheme shall be thoroughly tested prior to energizing the controlled equipment. A minimum of the following tests will be performed:
 - a. Verify power cables are disconnected or overload heaters are removed. (Starters with current transformers connected to overload must have leads disconnected.)
 - b. Verify termination of all control cables and tightness of connections.
 - c. Tighten all links of test disconnect type terminal blocks.
 - d. Verify operation of contactor by jumpering the control switch.
 - e. Verify operation of starter by using control switch (simulate any interlocks).
 - f. Verify operation of all control switch contacts.
 - g. Verify operation of any alarms.
 - h. Correct any minor deficiencies and notify Resident Project Representative.
 - i. Other tests as required to verify operation of all control equipment without energizing controlled equipment.
 2. Energized Functional Checks: These tests will be performed to simulate actual operation of equipment.
 - a. Check overload heaters (or protective devices) for proper size.
 - b. Check power lead terminations for tightness.
 - c. Install overload heaters and momentarily energize motor to verify rotation (this shall be coordinated with Resident Project Representative).
 - d. Once equipment has been energized, verify operation of control devices (opening pressure switches, level switches, and related devices).
 - e. Simulate operation of control devices by removal of pressure, flow, and related parameters.
 - f. Verify operation of any auto-transfer schemes.
 - g. Testing of all schemes should be thorough enough to simulate actual operating conditions as much as possible.
- E. Ground System:

1. Measure and record ground resistance at the following equipment and structures to plant ground grid system:
 - a. Lightning arrestor grounds.
 - b. Generator frame and neutral transformer ground.
 - c. Generator PT and surge unit.
 - d. Switchgear and load centers.
 - e. Medium-voltage motors.
 - f. Power transformer frames and neutral grounds.
 - g. Control panels and consoles.
 - h. Motor control centers, panelboards, switchboards, and bench boards.
 - i. Power control center equipment.
 - j. Other miscellaneous grounds selected at random in a manner representative of the entire installation.
 2. Perform tests using a commercial model ground test set.
- F. Alarm, Events Recorder, Data Acquisition Systems, Distributed Control Systems, and Programmable Logic Controllers:
1. Close cooperation will be required with manufacturer's service representative to functionally test this equipment.
 2. This equipment is solid state and requires careful checking of external circuitry prior to final connection. Manufacturer's representative should be consulted on the precautions that are required in handling this equipment.
 3. All external wiring will be checked for continuity, grounds, short circuits, and absence of extraneous voltage.
 4. Alarms, Events Recorder, and Distributed Control System Alarms:
 - a. Operate alarm initiating device (relay, pressure switch, or similar devices). Verify that the correct visual point and printer point are actuated. Verify correct printing for visual alarm and printer.
 5. Data Acquisition System, Distributed Control System, and Programmable Logic Controller:
 - a. Verify that external point is correct input. Verify wording on CRT or printer for each point.
- G. Instrument Loop Check: These checks will consist of functional tests of complete control loops. The completion of these tests will require cooperation with the instrument technicians and combustion safeguard manufacturer's representative.
1. Check all wiring for connection to correct device and proper polarity. Correct wiring if required.
 2. Simulate operation of transmitter and verify that control signal is being received at control cabinet and indicating device (usually indicator on control board).
 3. Verify operation of controlled device (valve, damper, or other device).
 4. Verify the controlled device performs correctly when operated from the associated control station.
 5. If possible, operate transmitter to verify operation of controlled device.

END OF SECTION 26 08 01

SECTION 261116 - UNIT SUBSTATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes indoor unit substations, each consisting of the following:
 - 1. Primary incoming section.
 - 2. Transformer.
 - 3. Secondary Switchboard.

1.03 RELATED REQUIREMENTS:

- A. SECTION 262413 - LOW VOLTAGE SWITCHBOARD
- B. SECTION 261200 - MEDIUM VOLTAGE TRANSFORMER

1.04 DEFINITIONS:

- A. NETA ATS: International Electrical Testing Association Acceptance Testing Specification.

1.05 SUBMITTALS:

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. 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: Power, signal, and control wiring.
 - 2. Dimensioned plans and elevations showing major components and features.
 - 3. One-line diagram.
 - 4. Three-Line diagrams.
 - 5. Breaker Schematics.
 - 6. List of materials.
 - 7. Nameplate legends.
 - 8. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
 - 9. Short-time and short-circuit current ratings of unit substations and components.
 - 10. PLC Wiring Diagram
 - 11. Ratings of individual protective devices.
 - 12. Input/Output list.
 - 13. Communication Architecture Diagram.
 - 14. SCADA System Connection Diagram.
- C. Time-Current Characteristic Curves: For overcurrent protective devices.
 - 1. Dimensioned outline of unit substation, conduit entries, and bonding locations.
- D. Product Certificates: For unit substations, signed by product manufacturer.
- E. Certified factory test reports in PDF format.

SECTION 261116 - UNIT SUBSTATIONS: continued

- F. Field quality-control test reports.
 - G. Manufacturer Seismic Qualifications.
 - H. Operation and Maintenance Data: For unit substations include operation and maintenance manuals.
 - I. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Touchup Paint: Two half-pint containers of paint matching enclosure's exterior finish.
 - 2. Spare indicating Lights
 - 3. Primary switch contact lubricant
 - 4. Spare fuses.
 - a. VT Fuses
 - b. Control power fuses
 - 5. One set of spare mounting gaskets for bushings, hand holes and gaskets associated with pressure relief devices.
 - 6. Provide Manufacturer recommended spare parts.
 - J. Arc Flash Study/ Protection Settings:
 - 1. The Contractor shall coordinate with vendor and be responsible for performing a complete arc flash hazard analysis and protection settings for all new and modified electrical distribution equipment under this project scope, including the indoor unit substation (USS).
 - 2. The study shall be performed in accordance with the latest editions of NFPA 70E, IEEE 1584, and applicable OSHA regulations.
 - 3. The Contractor shall coordinate with equipment vendors to obtain all necessary protective device data, nameplate information, and settings for inclusion in the study and settings.
 - 4. The Contractor shall provide:
 - a. Final arc flash report including one-line diagrams, short-circuit analysis, protective device coordination, and arc flash calculations with attached supporting documentation.
 - b. Arc flash warning labels for each applicable piece of equipment, printed and installed by the Contractor prior to system energization.
 - c. Electronic copies of study files and reports for Owner's record.
 - 5. The Contractor shall update the arc flash study to reflect actual as-built conditions prior to project closeout.
- 1.06 QUALITY ASSURANCE:
- A. Source Limitations: Obtain all sections of unit substation through one source from a single manufacturer.
 - B. Transformers, switchgear and switchboard shall be front aligned.
 - C. Product Options: Drawings indicate size, profiles, and dimensional requirements of unit substations and are based on the specific system indicated. Refer to DIVISION 01, Section "Product Requirements."

SECTION 261116 - UNIT SUBSTATIONS: continued

- D. 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.
 - E. Comply with IEEE C2.
 - F. Comply with IEEE C37.121.
 - G. Comply with NFPA 70.
 - H. Vendor to provide a recommended equipment installation field test check list to confirm installation meets manufacturers requirements.
- 1.07 DELIVERY AND HANDLING:
- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
 - B. Coordinate delivery of unit substations to allow movement into designated space.
 - C. Store unit substation components in a conditioned space protected from weather so condensation will not form on or in units.
 - D. Shipping splits shall be assembled by manufacturers service personnel at owners site.
- 1.08 PROJECT CONDITIONS:
- A. Field Measurements: Indicate measurements on Shop Drawings.
 - B. Foot print limitations: The available space at the existing facility for new equipment to be added is limited. The equipment shall be arranged to fit within a maximum allocated area of 33'-6 1/2" (L) x 23'-1 1/2" (W).

PART 2 - PRODUCTS

- 2.01 MANUFACTURERS:
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Control, Inc/ GE
 - 2. Cutler-Hammer/ Eaton
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric. (Basis of Design)
- 2.02 MANUFACTURED UNITS:
- A. Indoor Unit Arrangement: Transformer and Switchboard shall be assembled and about each other on a single housekeeping pad. Once assembled components will have the appearance of one single piece of equipment.
 - B. Enclosure Material: Steel, NEMA 1
- 2.03 INCOMING SECTION:
- A. Primary Incoming Section: Air terminal compartment with hinged door. Silver-plated copper bar for incoming line termination, lugs provided.

SECTION 261116 - UNIT SUBSTATIONS: continued

1. Primary Incoming Voltage: 12.47kV
 2. Continuous-Current Rating: 300A
 3. Primary Impulse withstand rating: 95kV BIL
 4. Short Circuit Rating: 85kA
- B. The primary air terminal compartment door shall be provided with a padlockable handle. A single padlock hasp shall be provided through the door, with the hasp loops securely fastened to the internal structural frame.
- 2.04 DRY-TYPE TRANSFORMER SECTION:
- A. Description: IEEE C57.12.51, NEMA ST 20, and dry-type, 3-phase, 6-winding, unit substation transformer.
 - B. Enclosure: Indoor, ventilated, cast coil/encapsulated coil, with primary and secondary windings individually cast in epoxy; with insulation system rated at 185°C with an 30°C average winding temperature rise above a maximum ambient temperature of 40°C.
 - C. Cooling System: Class AN/AF, air cooled/fan cooled, complying with IEEE C57.12.01.
 - D. Insulation Materials: IEEE C57.12.51, rated 220°C.
 - E. Basic Impulse Level: 95kV HV side; 30kV LV side.
 - F. Full-Capacity Voltage Taps: 4 nominal 2.5% taps, 2 above and 2 below rated primary voltage.
 - G. Sound level may not exceed 72 DB.
 - H. Impedance: 5.75%; $\pm 0.5\%$.
- 2.05 SECONDARY DISTRIBUTION:
- A. Low-voltage switchgear as specified in DIVISION 26, Section "Low-Voltage Switchgear" and "Low-Voltage Switchboard".
- 2.06 SOURCE QUALITY CONTROL:
- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.91q. Conduct switchgear and switchboard tests according to ANSI C37.51.
 - B. Factory Tests: Perform the following factory-certified tests on each unit substation:
 1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
 2. Visual inspection of internal, external components and structure.
 3. Ratios on the rated voltage connection and on tap extreme connections.
 4. Polarity and phase relation on the rated voltage connection.
 5. No-load loss at rated voltage on the rated voltage connection.
 6. Exciting current at rated voltage on the rated voltage connection.
 7. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 8. Applied potential.
 9. Induced potential.
 10. Dielectric withstand tests.
 11. Partial discharge test. q

SECTION 261116 - UNIT SUBSTATIONS: continued

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL:

- A. Manufacturer's authorized Field service representative shall assemble various shipping splits onsite adjacent to each other on a single housekeeping pad complete with field check documentation.
- B. Manufacturers train Owner's maintenance personnel to adjust, operate, and maintain systems. Manufacturer service representative shall inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist contractor(s) in field testing listed below. Report results in writing.
 - 1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
 - 2. After installing unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
 - 3. Set field-adjustable switches and circuit-breaker trip ranges.
 - 4. After installing unit substation and after electrical circuitry has been energized, test for compliance with requirements.
 - 5. Factory-authorized service representative shall train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 261116

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the switchgear, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section. It is intended to purchase all components of this Unit Sub-station from a single manufacturer.
- B. Specification Section: 26 24 13 Low Voltage Switchboard
- C. Specification Section 26 11 16 Unit Substation

1.02 SUMMARY:

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Medium-voltage, dry-type, cast-coil, unit substation transformers.

1.03 DEFINITIONS:

- A. NETA ATS: International Electrical Testing Association Acceptance Testing Specification.

1.04 REFERENCE STANDARDS

- A. 10 CFR 429 - Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment; Current Edition.
- B. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- C. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).
- D. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- E. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. ICC-ES AC156 - Acceptance Criteria for Seismic Certification by Shake-Table Testing of Nonstructural Components; 2010, with Editorial Revision (2015).
- G. IEEE C57.12.01 - IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers; 2020.
- H. IEEE C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers; 2020.
- I. ISO 9001 - Quality Management Systems — Requirements; 2015.
- J. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.
- K. NEMA TR 1 - Transformers, Step Voltage Regulators and Reactors; 2013 (Reapproved 2019).
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.
- N. UL 1562 - Standard for Transformers, Distribution, Dry-Type – Over 600 Volts; Current Edition, Including All Revisions.

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS: continued

1.05 SUBMITTALS:

- A. See Division 1- Administrative Requirements for submittal procedures.
- B. Provide sufficient information to determine compliance with Contract Documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain. Identify specific model numbers, options, and features of equipment proposed.
- C. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
- D. Indicate deviations from Contract Documents with reference to corresponding drawing or specification number and written justification for deviation.
- E. Shop Drawings: Indicate enclosure dimensions, kVA, primary and secondary nominal voltage, voltage taps, required clearances, diagram power wiring.
- F. Coordination Drawings: Floor plans, drawn to scale on which connections to other unit substation equipment are shown, anchor points and points of attachment.
- G. Operational Readiness Report:
 - 1. Document test results, including assumptions, conditions, allowances, and corrections made.
 - 2. Provide listing of field modifications and adjustments made including settings/parameters not identified as factory defaults within equipment's operations and maintenance manual documentation.
 - 3. Include certification, signed by manufacturer's representative, that equipment and associated system have been installed, configured, and tested in accordance with manufacturer's recommendations, conforms to requirements of Contract Documents, and is ready for operation.
- H. Functional Demonstration Testing Report: Document test results, including assumptions, conditions, allowances, and corrections made.
- I. Manufacturer's qualification statement.
- J. Operation and Maintenance Data: Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - a. Include manufacturer, supplier, support, and repair center contact information.
 - b. Include manufacturer's standard operation and maintenance data assembled for each size and type of equipment furnished.
 - c. Include contact information for parts stocking location closest to Owner.
 - d. Identify critical spare parts associated with long lead times and/or those critical to unit operation.
 - e. Identify maintenance spare parts required to regularly perform scheduled equipment maintenance including, but not limited to, consumable parts required to be exchanged during scheduled maintenance periods.
- K. Specimen Warranty: Statement of standard warranty and extended warranty options/costs.

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS: continued

- L. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. Spare Parts: For each type and size of unit installed.
 - a. Provide minimum spare parts recommended by manufacturer.
 - b. Touch-Up Paint for Finishes: One pint can.
 - c. Package and mark spare parts for long-term storage. Provide separate anti-static containers for printed circuit boards.
 - d. Vendor to provide manufacturers recommended spare parts.
 - N. Source quality-control test reports.
 - O. Operation and Maintenance Data: For transformer and accessories and maintenance manuals.
- 1.06 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 the following:
 - 1. IEEE C2.q
 - 2. ANSI C57.12.28
 - 3. IEEE C57.12.70
 - 4. IEEE C57.12.80.
 - 5. NFPA 70.
- 1.07 DELIVERY AND HANDLING:
- A. Deliver transformers protected from weather so condensation will not form on or in units.
 - B. Vendors to protect equipment damage from loading and shipping vibrations.
- 1.08 COORDINATION:
- A. Coordinate delivery date and time with owner. Provide owner with 5 day notice prior to arrival.

PART 2 - PRODUCTS

- 2.01 MANUFACTURERS:
- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Control, Inc / GE
 - 2. Cutler-Hammer / Eaton
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; Schneider Electric.
- 2.02 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS:
- A. Description: NEMA ST 20, IEEE C57.12.01, ANSI C57.12.51 UL 1562 listed and labeled dry-type, 3- phase copper wound transformer.
 - 1. Indoor, ventilated, cast coil and with insulation system rated at 185°C with a 115°C average winding temperature rise above a maximum ambient temperature of 40°C.

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS: continued

- B. Primary Connection: Air terminal compartment with hinged door. Silver-plated copper bar for incoming line termination, lugs provided.
- C. Secondary Connection: Transition terminal compartment with connection pattern to match switchgear.
- D. Insulation Materials: IEEE C57.12.01, rated at 185°C.
- E. Basic Impulse Level: 95kV BIL for primary, 30kV BIL for secondary.
- F. Full-Capacity Voltage Taps: Four nominal 2.5% taps, 2 above and 2 below rated primary voltage.
- G. Tap Operation: Taps should be suitable for operation when de-energized.
- H. Cooling System: Class AN/AF, self-cooled/fan cooled, complying with IEEE C57.12.01.
- I. Sound level may not exceed 72 dBA.
- J. Impedance: $5.75\% \pm 0.5\%$
- K. Accessories: Grounding pads, lifting lugs, and provisions for jacking under base. Transformers shall have a steel base and frame allowing use of pipe rollers in any direction, and an insulated, low-voltage, neutral bushing with removable ground strap.
- L. Winding Temperature Monitoring: The Transformer shall be provided with a winding temperature indicator that displays the highest winding temperature.
- M. Control Power: All accessories requiring power shall be supplied from a control power transformer (CPT) located within the transformer enclosure. The CPT shall be sized appropriately to supply all required accessory loads with adequate margin and shall include primary and secondary protection.
- N. Lightning Arresters: The distribution class lightning arresters shall be provided and installed within the switchgear or air terminal compartment.

2.03 SOURCE QUALITY CONTROL:

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.51.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
 - 1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 - 2. Ratios on rated-voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on rated-voltage connection.
 - 4. No-load loss at rated voltage on rated-voltage connection.
 - 5. Excitation current at rated voltage on rated-voltage connection.
 - 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 - 7. Applied potential.
 - 8. Induced potential.
 - 9. Dielectric withstand tests
 - 10. Partial discharge test
 - 11. Owner will be given the opportunity to witness all required factory tests. Notify Engineer at least 14 days before date of tests and indicate their approximate duration.

SECTION 261200 - MEDIUM-VOLTAGE TRANSFORMERS: continued

2.04 MAINTENANCE EQUIPMENT AND SPARE PARTS:

- A. Three spare high-voltage bushing of each type.
- B. Three spare low-voltage bushing of each type.
- C. One spare neutral bushing of each type.

PART 3 - EXECUTION

3.01 MANUFACTURER'S FIELD SERVICE INSTALLATION:

- A. Manufacturer to provide a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Refer to Bid Form 00 41 63 for timeline on duration for installation, commissioning and startup activities.

END OF SECTION 261200

SECTION 26 24 00 – PANELBOARDS AND TRANSFORMERS:

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes panelboards and dry-type transformers for low-voltage power applications.
- B. Furnish and install quantities and types as specified or as indicated.

1.02 RELATED REQUIREMENTS:

- A. Section 26 05 26 - Grounding.

1.03 REFERENCE STANDARDS:

- A. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE C57 Series - Transformers, Regulators, and Reactors.
 - 2. IEEE C57.12.01 – General Requirements for Dry-Type Distribution and Power Transformers.
 - 3. IEEE C57.12.91 – IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
 - 4. IEEE C37.20.1 - Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
- B. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code (NEC).
- C. National Electrical Manufacturers Association (NEMA):
 - 1. NEMA ST-20 – Dry Type Transformers for General Applications.
 - 2. NEMA ICS 1 - Industrial Control and Systems General Requirements.
 - 3. NEMA ICS 4 - Application Guideline for Terminal Blocks.
 - 4. NEMA PB 1 - Panelboards.
 - 5. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).
- D. Underwriters' Laboratories, Inc. (UL):
 - 1. UL 50 - UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - 2. UL 67 - Panelboards.
 - 3. UL 489 - UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
 - 4. UL 506 - UL Standard for Safety Specialty Transformers.
 - 5. UL 508 - UL Standard for Industrial Control Equipment.
 - 6. UL 891 - UL Standard for Safety Switchboards.
 - 7. UL 1561 – UL Standard for Safety for Dry Type General Purpose and Power Transformers.
- E. Factory Mutual Global (FM).
- F. DOE 2016 (10 CFR Part 431) – Transformer efficiency mandated by the U.S. Department of Energy.

1.04 SUBMITTALS:

- A. Submit as specified in Division 01.
- B. Includes, but not limited to, the following:
 - 1. General arrangement and outline information.
 - 2. Schematic power diagrams.
 - 3. Wiring diagrams.
 - 4. Bills of material.
 - 5. Nameplate information.
 - 6. Protective device coordination curves and setting documentation.
 - 7. Any other information required by Engineer or Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Panelboards:
 - 1. ABB / General Electric Company.
 - 2. Eaton / Cutler-Hammer.
 - 3. Schnieder Electric / Square D
- B. Transformers:
 - 1. ABB / General Electric Company.
 - 2. Eaton / Cutler-Hammer.
 - 3. Schnieder Electric / Square D
- C. Mini Load Centers:
 - 1. ABB / General Electric Company.
 - 2. Eaton / Cutler-Hammer.
 - 3. Schnieder Electric / Square D

2.02 PANELBOARDS:

- A. General:
 - 1. Heavy-duty type with voltage and ampere ratings as indicated.
 - 2. Enclosures of the following types:
 - a. NEMA 1 - General Purpose for indoor nonhazardous locations.
 - b. NEMA 3R - Raintight for outdoor locations.
 - 3. Panelboards in code gage, hot-dipped galvanized sheet metal boxes with code gage steel trim and finished with a rust inhibiting primer and light gray paint (formerly ANSI Z55.1.61 No. 61).
 - 4. Switchboards constructed of sheet steel for floor mounting and finished with a rust inhibiting primer and light gray paint (formerly ANSI Z55.1.61 No. 61).
 - 5. Hinged door with lock and catch combination in the front trim of all panelboards.
 - 6. Phenolic nameplate on front of panel engraved with the panelboard or switchboard designation, and above each breaker operating handle on switchboards. Refer to Section 26 05 06 for nameplate specifications.
 - 7. Breakers with trip rating and number of poles as indicated.
 - 8. Future breaker space for the number of poles as indicated.
 - 9. Copper main buses of the capacity indicated.

SECTION 26 24 00 - 2

26 24 00 PANELBOARDS AND TRANSFORMERS

10. The short circuit current rating of the assembled panelboard or switchboard shall be equal to or greater than the interrupting capacity of the highest rated branch breaker.
11. Each circuit breaker provided with an integral metal locking device to facilitate locking individual breakers in OFF position with a padlock.
12. Breakers used to switch lighting circuits listed and marked HID.
13. Breakers used for heating, air-conditioning, and refrigeration listed and marked HACR.
- B. 120/208V Panelboards:
 1. Rated 240Vac, 3-phase, 4 wire, solid neutral, with main breaker or lugs as indicated.
 2. Provide 150 ampere frame size bolt-on thermal-magnetic breakers with noninterchangeable trip units.
 3. Breakers shall have a minimum interrupting capacity of 14,000 rms amperes symmetrical at 240Vac.
 4. Cutler-Hammer Type POW-R-LINE1 or General Electric Type AQ.

2.03 TRANSFORMERS:

- A. Dry type with kVA rating as indicated on the drawing.
- B. Suitable for indoor or outdoor installation.
- C. Encapsulated core and coils.
- D. Copper windings.
- E. Noise level not to exceed NEMA ST1 standards as follows:
 1. 0 9 kVA - 40 dB.
 2. 10 50 kVA - 45 dB.
 3. 51 150 kVA - 50 dB.
 4. 151 300 kVA - 55 dB.
 5. 301 500 kVA - 60 dB.
- F. Class H insulation with 115°C maximum temperature rise in 40°C ambient under continuous full load operation.
- G. 480-120/208V, 3-phase, 60 hertz, delta-wye connected with taps as follows:
 1. Minimum of four 2-1/2% full-capacity taps, 2 above (FCAN) and 2 below (FCBN) 480V.
 2. General Electric Type ML for 3 15 kVA and Type QL for 30 kVA and larger or Cutler-Hammer Type EPT for 3 15 kVA and Type DT 3 for 30 kVA and larger.

2.04 MINI-LOAD CENTERS:

- A. Provide combination 480-120/208V, 3-phase, 4-wire, dry-type transformer and 120/208V distribution panel with transformer, main buses, primary and secondary breakers sized as indicated.
- B. Transformer and panelboard to be mounted in one common enclosure suitable for indoor and outdoor installation.
- C. Provide two 5% full-capacity below normal (FCBN) taps.
- D. Provide branch breakers of sizes and quantities indicated with minimum interrupting rating of 10,000 amperes at 240Vac for single phase units and 14,000 amperes for three phase units.
- E. Cutler-Hammer Mini-Power Center.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install at locations indicated including all necessary mounting and supporting materials.
2. Locate and arrange with proper clearances from other equipment and material to obtain good accessibility for operation and maintenance.
3. Space away from walls or columns at least 1/4 inch to prevent surface moisture from rusting the enclosure.
4. Refer to structural specification and drawing package for concrete foundations.
5. Provide all necessary floor openings unless indicated as being provided by others.
6. Clean all welds, scars, and abrasions and remove metal splatter, rust and foreign material and apply organic zinc rich coating.
 - a. Carboline - Carbozinc 859.
 - b. International - Interzinc 52 HS.
 - c. Tnemec - Tnemezinc 90-97.

B. Panelboards:

1. Flush mount in finished areas and surface mount on walls or columns in all other areas.
2. Install with top of panelboard approximately 6 feet above floor.
3. Provide typed circuit directory in each panelboard indicating branch circuit loads.
4. Rearrange circuit breaker locations to match the circuit sequence shown on the panelboard schedules.
5. Ground all neutral buses to the station ground system.

C. Owner furnished Switchboards:

1. Receive, unload, store/maintain, set, and install.
2. Shim so that unit is level, anchor to foundation with bolts cast in foundation or with cinch anchors, and grout.
3. Ground all neutral buses to the station ground system.

D. Transformers:

1. Floor mount wherever possible unless otherwise indicated.
2. Provide flexible conduit connections to minimize vibration and noise.

E. Mini Load Centers:

1. Install with top of panelboard section approximately 6 feet above floor.
2. Provide typed circuit directory in panelboard indicating branch circuit loads.
3. Rearrange circuit breaker locations to match the circuit sequence shown on the panelboard schedules.
4. Ground all neutral buses to the station ground system.

END OF SECTION SECTION 26 24 00

SECTION 26 24 13 – SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section specifies switchboard work that is indicated by drawings and schedules.
- B. Types of switchboards specified in this Section include the following:
 - 1. Low-voltage dead-Front Switchboards (SWBD)
 - 2. Overcurrent protective devices.
 - 3. Metering Equipment
 - 4. PLC
 - 5. Remote Breaker Control Panel

1.02 REFERENCE STANDARDS:

- A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendment (2017).
- D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. IEC 62443-4-1 - Security for Industrial Automation and Control Systems – Part 4-1: Secure Product Development Lifecycle Requirements; 2018.
- F. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020 (Corrigendum 2022).
- G. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks; 2020, with Amendment (2021).
- H. ISO 9001 - Quality Management Systems — Requirements; 2015.
- I. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.
- J. MIL-STD-220 - Method of Insertion Loss Measurement; 2009c (Validated 2019).
- K. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- L. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.
- M. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.
- N. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.
- O. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.
- P. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment and Systems; 2021.
- Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

SECTION 26 24 13 - SWITCHBOARDS: continued

- R. NFPA 70B - Recommended Practice for Electrical Equipment Maintenance; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- S. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.
- T. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- U. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- V. UL 486A - Wire Connections and Soldering Lugs for Use in Copper Conductors.
- W. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- X. UL 891 - Switchboards; Current Edition, Including All Revisions.
- Y. UL 977 - Fused Power-Circuit Devices; Current Edition, Including All Revisions.
- Z. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.
- AA. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.
- BB. UL 1066 - Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures; Current Edition, Including All Revisions.
- CC. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
- DD. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- EE. UL RP 2986 - Recommended Practice for Measuring Incident Energy Exposure; 2015.

1.03 SUBMITTALS:

- A. Refer to Division 01 for administrative and procedural requirements for submittals.
- B. Includes, but not limited to, the following:
 - 1. Product Data: Submit manufacturer's data on switchboards including, but not limited to, voltages, number of phases, frequency, short-circuit, and continuous current ratings. Provide application data and time-current trip curves for main and branch circuit-breakers and fuses. Provide time-current curves for fuse melting and clearing.
 - 2. Shop Drawings: Submit dimensioned drawings of switchboards showing accurately dimensioned equipment sections, including auxiliary compartments, section components, and combination sections. Indicate weight of each section. Indicate all required access points for all terminations.
 - 3. Submit paint manufacturer's certification of VOC compliance and MSDS sheets. Submit certification of paint VOC level compliance as required by local or regional governing authorities.
 - 4. Wiring Diagrams: Submit a wiring diagram for switchboards showing connections to electrical power feeders and distribution branches. Differentiate between portions of wiring that are manufacturer factory-installed and portions that are field-installed.
 - 5. Provide composite time-current curves. Clearly indicate all device settings and available fault currents.
 - 6. Operation and Maintenance Manual.

7. All Field Test Data.
8. Proposed Mimic Bus.
9. Refer to additional submittal requirements in 01 33 04.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver switchboards and components properly packaged and mounted on pallets or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboard and components which protect equipment from damage. Install impact measuring meters in containers which will indicate whether the container has been bumped or dropped. Impact meters will be returned to the manufacturer for reuse upon delivery of switchboards.
- B. Store indoors in climate-controlled space to prevent condensing.
- C. Handle switchboard equipment carefully to prevent physical damage to equipment and components.

1.05 SEQUENCING AND SCHEDULING:

- A. Schedule delivery of switchboard equipment with owner and Engineer. Provide 5 days' notice prior to site arrival.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Subject to compliance with requirements, provide switchboard units of one of the following (for each type, and rating of switchboard):
 1. ABB Control, Inc / GE
 2. Cutler-Hammer / Eaton
 3. Siemens Energy & Automation, Inc.
 4. Square D; Schneider Electric.

2.02 EQUIPMENT SECTIONS AND COMPONENTS:

- A. General: Except as otherwise indicated, provide switchboards and ancillary components of types, sizes, characteristics, and ratings indicated which comply with manufacturer's standard design, materials, components, and construction, in accordance with published product information, and as required for complete installation. Provide terminals UL rated for 75°C (minimum) conductors.
- B. AC Dead-Front Distribution Switchboards: Factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings, and characteristics indicated; consisting of vertical panel units and containing circuit-breakers of quantities, ratings, and types indicated. Provide silver-plated copper main bus with connections to circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise to no greater than 65°C above average ambient temperature of 30°C; with main bus and tap connections silver-surfaced and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Copper bus current density shall not exceed 1,200 amperes per square inch. Brace bus for short-circuit stresses greater than or equal to the minimum interrupting capacity indicated. Provide accessibility of line and load terminations from front of switchboard. Prime and coat switchboard with manufacturer's

SECTION 26 24 13 - SWITCHBOARDS: continued

- standard finish and color. Provide factory-painted white mimic bus on front of each switchboard. Provide equipment with built-in lifting eyes and yokes. Provide vertical individual panel units, suitable for bolting together at project site. Construct switchboard enclosures suitable for the following environment:
1. Installation: Indoors, NEMA Type 1.
- C. Enclosures: Construct dead-front switchboards suitable for floor mounting, with front cabling/wiring accessibility and conduit accessibility as indicated. Provide welded steel channel framework; hinge front wireway covers to permit ready access to branch circuit-breaker load side terminals. Enclosure shall be suitable for being rolled or pushed into final location. Coat enclosures with manufacturer's standard corrosive-resistant finish.
1. Factory Paint:
 - a. Equipment Manufacturers standard coating system may be applied, which is suitable for the intended environment and service, but which does not contain any lead (0.00%), zinc or strontium chromates, mercury or mercury compounds, or asbestos. Coatings shall also be VOC compliant to meet the VOC level as required by the local or regional governing authorities. Equipment Manufacturers shall submit certification by coating manufacturers, including MSDS sheets, verifying these requirements.
- D. Circuit Breakers: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information and as required for a complete installation.
1. Molded-Case Circuit Breakers (MCCBs):
 - a. Comply with FS W-C-375; listed and labeled as complying with UL 489.
 - b. Lugs: Mechanical type.
 - c. Circuit Breaker Type:
 - 1) Provide thermal magnetic circuit breakers unless otherwise indicated for circuit breaker frame sizes less than 101 amperes.
 - d. Electronic Trip Units:
 - 1) Microprocessor based, with circuit breaker status display and LED trip indicators for breakers greater than 101 amperes. All Electronic trip breakers shall be rated for 100% duty.
 - 2) Provide electronic trip units with field-adjustable long-time, short-time, instantaneous and ground-fault protection settings.
 - e. Provide the following where indicated.
 - 1) Shunt Trip: Provide 120 VAC coil, energized from separate circuit.
 - 2) Auxiliary Contacts: Two SPDT switches for indicating status of circuit breaker contacts.
- E. Switchboard Bus: Provide switchboard busing with sufficient cross-sectional area to fulfill UL 891 pertaining to temperature rise. Bus rating shall be as indicated in the One-Line. Construct through-bus of copper (with silver-plated connections), with ampacity rating indicated, and

with short-circuit current rating indicated. Provide fully rated main bus (tapered bus is not acceptable). Provide full capacity neutral bus. Provide ground bus full length of switchboard, firmly connected to each vertical section of the switchboard.

1. Power Metering:
 - a. Factory installed, integrated within low-voltage switchboard.
 - b. Applications:
 - (1) Power Meter 5500 (or an equivalent meter) downstream of all breakers 3000A and greater.
 - (2) ION9000 series meter on the secondary side of the transformer.
 - c. ION9000 meter to be located close to the incoming section of the SWBD and 5500 power meter to be located close to the associated breaker.
2. PLC:
 - a. Programmable Controller:

The system shall be controlled by an integral programmable logic controller (PLC). Manufacturer shall provide networking/communication diagrams and all I/O and communication requirements for breaker control and monitoring to owner.
 - b. Minimum I/O for each breaker shall include:
 - (1) Voltage
 - (2) Current
 - (3) Breaker Status
 - (4) Breaker Open
 - (5) Breaker Closed
 - (6) Breaker Tripped
 - c. The following provisions shall be made to communicate with the owner provided programmable control system:
 - (1) Ethernet communications to network all I/O back to PLC controller.
 - (2) Modbus RTU Protocol or engineer/owner approved alternate.
- F. Future equipment and spare parts:
 1. Power Distribution Switchboards shall include bus extensions at the ends of the switchboard to accommodate future sections.
 2. Space shall be provided for a minimum of four (4) additional circuit breakers to allow for future expansion without exceeding allotted footprint.
- G. Ground fault protection (GFP) interlocking: For 277/480V systems requiring ground fault protection, both the main circuit breaker and feeder circuit breakers of 100A and more shall be equipped with GFP. The system shall employ a sone interlocking scheme between the main and feeder breaker to ensure proper coordination and selective tripping in accordance with applicable standards.
- H. All meters and PLC equipment shall be installed in isolated or barriered compartments. All potential transformers (PTs) and control power transformers (CPTs) shall be installed in separate compartments from the metering and control devices. Current Transformer (CT) shorting blocks shall be located within the same compartments as the meters. All terminal strips used for external I/O connections shall also be located within these low-voltage metering and control compartments.

SECTION 26 24 13 - SWITCHBOARDS: continued

- I. Remote Breaker Control Panel: Provide a wall-mounted Remote Breaker Control Panel for each medium voltage breaker. The panel can be HMI based and connected to the internal switchboard PLC or it can include open/close breaker switches for three breakers (3,000A, 2,000A, 2,000A), breaker status indication lights (open, closed, and trip), and an emergency trip pushbutton. The panel shall be factory wired, tested, and suitable for interface with the breaker control circuit through the PLC or directly with the breakers. Enclosure shall be NEMA 12 rated for indoor installation.

END OF SECTION 26 24 13

SECTION 26 29 23 – VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.02 SUMMARY:

- A. This Section includes separately enclosed, pre-assembled, combination VFCs, rated 600V and less, for speed control of three-phase, squirrel-cage induction motors.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards: (Comply with applicable requirements of the following standards).
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
 - b. ICS 1 - Standard for Industrial Control and Systems: General Requirements.
 - c. ICS 6 - Enclosures.
 - d. ICS 7 - Adjustable Speed Drives.
 - e. ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
 - f. ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.
 - g. ICS 61800-3 - Adjustable speed electrical power drive systems - Part 3: EMC Requirements and Specific Test Methods.
 - 2. National Fire Protection Association (NFPA):
 - a. NFPA 70 - National Electrical Code.
 - 3. Underwriters Laboratories (UL):
 - a. 489 - UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - b. 508C - UL Standard for Safety Power Conversion Equipment.
 - c. 1995 - UL Standard for Safety Heating and Cooling Equipment.
 - 4. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 519 - Recommended Practices and requirements for Harmonic Control in Electrical Power Systems.
 - b. 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
 - 5. InterNational Electrical Testing Association (NETA):
 - a. ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

1.04 SUBMITTALS:

- A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

- B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment. Enclosure types and details.
 - 1. Nameplate legends.
 - 2. Short-circuit current (withstand) rating of enclosed unit.
 - 3. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
 - 4. Specified modifications.
 - 5. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.
- C. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Allen-Bradley
- B. Toshiba
- C. Danfoss
- D. Siemens
- E. ABB

2.02 VARIABLE FREQUENCY MOTOR CONTROLLERS:

- A. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Application: Variable torque loads.
- C. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT / PWM inverter) factory packaged in an enclosure, with integral disconnecting means, overcurrent, and overload protection; listed and labeled by UL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
 - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 - 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 - 3. Listed and labeled for integrated short-circuit current (withstand) rating.
 - 4. UL 1995 Plenum Rated.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
 - 1. Input AC Voltage Tolerance: +10% and -15% of VFC input voltage rating.
 - 2. Input AC Voltage Unbalance: Not exceeding 5%.
 - 3. Input Frequency Tolerance: $\pm 3\%$ of VFC frequency rating.
 - 4. Minimum Efficiency: 96% at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 96% under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 42KA minimum or to match the KA rating of the upstream equipment if it is greater than 42KA.
7. Ambient Temperature Rating: Not less than 14°F (-10°C) and not exceeding 104°F (40°C).
8. Ambient Storage Temperature Rating: Not less than -4°F (-20°C) and not exceeding 140°F (60°C).
9. Humidity Rating: Less than 95% (noncondensing).
10. Altitude Rating: Not exceeding 3,300 ft. (1,005 m).
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100% of rated torque from 3 to 60 Hz.
14. Speed Regulation: ±5%.
15. Output Carrier Frequency: Selectable; 1.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
17. Inverter Logic: Microprocessor based, isolated from all power circuits.
18. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
19. Internal Adjustability Capabilities:
 - a. Minimum Speed: 5 to 25% of maximum rpm.
 - b. Maximum Speed: 80 to 100% of maximum rpm.
 - c. Acceleration: 0.1 to 999.9 seconds.
 - d. Deceleration: 0.1 to 999.9 seconds.
 - e. Current Limit: 30 to minimum of 150% of maximum rating.
20. Self-Protection and Reliability Features:
 - a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10% or more above nominal line voltage.
 - b. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 - c. Under- and overvoltage trips.
 - d. Inverter overcurrent trips.
 - e. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
 - f. Critical frequency rejection, with three selectable, adjustable deadbands.
 - g. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - h. Loss-of-phase protection.
 - i. Reverse-phase protection.
 - j. Short-circuit protection.
 - k. Motor overtemperature fault.
21. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

22. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
23. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- G. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
 1. Disconnect Rating: Not less than 115% of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 2. Auxiliary Contacts: NO/NC, arranged to activate before disconnect opens.
- H. Provide a lockable disconnecting means integral to each VFD. Disconnecting means shall be UL listed, horsepower rated and sized for the applied load. Provide provisions for padlocking in the open position to comply with lockout/tagout (LOTO) requirements. Install disconnects within the VFD enclosure or as a separate adjacent device.

2.03 CONTROLS AND INDICATION:

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
 1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
 2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
 3. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
 1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).

8. DC-link voltage (Vdc).
 9. Set point frequency (Hz).
 10. Motor output voltage (Vac).
 - E. Control Signal Interfaces:
 1. Electric Input Signal Interface:
 - a. A minimum of two programmable analog inputs: 0- to 10Vdc or 4- to 20-mA dc, coordinate with BAS and controls contractor.
 - b. A minimum of six multifunction programmable digital inputs.
 - c. Pneumatic Input Signal Interface: 3 to 15 psig (20 to 104 kPa).
 - d. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems.
 - e. Potentiometer using up/down digital inputs.
 - f. Fixed frequencies using digital inputs.
 - g. Input to allow aux contacts off of downstream disconnects to turn off the VFC when the disconnect is operated.
 - F. Output Signal Interface: A minimum of one programmable analog output signal(s) 0- to 10Vdc or 4- to 20-mA dc, coordinate with BAS and controls contractor, which can be configured for any of the following:
 1. Output frequency (Hz).
 2. Output current (load).
 3. DC-link voltage (Vdc).
 4. Motor torque (percent).
 5. Motor speed (rpm).
 6. Set point frequency (Hz).
 - G. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120Vac, 1 A) for remote indication of the following:
 1. Motor running.
 2. Set point speed reached.
 3. Fault and warning indication (overtemperature or overcurrent).
 4. PID high- or low-speed limits reached.
 - H. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
 - I. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
 1. Network Communications Ports: Ethernet, coordinate with BAS vendor.
 2. Embedded BAS Protocols for Network Communications: coordinate with BAS and controls contractor.
- 2.04 LINE CONDITIONING AND FILTERING:
- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 5% and THD(V) to 3%.
 - B. EMI/RFI Filtering: CE marked; certify compliance with NEMA ICS 61800-3 for Category C2.
- 2.05 MAINTENANCE BYPASS SYSTEMS:

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Contactor Configuration: Reduced-voltage (autotransformer) type.
 - 1. NORMAL/BYPASS selector switch.
 - 2. HAND/OFF/AUTO selector switch.
 - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
- D. Overload Relays: NEMA ICS 2.

2.06 ENCLOSURES:

- A. VFC Enclosures: NEMA 250, Type 12 if installed indoors, Type 3R if installed outdoors, or equivalent IEC IP Type.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2,000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Floor-Mounted Controllers: Install VFCs on 4 inch (100 mm) nominal thickness concrete base. Comply with requirements for concrete base specified in Section 03 30 00 - Cast-in-Place Concrete.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450 mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.03 CONTROL WIRING INSTALLATION:

- A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 26 05 23 - Control-Voltage Electrical Power Cables.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL:

- A. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
- B. Test continuity of each circuit.
- C. Tests and Inspections:
 1. Inspect VFC, wiring, components, connections, and equipment installation.
 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 3. Verify that voltages at VFC locations are within 10% of motor nameplate rated voltages.
 4. Test each motor for proper phase rotation.
 5. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFCs will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 29 23

SECTION 28 44 00 - REFRIGERANT DETECTION AND ALARMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. All project specifications, drawings, and general provisions apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and current installation. Any specific reference mentioned herein are for convenience only.

1.02 SUMMARY:

- A. The purpose of this specification is to define all requirements for the procurement, installation, and calibration of the refrigerant monitors system.
- B. Locate, install, and configure functionality of refrigerant monitor, and sensors as specified here and on the associated drawings.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards (Latest Edition):
 - 1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. 15 - Safety Standard for Refrigeration Systems (ANSI).
 - b. 34 - Designation and Safety Classification of Refrigerant (ANSI).
 - c. 147 - Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems (ANSI).
 - 2. ASTM International (ASTM):
 - a. D2737 - Polyethylene (PE) Plastic Tubing.
 - 3. Code of Federal Regulations (CFR):
 - a. 42 CFR - Public Health, Part 84 - "Approval of Respiratory Protective Devices," Subpart H - "Self-Contained Breathing Apparatus."
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. 250 - Enclosures for Electrical Equipment (1,000V Maximum).
 - 5. Underwriters Laboratories Inc. (UL):
 - a. 464 - Audible Signal Appliances.
 - b. 1971 - Signaling Devices for the Hearing Impaired.

1.04 SUBMITTALS:

- A. Product Data:
 - 1. For each type of refrigerant monitored, include refrigerant sensing range in ppm, temperature and humidity range, alarm outputs, display range, furnished specialties, installation requirements, and electric power requirement.
- B. Shop Drawings:
 - 1. Air-Sampling Tubing Diagrams: Size, routing, length of run, and termination including elevation above finished floor.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

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3. Panel Layout diagrams: Refrigerant monitor and peripheral control enclosures.
 - C. Coordination Drawings: Include machinery-room layout showing location of monitoring devices, controls enclosures, emergency alarm push buttons and air-sampling tubing with filter/inlet locations in relation to refrigerant equipment.
 - D. Product Certificates: For monitoring devices, signed by product manufacturer.
 - E. Field quality control test reports.
 - F. Operation and Maintenance Data: For refrigerant monitoring equipment. Data shall include operation and maintenance manuals.
 - G. Training Manuals: provide manuals for Refrigerant Leak monitoring equipment operation.
 - H. Installation Drawings: Provide As-built CAD files of all Shop and Coordination Drawings, and copies of the final testing documentation no later than 30 days after the completion of equipment installation, testing and commissioning.
 - I. One calibration kit including a clean air calibration gas bottle for zero calibration, and R-514A refrigerant calibration gas for span calibration, minimum 58-L capacity, pressure regulator, and tubing.
- 1.05 COORDINATION:
- A. Coordinate refrigerant detection and alarm system with refrigerant contained in refrigeration equipment for compatibility.
 - B. Coordinate work activities with all other trades for installation and testing.

PART 2 - PRODUCTS

- 2.01 PHOTOACOUSTIC INFRARED (PIR) REFRIGERANT MONITOR:
- A. Manufacturer/ Model: Thermal Gas Systems/ Haloguard III
Microprocessor: A704
 - B. ASHRAE: Monitoring system shall comply with ASHRAE 15.
 - C. Performance:
 1. New Refrigerant to Be Monitored: R-514A
 - a. Existing Refrigerants: R-22, R-123, R-134A
 2. Range: 0 to 1000 ppm.
 3. Minimum Detectability: 1 ppm.
 4. Accuracy: ± 1 ppm $\pm 10\%$ of reading from 0-1000 ppm
 5. Warmup Cycle Time: 20 minutes. (1 hour – cold start)
 6. Detection Level Set Points:
 - a. Detection Level 1 (Leak) - LO Alarm: 25 ppm.
 - b. Detection Level 2 (Occupational Exposure Limit (OEL)) - HI Alarm: 50 ppm.
 - c. Detection Level 3 (Refrigerant Concentration Limit (RCL) - Evacuate) – HI HI Alarm: 1000 ppm.
 7. Operating Temperature: 32 to 122°F (0 to 50°C).
 8. Relative Humidity: 5 to 90%, noncondensing over the operating temperature range.
 - D. Input/Output Features:

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1. AC Power Rating: 100-240Vac, 50/60 Hz, 65 W.
2. Number of Sensor Points per chiller: 4
3. Number of Gas Monitoring Inlet Ports: 8
4. Alarm Relays: 7 SPDT contacts – 10 A 240 VAC (resistive). 1 fault relay, 6 programmable alarm relays.
5. Alarm Set Points: Displayed and adjustable through keypad on front of meter.
6. Alarm Acknowledge Mode: Auto; non-latching; alarm silenced for 20 minutes and reactivate if not corrected.
7. Display: Alphanumeric LCD, LED indicating lights for each detection level; alarm status LEDs and service fault/trouble LEDs.
8. Audible Output: Local audible alarm
9. Visible Output: Front panel indication lights (Three alarm LEDs)
10. Serial Interface: N/A
11. Enclosure: NEMA 12

2.02 AUDIBLE/STROBE ALARM

- A. Manufacturer/ Model: Wheelock MT4-115-WH-VNS.
WBB Weather Resistant Backbox (White 2411).
- B. Relative Humidity: 95% RH maximum.
- C. Temperature: -31°F to 150°F
- D. Outdoor Use: Yes

2.03 MONITORING AND ALARMING:

- A. The Refrigerant Monitoring system shall continuously monitor programmed zones for refrigerant and transmit the following information to the BMS via hardwired connections from the alarm relays:
 1. Refrigerant detection alarms.
 2. Refrigerant detection system health fault/ trouble.

2.04 AIR-SAMPLING TUBING:

- A. Polyethylene Tubing: ASTM D2737, flame-retardant, nonmetallic tubing rated for ambient temperature range of 10 to 150°F (-13 to +65°C); Alternatively, copper tubing can be used for Air, Sampling and Purge line connections.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Comply with ASHRAE 15 and ASHRAE 147.
- B. Reprogram the two channels currently being used for Chiller 3 and 4, respectively, to read R-514a (while maintaining detection of the existing refrigerants) upon installation of the A704 microprocessor.
 1. Testing shall be completed to verify proper detection of all refrigerant types to be detected.

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- C. Air, Sampling and Purge line flex tubing shall be supported with Unistrut or conduit (PVC/metal). Tubing runs shall be protected from physical damage.
- D. Install air-sampling tubing with sufficient slack and flexible connections to allow for vibration of tubing and movement of equipment.
- E. Purge air-sampling tubing with dry, oil-free compressed air before connecting to monitor.
- F. Color-code air-sampling tubing for future identification and service of air-sampling multiple-point monitors.
- G. Extend fresh air purge line tubing to Control Room ceiling plenum space from the inlet connection port of NDIR monitors.

3.02 FIELD QUALITY CONTROL:

- A. Testing Agency: Construction manager will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Tests and Inspections:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
 - 2. Test and adjust controls and alarms.
 - 3. Test Reports: Prepare a written report to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Contractor shall repair or replace malfunctioning units and retest as specified above. Repair, retesting and replacement of malfunctioning units shall continue until a condition of satisfaction is achieved.

3.03 DEMONSTRATION:

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain refrigerant detection devices.

END OF SECTION 28 44 00

SECTION 31 63 29 – DRILLED SHAFT FOUNDATIONS

PART 1 - GENERAL

1.01 SUMMARY:

- A. Work under this SECTION consists of furnishing all supervision, labor, equipment, materials, and quality control necessary to install all drilled shafts for IU Chiller Replacement.
- B. Work under this SECTION shall conform to all requirements of ACI 336.1 published by the American Concrete Institute, Farmington Hills, Michigan, except as modified herein.
- C. Drilled shafts shall be embedded as indicated on the Drawings.
- D. Contractor shall visit the Site prior to bidding to observe and review specific Site conditions and requirements for equipment, methods, and costs to install drilled shafts.
- E. Contractor shall verify the location of all underground conduits, piping, duct banks and utilities prior to installing drilled shafts.
- F. Owner will retain a Geotechnical Representative as defined herein.

1.02 RELATED REQUIREMENTS:

- A. SECTION 03 10 00 – Concrete Formwork.
- B. SECTION 03 20 00 – Concrete Reinforcement.
- C. SECTION 03 30 00 – Concrete.

1.03 REFERENCE STANDARDS:

- A. General:
 - 1. Standards listed by reference, including revisions by issuing authority, form a part of this SECTION to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
 - 2. Where specifications and reference documents conflict, the specification shall govern.
 - 3. Unless otherwise noted, the latest revision of the following reference standards shall apply to this SECTION.
- B. Applicable Standards:
 - 1. American Concrete Institute (ACI):
 - a. 336.1 - Specification for the Construction of Drilled Piers.
 - 2. American Petroleum Institute (API):
 - a. 13A - Specification for Drilling-Fluid Materials.
 - 3. ASTM International (ASTM):
 - a. D698 – Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - b. D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - c. D4253 – Maximum Index Density of Soils Using a Vibratory Table.
 - d. D4254 – Minimum Index Density of Soils and Calculation of Relative Density.

1.04 DEFINITIONS:

- A. Bearing Stratum - The formation(s) or layer(s) of gray or brown, slightly weathered fossiliferous limestone that support the shaft and loads imposed on it.
- B. Geotechnical Representative – The Geotechnical Representative is responsible for observation and recording of material verification, drilled shaft installation sequence and methods, and other quality control documentation as specified herein.

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- C. Pumping of Concrete - Concrete placed under water or through slurry conveyed by pressure through a rigid pipe or flexible hose and discharged directly to bottom of shaft. Pressure is applied by piston pumps, pneumatic compressed air, or squeeze pressure pumps in accordance with ACI 336.1. NOTE: Placement of concrete under water or through slurry will not be permitted during construction of drilled shafts which bear upon or are socketed into rock.
- D. Rock Excavation – Intact rock material encountered in excavating drilled shafts which cannot be removed with a conventional earth auger, and which requires a rock auger, core barrel, or hand labor using air-powered tools and/or other special excavation procedures. Refusal of the earth auger shall be defined as a penetration rate equal to, or less than, 1 foot per 10-minute period with the full torque and crowd continuously applied. Earth, clay, coal seams, boulders, cobbles, rock fragments, soft fractured materials, or voids encountered between rock units will not be considered Rock Excavation.
- E. Slurry - Method of advancing drilled shaft hole where bentonite (sodium montmorillonite in accordance with API 13A) or anionic polymer is mixed with clean water or water within shaft to produce a slurry mixture capable of maintaining the stability of shaft walls and bottom in potentially caving and/or water-bearing soils. Slurry is also used to increase density of fluid within shaft to offset exterior hydrostatic pressure and to facilitate removal of coarser grained soils by mixing and incorporation into the slurry mixture. NOTE: The use of slurry will not be permitted during construction of that portion of drilled shafts which bear upon or are socketed into rock.
- F. Socket - Advancement of the drilled shaft into gray or brown, slightly weathered fossiliferous limestone without visible voids, generally commencing from the elevation at which the defined socket material is first encountered around the full perimeter of the socket excavation, and generally exhibiting a hard, massive, and solid appearance. Unless specifically identified above, socket shall not exhibit or contain clay seams, voids, solution cavities, cobbles, boulders, or broken, rubbly, or weathered rock conditions. Cobbles and boulders, as defined by ASTM D2487, or portions of irregular rock contact along the shaft side wall shall not be considered for purposes of developing a minimum embedment for socket. Socket may or may not be considered cumulative along the side wall of the shaft, depending upon the size, extent, location and frequency of cracks, crevices, and clay seams that can be cleaned and filled by dental work. Geotechnical Representative shall evaluate extent of irregularities and their effect upon detrimental settlement in defining adequate socket.
- G. Termination Criteria – All shafts shall be extended to achieve the minimum socket and embedment criteria indicated.
- H. Tremie - Concrete placed under water or through slurry by means of gravity flow through a rigid pipe. NOTE: The use of the tremie method of placing concrete will not be permitted. Pumping will be required when placing concrete under water or through slurry.

1.05 EXPERIENCE QUALIFICATIONS:

- A. Drilled Shaft Contractor
 - 1. A minimum of five (5) years of experience in drilled shaft construction, including experience with similar subsurface materials, water conditions, shaft dimensions, and special techniques as required.
 - 2. Submit a written description of equipment and techniques proposed for use on this Contract, and the name of three (3) similar projects successfully completed in the last five (5) years.
 - 3. The experience statement of past work and description of equipment and techniques proposed for use shall be submitted at time of Bid and will be considered in the evaluation of bids.

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- B. All other guidelines for submitting information shall be followed in accordance with that specified in "INSTRUCTIONS TO BIDDERS."

1.06 SUBMITTALS:

- A. Submit as specified in DIVISION 01.
- B. Bid Submittals:
 - 1. Proposed drilled shaft rig name, model number, maximum continuous torque rating (ft-lb), maximum downward force ("crowd"), proposed earth and rock auger attachments, and proposed special techniques and equipment. Submittals shall reflect any Contractor modifications that affect the torque and crowd ratings.
 - 2. Proposed method(s) of construction – dry and uncased, temporary casing, slurry, or other procedure. If slurry methods are proposed, indicate whether mineral and/or polymer slurry will be utilized.
 - 3. Experience Qualifications.
- C. Pre-Construction Submittals: Submit the following items two (2) weeks prior to start of Work. Work shall not begin until all the submittals have been received and approved by the Owner. The Contractor shall allow the Owner two (2) weeks to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.
 - 1. Detailed procedures for each anticipated method of construction - dry and uncased, temporary casing, slurry, or other procedure including:
 - a. Sequence of excavation, concrete placement, rebar cage placement, and placement of embedded items such as anchor bolts.
 - b. Method of concrete placement (i.e., free-fall, pump, or other).
 - c. Methods to prevent segregation of concrete during placement.
 - d. Methods to prevent caving or deterioration of the sidewalls and base of the excavation.
 - e. Equipment and procedures for cleanout of bottom of drilled shaft and walls of rock socket.
 - f. Procedures for supporting rebar cage during concrete placement, including type, size and material construction of spacers to be used.
 - g. Procedures for supporting anchor bolts or other embedded items (as applicable).
 - h. Procedures for, and sequence of, installation and removal of temporary casing.
 - i. Procedures for emergency cold joint construction in the event concrete placement is unexpectedly interrupted.
 - j. Procedures for placement and mix design for controlled low strength material (CLSM) mix, as applicable to backfill rejected drilled shaft foundations.
 - 2. Backfill material and procedures.
- D. Construction and Closeout Submittals:
 - 1. Drilled Shafts: Submit at the completion of each day, drilled shaft construction logs similar to the form at the end of this SECTION and which contain the following information, where applicable.
 - a. Identification number.
 - b. Shaft dimensions.
 - c. Ground surface elevation.
 - d. Bottom of concrete elevation.
 - e. Top of concrete elevation.
 - f. Description of soils and/or rock encountered during drilling and the depths at which transitions occur.

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- g. A graph depicting the total volume of concrete and volume of concrete placed compared to theoretical concrete volume versus depth (only applicable to drilled shafts large enough to require multiple concrete trucks).
- h. Bearing stratum description.
- i. Nature and location of obstructions.
- j. Water conditions during drilling and concrete placement.
- k. Amount of Unclassified Excavation.
- l. Amount of Rock Excavation and length of socket.
- m. Method of construction - dry and uncased, temporary casing, slurry, or other.
- 2. As-built shaft location and elevation data.
- 3. Detailed description of any remediation performed to resolve non-conforming work as described herein.

PART 2 - PRODUCTS

2.01 CONCRETE:

- A. As specified in SECTION 03 30 00, except as follows:
 - 1. Minimum compressive strength of 4500 psi at 28 days.
 - 2. Slump requirements for concrete placed in drilled shafts shall be based on the construction method used, as follows:
 - a. For dry uncased excavations: 4 to 6 inches.
 - b. For temporarily cased excavations: 6 to 8 inches.
 - c. For slurry excavations or placement of concrete under water: 7 to 9 inches.

2.02 CONCRETE REINFORCEMENT:

- A. As specified in SECTION 03 20 00.

2.03 CONCRETE FORMS:

- A. As specified in SECTION 03 10 00.

2.04 SLURRY:

- A. Slurry shall consist of a mixture of bentonite (sodium montmorillonite conforming to API 13A) or anionic polymer and water to produce a slurry of sufficient density to maintain stability of the shaft walls and bottom and to facilitate removal of coarser grained soils from the excavation.
- B. Slurry shall be transported, premixed, and processed using equipment made specifically for these purposes. Mixing slurry within the foundation excavation is not permitted.
- C. Slurry properties such as density, sand content, pH, viscosity, etc., shall be tested and maintained per manufacturer's recommended ranges through the duration of excavation.

2.05 CASING:

- A. Temporary and permanent casing shall be steel and of sufficient strength to prevent collapse or cave-in of the excavation and prevent soil and water from entering the excavation during drilling, field observation, and concrete placement.

2.06 DRILLING EQUIPMENT:

- A. Excavate drilled shafts with an auger rig capable of drilling, as a minimum, the diameter and depth of foundations, including sockets, as shown on the Drawings in the subsurface materials present. Contractor is responsible for selecting appropriate drilling equipment and procedures

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as required to install the drilled shafts as indicated and in the subsurface conditions present.
Other methods of excavation shall not be permitted.

PART 3 - EXECUTION

3.01 PREDRILLING:

- A. At Contractor's expense, drilled shaft foundations may be predrilled by an approved method to determine the depth to rock.

3.02 GENERAL EXCAVATION:

- A. Unless otherwise approved in advance, construction of each drilled shaft shall be completed during one working day, including full excavation and placement of concrete.
- B. Keep the ground surface for a minimum of 2 feet from the edge of the excavation clean and level.
- C. Dispose of materials removed from the excavation at an off-site location unless otherwise directed.
- D. Locate drilled shaft as indicated within the following tolerances. Deviations in excess of these tolerances shall be corrected at Contractor's expense, including additional costs for engineering, redesign, and inspection:
 - 1. Centerline: Within 2 inches or 4 percent of shaft diameter, whichever is less, of location indicated.
 - 2. Diameter: Plus 3 inches, minus 1 inch.
 - 3. Plumb: 1 percent of the length, 12.5 percent of shaft diameter, or 15 inches total, whichever is less.
 - 4. Cutoff Elevation: Plus 1 inch or minus 1 inch from cutoff elevation indicated.
- E. Provide temporary casing with a minimum inside diameter equal to the nominal diameter of the drilled shaft and a sufficient strength to withstand the soil pressure. Provide casing on Site prior to start of excavation. At minimum, install temporary casing under the following conditions:
 - 1. Prior to personnel entering the excavation.
 - 2. To control seepage.
 - 3. To prevent collapse of the walls.
- F. When casing is installed to control seepage or prevent collapse of the walls, casing shall be advanced in intimate contact with the surrounding soils and ahead of any excavation.
- G. Casing may be permanently left in place, provided that it is advanced in intimate contact with the surrounding soils and ahead of any excavation. Casings manufactured with fiber-based products shall not be used or permanently left in place. Casing shall not be extended into the socket.
- H. Remove all material regardless of classification within the shaft to meet the termination criteria as defined herein. Geotechnical Representative will field observe the excavation or drilling spoils and determine whether the excavation has achieved the required termination criteria. If termination criteria has not been met, Contractor shall extend the excavation until the criteria has been met or shall contact the Owner for direction.
- I. Excavate shaft bottom to a level plane. Cleanout and remove all loose material and spoil from sides and bottom of the shaft to the degree determined by the Geotechnical Representative, and prior to placing concrete. In no case shall the thickness of sediments on the shaft bottom exceed one-half inch.

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- J. Drilled shafts which are overexcavated without Geotechnical Representative's approval shall have the overexcavation filled with reinforced concrete, provide steel with adequate lap splice at Contractor's expense.
- K. Take all precautions necessary to prevent blowouts and disturbance of the sides or bottom of the excavation. If required, maintain water or slurry in the shaft at all times at a height sufficient to produce a positive head in the shaft.
- L. If loose soil, a high water table, or other condition which causes the sides or bottom of the excavation to be unstable is encountered, advance the excavation through use of slurry, a temporary casing, or other approved method. The use of slurry shall be required for the construction of drilled shafts in cohesionless materials below the water table.
- M. When slurry is used, maintain a positive head in the excavation at all times until placement of concrete. Circulate the slurry with sufficient consistency and velocity to remove the dislodged materials from the hole. Materials encountered which are too heavy to be removed by the slurry, may be removed by other approved means.
- N. Mixing of slurry shall not be allowed in the drilled shaft excavation.
- O. Selection of, use, and disposal of all slurry shall comply with contract documents and all applicable local, state, and federal requirements.

3.03 SOCKET EXCAVATION

- A. Sockets shall be excavated as indicated on the Drawings and defined herein.
- B. All soft, weathered, and broken rock shall be removed to establish socket depths into the specified material as indicated.
- C. Socket depth shall be measured along the side of least dimension where penetration occurs into sloping socket strata.
- D. Blasting shall not be permitted.
- E. Clean sides of socket of any loose material and rock paste to provide full bond between concrete and undisturbed socket material.
 - 1. Hand clean sides of socket or use other equipment approved by Geotechnical Representative.
 - 2. Water shall not be used for cleaning if detrimental to the integrity of the socket material.
- F. During cleaning and inspection of each drilled shaft socket, lower the casing only to the top of the socket. Once socket has been cleaned and inspected, casing shall not be lowered into any portion of the socket where skin friction is utilized.

3.04 BACKFILLING:

- A. Restore the ground surface to required grade in the lateral direction around the drilled shaft with on-site soils, to replace any soils that have collapsed or sloughed as a result of the Work.
- B. Prior to any backfilling operations, submit proposed methods and materials for approval.
- C. Placement and compaction of soils required to restore the ground surface to required grade shall be completed in accordance with the following:
 - 1. Cohesive Soils:
 - a. Materials include silts and clays generally exclusive of topsoil, sands and gravel. Materials for which impact compaction will produce a well-defined moisture-density relationship curve.
 - b. Compaction shall achieve a minimum of 95 percent of maximum density with a moisture content plus or minus three (3) percent of optimum moisture per ASTM D698.

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3.05

2. Cohesionless Soils:

- a. Materials include gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of topsoil, clayey and silty materials. Materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
- b. Compaction shall achieve a minimum of 70 percent relative density as per ASTM D4253 and D4254.

3.06 CONCRETE FORMWORK:

- A. As specified in SECTION 03 10 00.
- B. Form the drilled shaft with round forms with an inside diameter equal to the drilled shaft's nominal diameter and of sufficient strength to restrain the concrete without deformation or settlement. Mushrooming at the top of the drilled shaft shall not be permitted.
- C. Construct forms to be removable without marring concrete surface.
- D. Surface of forms shall provide smooth, dense, plane surface to finished concrete where exposed to view.
- E. Contractor shall be responsible for structural adequacy of formwork.
- F. Do not remove forms and supports until at least 24 hours after completion of concrete placement (this period is a cumulative number of hours, not necessarily consecutive, during which the temperature of the concrete surface is above 50°F).

3.07 CONCRETE STEEL REINFORCEMENT:

- A. As specified in SECTION 03 20 00.
- B. Unless otherwise indicated or approved, welding on concrete steel reinforcement is not permissible.
- C. Wet setting of anchor bolts shall not be permitted.
- D. Splice concrete steel reinforcement only as indicated.
- E. Support or tie off the rebar cage to prevent downward movement.
- F. Shall be fabricated as indicated prior to completion of excavation.
- G. Provide spacers of sufficient quantity, design and material construction to maintain appropriate clearance from the side walls or casing and shaft bottom. Spacers shall be located at the top, bottom, and at every 10 feet vertical interval between. A minimum of one spacer per foot of shaft diameter shall be spaced equally around the perimeter of the reinforcing cage at each vertical interval.

3.08 CONCRETE PLACEMENT:

- A. Wet forms with clear, potable water prior to placing concrete.
- B. Prior to placement of concrete, center reinforcing cages in the drilled shaft excavation and suspend or tie them off in an approved manner to cutoff elevation.
- C. Place concrete immediately after final inspection and approval by Geotechnical Representative.
- D. Concrete not placed within 90 minutes from batch time shall be rejected.
- E. Fill entire volume of drilled shaft with concrete to the cutoff elevation in one continuous operation. Cold joints and construction joints are not permitted unless otherwise indicated on the Contract Drawings. Complete concreting within the same working day in which drilled shaft is excavated. If concrete is not placed within 4 hours of completion of excavation, the

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- bottom of the excavation shall be re-augured to remove any softened bearing material and re-inspected by the Geotechnical Representative.
- F. Where practical, and without compromising the stability of the excavation, dewater excavation before placing concrete. Hold the water level in the bottom of the excavation prior to concreting at a nominal depth not to exceed 2 inches.
 - G. In dry excavations, place concrete with an approved drop pipe or funneling device. Approval of the funneling device shall be dependent upon Contractor's demonstrated ability to direct concrete flow so as not to fall or strike against the sides of the temporary casing, the sides of the drilled shaft excavation, or steel reinforcement before reaching the bottom. Use an extension pipe to limit the maximum concrete free-fall distance to 15 times the cage diameter, but no more than 60 feet.
 - H. Place concrete in a manner that will not cause segregation of the particles or permit infiltration of water or any other occurrence which would tend to decrease the strength of the concrete or the capacity of the finished drilled shaft.
 - I. Where dewatering to a depth of 2 inches or less is impractical, or when using the slurry method, place concrete under water or through slurry as follows:
 - 1. Use a rigid pipe or flexible hose. Displace the slurry mud or water as the concrete is placed. Keep the end of the pipe or hose embedded in the concrete as the concrete is placed.
 - 2. Should the end of the pipe or hose be accidentally pulled out of the concrete during the placement, discontinue the placing immediately and withdraw the pipe or hose to the surface. Reseal the pipe or hose at its bottom. Reinsert pipe in the shaft with the sealed end extending into the concrete to the level before the pullout. Placement may then be resumed.
 - 3. Over pour the cutoff point shown on the Drawings. Dip out the excess concrete. Geotechnical Representative will then visually observe the concrete at the top of the pour. If any contamination of the concrete is observed, reinsert the pipe or hose a sufficient distance into the concrete and continue placing fresh concrete until the contaminated concrete has been replaced by uncontaminated concrete.
 - 4. Draw off slurry displaced during concrete placement and remove from the Site.
 - 5. Use of a tremie pipe, in lieu of pumping, shall not be permitted.
 - J. Do not disturb the temporary casing, until a sufficient depth of concrete has been placed in the shaft excavation such that no voids will occur in the shaft due to intrusion of soil or water as the temporary casing is being withdrawn. If a known void is present along the sides of the drilled shaft, sufficient concrete shall be placed prior to disturbing the temporary casing such that sufficient concrete will remain above the bottom of casing after the void is passed.
 - K. Coordinate the withdrawal of temporary casing with concrete placement to maintain a minimum concrete head of five (5) feet above the casing bottom or until a sufficient depth of concrete has been placed to prevent intrusion of soil or water into the shaft concrete as the temporary casing is being withdrawn. Keep the temporary casing plumb and withdraw with a smooth, vertical motion, without jerks.
 - L. Should soil, rock, or water enter the excavation and contaminate the concrete, remove the contaminated concrete before completing pour.
 - M. Place concrete in accordance with applicable practices recommended by ACI.
 - N. Conveying:
 - 1. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.

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Indiana University
Bloomington, IN

Issued For Bid

IU Project 20240165
May 12, 2026

2. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.
3. Do not use aluminum conveying equipment.
- O. Consolidation of Concrete:
 1. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
 2. Vibrate concrete within the top 5 feet, only after temporary casing has been pulled or when casing is permanent.
 3. Vibrate concrete until the concrete is thoroughly consolidated and the voids filled as evidenced by the level appearance of the concrete at the exposed surface and the embedment of the surface aggregate. Do not over vibrate to avoid segregation of concrete aggregate from the cement paste.
- P. Additionally, as specified in SECTION 03 30 00.

3.09 NON-CONFORMING WORK:

- A. Contractor shall be solely responsible for full compliance with the Contract Documents regardless of if and when discrepancies are brought to their attention. Contractor shall be responsible for all re-work necessary to achieve full compliance with the Contract Documents. Repairs or replacement shall be at the sole expense of the Contractor, including the costs to redesign, as required.
- B. Owner may employ one or more of their representatives for observation and testing services.
- C. Owner or Geotechnical Representative may reject any shafts which, in their opinion, do not conform to the Contract Documents.
- D. As directed by Owner, perform the following for rejected shafts at no additional cost to Owner:
 1. Leave shafts in place, cut off as directed, and install one or more replacement shafts in designated location(s).
 2. Withdraw the shaft and install a new shaft in the same location.
 3. Any holes which result from shaft withdrawal or excavation that results in unstable excavation shall be backfilled with controlled low strength material (CLSM) with strength characteristics equal to or greater than the material excavated. Contractor shall provide documentation of proposed CLSM mix planned for use.
 4. Pressure grouting to fill voids or restore sidewall or base soil conditions that have been disturbed due to the Work.
 5. Other remediation work, as directed.

END OF SECTION 31 63 29

Owner _____
Project Name _____
Project No. _____
Contract No. _____

Single Shaft
Record Report

Shaft No. _____

AS DESIGNED (Per Drawings)

Shaft Location/Area _____
Type/Diameter _____
Top Elevation (ft) _____
Length (ft) _____
Rebar Length (ft) _____

AS CONSTRUCTED

Started _____
Date/Time Completed _____
Diameter _____
Top Elevation (ft) _____
Bottom Elevation (ft) _____
Length (ft) _____
Tolerance _____
Plumbness _____
Concrete, Cy _____
Concrete Mix ID _____
Rebar Length _____
Socket Length (ft) _____

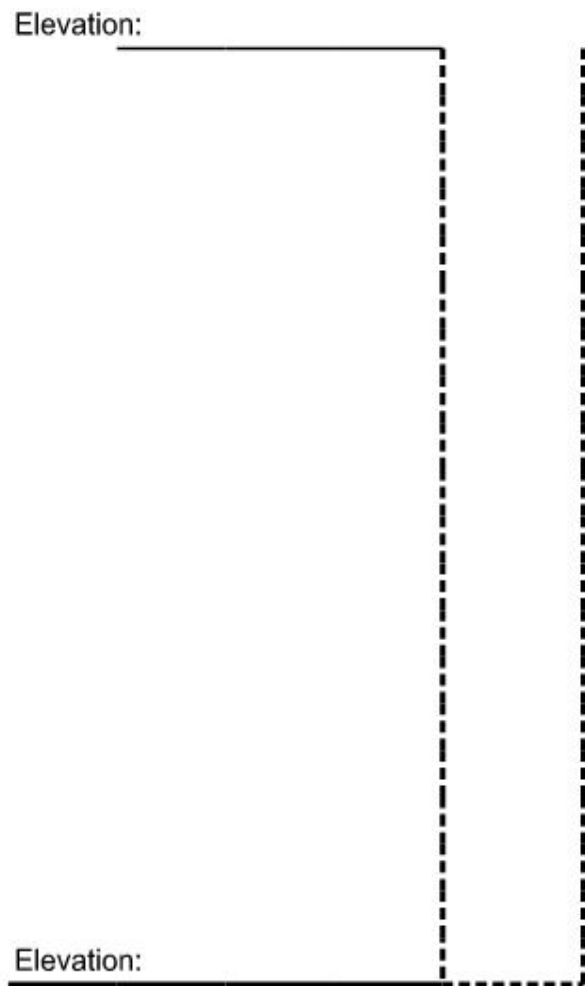
REMARKS

Bearing Material Description _____

Rebar - Size & Condition _____

Notes _____

Shaft Log *(INCLUDE: Ground Elevations, Size, Shaft Casing, Water Conditions, Drilling & Concreting, Nature & Location of Obstructions, & All Other Pertinent Information.)*



Time of Concrete Placement Start _____
Finish _____

Drilled Shaft Subcontractor

General Contractor

Observer Name & Company

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. This Section includes the requirements for instrumentation Common Work by this Contract. Contractor shall furnish, provide, install, tube, wire and calibrate all devices and controls as specified and indicated.
- B. Work will vary for a given instrument. The Contract Instrument List (CIL) is included in Appendix A of 40 91 10. The CIL does not limit the scope of Work but provides a general scope of involvement by specifying construction contractor in the respective scope column.
- C. This Section includes general materials and methods for instruments, flow meters, gauges, indicators, thermowells, temperature elements, switches, controllers, and transmitters furnished as part of this Contract.

1.03 REFERENCE STANDARDS:

- A. Design, fabricate, assemble, test and install equipment and materials in accordance with the manufacturer's recommended procedures and to the applicable provisions of the following codes and standards:
 - 1. ASHRAE
 - a. 15 – Safety Standard for Refrigeration Systems
 - b. 34 – Designation and Classification of Refrigerants
 - 2. ASME (ASME, founded as American Society of Mechanical Engineers):
 - a. Pressure Vessel Code.
 - 3. ASTM International (ASTM, formerly known as American Society for Testing and Materials):
 - a. A182/A182M - Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A213/A213M - Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.
 - c. A1016/A1016M - General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless-Steel Tubes.
 - d. B75 - Standard Specification for Seamless Copper Tube.
 - 4. EPA US Environmental Protection Agency
 - 5. International Society of Automation (ISA).
 - 6. International Electrotechnical Commission (IEC):
 - a. 60529 - Degrees of Protection Provided by Enclosures
 - 7. NEC National Electric Code
 - 8. NEMA National Electrical Manufacturers Association

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

- 9. NFPA National Fire Protection Association Standards
- 10. NIST National Institute of Standards and Technology
- 11. OSHA Occupational Safety and Health Association Regulations
- 12. UL Compliance

1.04 DEFINITIONS:

- A. Instrument
 - 1. A device used directly or indirectly to measure, monitor, record or control a variable. The term includes primary elements, transmitters, analyzers, controllers, recorders, transducers, final control elements, signal converting or conditioning devices, computing devices, and electrical devices such as annunciators, switches, and pushbuttons. The term does not apply to parts (e.g.; receiver bellows or a resistor) that are internal components of an instrument.
- B. Field
 - 1. The areas where production occur (e.g.; the plant floor) exclusive of control rooms, administration areas, and welfare areas.
- C. Instrument Piping / Tubing
 - 1. All piping, tubing, tubing bundles, tube track and channel, valves, air supply filters and regulators, fittings, supports, hardware, supplies required for capillary lines and process connections, for pneumatic signals and interconnections, and for air supplies shall constitute the instrument piping / tubing system.
- D. Remote Mounted Instruments
 - 1. Instruments or components of instruments which are not mounted directly into the process or utility piping systems e.g.; remote transmitters/totalizers, and analyzers.
- E. "Provide" or "provided" shall mean "furnish and install".
- F. "Furnish" or "furnished" shall mean to supply to the project site but does not include installation.
- G. "Install" or "installed" shall mean to mount and connect but does not include furnishing.

1.05 ADJUSTMENT, START-UP AND DEMONSTRATION

- A. Adjust all systems and equipment to provide proper operation as indicated and described on the drawings and specified herein.
- B. Prior to final acceptance, operate systems and equipment for a minimum of 72 continuous hours and until normal operating conditions are achieved, as approved by the Owner. Clean systems and equipment.
- C. Demonstrate the proper operation of all systems and equipment to the Owner.

1.06 WARRANTIES AND GUARANTEES

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

- A. In addition to warranties called for in other sections of these specifications, work shall be guaranteed against defect due to faulty installation. Warranties and guarantees shall be for a period of not less than one year, beginning on the later date of final acceptance by Owner, or equipment start-up.
- B. Upon written notice from the Owner or Owner's Representative, promptly remedy, without cost to the Owner, any defects occurring or discovered during the guarantee period.

1.07 SUBMITTALS:

- A. For Equipment and Material Submittals:
 - 1. Bill of Materials.
 - 2. Manufacturers' Specification Sheets.
 - 3. Outline Drawings.
 - 4. Calibration Forms.
 - 5. Certificates of Completion of Factory Tests.
 - 6. Welding Procedures.
 - 7. Welding Qualification Test Records.
- B. For construction activities Submittals:
 - 1. Submit a weekly report of instruments and control devices not received to the Engineer.
 - 2. Instrument Stand Drawings to indicate:
 - a. Construction features, bracing, brackets, device mounting holes, and all dimensions for assembly.
 - b. Mounting locations for all devices to be mounted on the Instrument Stand. Complete bill of material for all items required to fabricate the instrument stand, instrument rack or heated instrument enclosure.
 - c. Listing of each instrument by tag number.
 - d. Drawing of typical installations will be acceptable provided that the individual applications are listed.
 - 3. Submit certified test reports and mill certification sheets for all tubing materials, except copper, in accordance with ASTM A1016/A1016M, Section 28, including at least the following:
 - a. ASTM specification and grade.
 - b. Chemical analysis.
 - c. Hardness test.
 - d. Tensile properties.
 - 4. Field Welding Procedures.
 - 5. Field Welders Qualification Test Reports.
 - 6. Tubing Pressure Test Procedures.
 - 7. Tubing Pressure Test Reports.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

- C. For Calibration activities Submittals:
 - 1. Instrument List. With status update.
 - 2. Test equipment calibration records. Submit for review prior to their use for each Device Calibration.
 - 3. Reference gas certification records. Submit for review prior to their use for each Device Calibration.
 - 4. Standard solution certification records. Submit for review prior to their use for each Device Calibration.
 - 5. Completed calibration sheets.
 - 6. Completed loop checkout sheets.

1.08 QUALITY ASSURANCE:

- A. Qualifications:
 - 1. All Equipment and Material shall be new and free of defects.
 - 2. All Equipment and Materials shall have an acceptable history of satisfactory reliable service in similar use for a period of at least three years at comparable pressure, temperature, voltage and design stress level.
 - 3. Equivalent newly developed equipment with less than three years actual service will be considered, from established manufacturers, if it has been adequately tested, meets the requirements of this Contract, and is approved by the Engineer.
- B. Factory Tests:
 - 1. Notify Purchaser when factory tests are to be made, with sufficient notice such that a representative may be present, if desired.
 - 2. Conduct all standard factory tests and all tests required by the applicable codes and standards.
 - 3. Submit certificates of completion of factory tests as compliance Submittals.
- C. Test Equipment Certification:
 - 1. Updated certification shall be maintained on all test instruments and equipment. Verification of certification shall be maintained onsite at all times.
 - 2. Pneumatic test equipment subject to drift should be periodically tested with a dead weight tester or manometer.

1.09 DELIVERY, HANDLING, AND STORAGE:

- A. Receive, unload and store all Material and Equipment to be installed by this Contract.
- B. Store all Material and Equipment according to manufacturers' recommendations to suitably protect from physical damage, weather, temperature effects, and all sources of water.
- C. All work found to be damaged due to inadequate protection shall be replaced by Contractor at no cost to the Owner without compromising the construction schedule.
- D. Maintain a complete inventory of all items received. Verify all tag numbers.

PART 2 - PRODUCTS

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

2.01 WIRE AND CABLE

A. Wire:

1. Power wiring (dedicated power enclosures) shall be sized for the load with #12 AWG being minimum size. Control wiring (dedicated control enclosures) shall be #14 AWG. Power and control wire shall be stranded copper wire type THWN or THHN, as an alternate, wiring inside of control panels can be type MTW.
2. Stranded copper #16 AWG wire type THHN with PVC insulation shall be used for discrete signal wiring external to control panels unless otherwise stated on the drawings.
3. Stranded, tinned copper #18 AWG, twisted, shielded pair (or three-conductor), with PVC insulation shall be used for instrument signal wiring.
4. Thermocouple couple extension wire shall be of the appropriate type as determined by the thermocouple type.
5. The wire color code for single-conductor wire insulation shall be as follows:

<u>Type</u>	<u>Color</u>
120VAC line power	Black
120 VAC line neutral	White
24 / 120VAC control signal power	Red
24 / 120VAC control signal neutral	White
Ground (Equipment)	Green, Green w/Yellow stripe
24+ VDC	Blue
24- VDC	Blue or Blue w/White Stripe
24 VDC Analog (shielded)	Red (+), Black (-) preferred Black (+), Clear (-) permitted
RTD (excitation)	Black, Red, or White
RTD (compensation)	(matches excitation color)
Intrinsically safe	Light Blue (shall be segregated from non-IS)
Interlocks (Safety Interlocks)	Yellow (Safety Instrumented Systems -SIS– wiring shall be segregated from non-SIS dictated by Safety Integrity Level - SIL)

B. Cable:

1. All communications cable shall have a minimum insulation rating of 300V.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

2. All communications and control cables placed in cable tray shall have an insulation rating at least equal to the highest voltage present in the tray.
3. All intrinsically safe cables shall have (intrinsic safety) light blue color insulation jacket.
4. Cables with a PLTC rating may be used in Class I, Div 2 environments.
5. Cables explicitly listed on drawings override this section of the specification.
6. Due to the variety of cable offerings and installation requirements, the cables listed below do not comprise an exhaustive list and should be used as suggested cables. The use of cables not listed below require a submittal to the Engineer for review/acceptance.
 - a. Instrument Analog Cable:
 - (1) 2-Conductor, Twisted, Shielded
 - (a) Plenum: 18 AWG stranded (19x30) tinned copper conductors (black, red), FEP insulation, twisted pairs, overall foil (100% coverage), 20 AWG stranded tinned copper drain wire, Low Smoke PVC jacket., 300V, 75°C, 1-pr., NEC/(UL) Type CMP Belden #82760.
 - (b) Non-plenum: 18 AWG stranded (19x30) tinned copper conductors (black, red), PVC insulation, twisted pairs, overall foil (100% coverage), 20 AWG stranded tinned copper drain wire, PVC jacket, 300V tray cable, 105°C, 1-pr., NEC/(UL) Type CMG/PLTC Belden #9318.
 - (2) 3-Conductor, RTD Extension Cable
 - (a) Non-plenum: 18 AWG stranded (19x30) tinned copper conductors (black, white, red), PVC insulation, twisted triad, unshielded, PVC jacket, 300V tray cable, 105°C, 1-triad., NEC/(UL) Type CMG/PLTC Belden #9493.
 - (3) 4-Conductor, RTD Extension Cable
 - (a) Non-plenum: 18 AWG stranded (19x30) tinned copper conductors (black, white, red, green), PVC insulation, twisted, unshielded, PVC jacket, 300V, 60°C, 4-conductor, NEC/(UL) Type CL3/CMG. Belden #8489.
 - b. Instrument Discrete Cable:
 - (1) 2-Conductor, Unshielded
 - (a) Non-plenum: 16 AWG stranded (7x24) bare copper conductors (black, red), PVC insulation, twisted, unshielded, PVC/Nylon jacket, 600V, 90°C, NEC/(UL) Type TC. Alpha #MC3826.
 - (2) 3-Conductor, Unshielded

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- (a) Non-plenum: 16 AWG stranded (7x24) bare copper conductors (black, red, blue), PVC insulation, twisted, unshielded, PVC/Nylon jacket, 600V, 90°C, NEC/(UL) Type TC. Alpha #MC3828.
 - (3) 4-Conductor, Unshielded
 - (a) Non-plenum: 16 AWG stranded (7x24) bare copper conductors (black, red, blue, orange), PVC insulation, twisted, unshielded, PVC/Nylon jacket, 600V, 90°C, NEC/(UL) Type TC. Alpha #MC3829
 - c. Communications Cable:
 - (1) Category 5E, Unshielded, Non-plenum
 - (a) 4 twisted pairs, 24 AWG bonded-pairs, solid bare copper conductors, polyolefin insulation, unshielded, industrial grade PVC jacket, Enhanced Category 5e, gigabit Ethernet, RJ-45 compatible, transmission speed up to 100 MHz, Ethernet/IP™ compliant, TIA/EIA-568-B.2, category 5e, NEC Type CMR, Belden # 7923A.
 - (2) Category 6, Unshielded, Non-plenum
 - (a) 4 twisted pairs, F/UTP-Foil Shielded, Riser-CMR, Premise Horizontal Cable, 23 AWG solid bare copper conductors, polyolefin insulation, overall foil shield (100% coverage), 24 AWG stranded tinned copper drain wire, industrial grade PVC jacket, 350MHz Category 6, gigabit Ethernet, RJ-45 compatible. Belden # 1351A.
 - (3) Category 6A, Unshielded, Non-plenum
 - (a) 4-Pair, U/UTP-Unshielded, Riser-CMR, Premise Horizontal Cable, 23 AWG Solid Bare Copper Conductors, Polyolefin Insulation, Double-H spline, Ripcord, Blue PVC Jacket Enhanced Category 6A, gigabit Ethernet, RJ-45 compatible, transmission speed up to 500 MHz. NEC Type CMR. Belden # 10GX12.
 - (4) Fiber OM3, Indoor/Outdoor Cable
 - (a) 6-Fiber, 50µm Core Diameter, 250µm Fiber Diameter, PVC Jacket Material, 2000 MHz.km Min. Effective Modal Bandwidth (EMB), 10 Gigabit Ethernet Performance 300m. Belden # TF-3BB-006-RN5.
- 2.02 PIPE, PIPE FITTINGS, AND VALVES IN PIPING:
- A. Pipe, pipe fittings and valves in piping shall conform to the requirements of the Piping Material Specifications (PMS). The PMSs are specified in DIVISION 22.
- 2.03 INSULATION:
- A. Field applied insulation shall conform to the requirements of DIVISION 22.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

2.04 INSTRUMENT SHUTOFF VALVES:

A. General:

1. Body sizes: Same as connecting tubing or piping.
2. End connections:
 - a. Sizes shall be the same as connecting tubing or piping nominal size.
 - b. Tubing systems: Use integral tube fittings or adapter tubing fittings. Fittings shall be as specified in this Section PART 2 - TUBING FITTINGS.
 - c. Piping systems: As specified by the PMS for the respective process pipeline.

B. Type A1 Shutoff Valves:

1. Type: 2-way Ball valve.
2. Body: Bronze.
3. Rating: 400 psig at 150°F.
4. Packing: Reinforced Teflon.
5. Seats: Reinforced Teflon.
6. Trim: B16 brass, chrome plated ball; B16 brass stem.
7. End Connections: 1/2-inch FNPT.

C. Type A2 Process Fluid Shutoff Valves:

1. Type: 2-valve, block and bleed
2. Body: 2,500-pound class ANSI 316 stainless steel.
3. Packing: Grafoil.
4. Seats: Metal to metal.
5. Trim: 316 Stainless steel, with free-swiveling ball end stem.
6. Inlet Connection: FNPT.
7. Outlet Connection: FNPT.
8. Valve: Constructed in compliance with the Power Piping Code.
9. Furnish with stainless-steel plug for test connection.

2.05 INSTRUMENT MANIFOLD VALVES:

A. General:

1. Shop or field fabrication of manifold instrument valves using individual instrument valves and tubing or piping is not acceptable.
2. Shall be 2-way valve style for inline instrument connection.
3. Shall be 3-way valve style with a plugged bleed/test connection for differential pressure instrumentation.
4. Furnish with stainless-steel plugs for test connections.
5. Include all necessary flange bolts and flange seals.
6. Provide 2-inch pipe mounting bracket.
7. Provide metal to metal seats.
8. Connections:
 - a. Threaded connection sizes shall be the same as connecting tubing or piping normal size.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

2.06 INSTRUMENT STANDS:

- A. Instrument Location Plans indicate which instruments shall be mounted on each instrument stand.
- B. Construct and assemble instrument stands as indicated on the Instrument Installation Drawings and Instrument Location Plans.
- C. Construct to allow the instrument to be mounted 4 feet-6 inches from grade or platform elevation to centerline of the instrument.
- D. Instrument stands supporting multiple instruments shall be constructed to allow a minimum of 18 inches between the center lines of the instruments.
- E. For all pressure transmitters with instrument shutoff valves, furnish mounting brackets to mount the transmitter.
- F. For all pressure or differential pressure transmitters with instrument manifold valves, furnish mounting brackets to mount the instrument manifold valve, not the transmitter.
- G. Instrument stands are used to provide a mounting means for field installed instruments and their accessories:
 - 1. Shutoff valves.
 - 2. Process sensing tubing.
 - 3. Heated instrument enclosure.
 - 4. Other devices as indicated or specified on the Instrument Installation Drawings.

2.07 WIRE LABELS

- A. All wires in the central utility plant will follow the following labeling scheme:
XXXXXXXXX
AAAAAA/BBBBB

Where XXXXXXXXX is the tag description (if applicable). AAAAAA is the wire termination point and BBBBBB is the wire origin.

- B. The wire will be labelled at both ends with adhesive wire labels or heat shrink labels.

PART 3 - EXECUTION

3.01 GENERAL:

- A. At all times personnel shall adhere to the Project Safety, Lockout Tagout, Permit to Work Procedures and all safety procedures established for this Project.
- B. Perform all Work necessary to install, connect, tube, wire, pipe and calibrate:
 - 1. In strict accordance with the manufacturer's recommendations.
 - 2. To make instruments and controls ready for successful operation.
 - 3. As specified and indicated on the CIL and Instrument Location Plan Drawings.
- C. Provide all equipment, materials, scaffolding, rigging, and tools to complete the Work.
- D. Provide all labor, including expert and common, specialized personnel, fitters, electricians, instrument technicians, and attendance of such personnel.
- E. Piping and tubing, welding and fabrication shall be in accordance with Section 22.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

- F. Coordinate all installation activities involving others. Identify restraints caused by others which affect performance of the Work. Resolve such restraints where possible and notify the Engineer when additional action is required to complete the Work.
- G. Instrument Location Plans shall be used to determine approximate location of instruments to be installed and their sensing line connections. Contractor shall advise the Engineer of interferences.
- H. Instruments not indicated on the Location Plan Drawings but listed in the CIL, shall be field located by the Contractor with the assistance of the Engineer.
- I. Install device tags for all devices without tags or as directed by the Engineer.
- J. Apply lubricant to threads of screwed transmitter covers prior to installation.

3.02 TUBING AND PIPING:

- A. Instrument tubing and piping shall be field routed by the Contractor.
- B. Fabricate and erect each sensing line from the root valve to the instrument, including tubing, piping, fittings and supports for each device.
- C. Fabricate and erect piping for all columns for level switches, level transmitters, level controllers, level indicators, and gauge glasses.
- D. Fabricate and erect all instrument air supply sub-headers and individual instrument supply lines from the instrument air headers to the individual air users as indicated on the Instrument Installation Drawings.
- E. Tubing and piping arrangements shall be as indicated. Install offsets, fittings, unions, vents, drains, and supports to make a complete installation.
- F. Install unions or flanges for each instrument or control device to allow convenient removal as follows:
 - 1. Install so lines may be broken for maintenance, valves removed, and equipment disconnected.
 - 2. Install flanges with bolt insulator kits or dielectric insulated unions for joining dissimilar piping materials, such as copper to iron or steel. Install such insulating devices in positions which receive axial loads only with no bending loads.
- G. Make flanged, screwed, and welded joints in accordance with DIVISION 22.
- H. Support tubing as follows:
 - 1. Support individual copper tubing continuously along the entire length.
 - 2. Support stainless-steel tubing either continuously or from individual supports with spacing not to exceed the following distances:
 - a. For 1/4-inch OD tubing, use 3 feet maximum spacing.
 - b. For 3/8-inch OD tubing, use 4 feet maximum spacing.
 - c. For 1/2-inch OD tubing, use 5 feet maximum spacing.
 - 3. Supports shall allow for thermal expansion of tubing and equipment.
 - 4. Provide vibration isolating materials, which in the opinion of the Engineer are required to prevent tube surface damage due to rubbing on supports.
- I. Fabricate and erect tubing and piping in accordance with the requirements of ASME Power Piping Code, and in accordance with ASME Boiler and Pressure Vessel Code.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

- J. Tubing and piping shall be installed either perpendicular to or parallel to the building structure, the floor, or the major equipment.
- K. Tubing and piping shall be installed with a minimum clearance of 7 ft.-6 inches over passageways and walkways.
- L. Tubing routing and supports shall not interfere with maintenance activities including, but not limited to strainer cleaning/removal, heat exchanger tube bundle replacement, motor coupling, motor replacement, or pump replacement.
- M. Sensing lines for differential pressure type instruments shall have their sensing lines routed tother, side-by-side.
- N. Verify tube fitting pull-up with the manufacturer's gap inspection gage.
- O. Clean and blow out all tubing with compressed air prior to connecting to instruments.
- P. Perform pressure tests on all tubing and tubing fittings per ASME B31.1. Initial service testing shall be approved by Engineer. Contractor shall repair all leaks found.
- Q. Flexible tubing end connections shall be installed in the same plane and free from all torsion effects during service conditions and non-operating periods.

3.03 VALVES IN TUBING:

- A. Install Instrument Shutoff Valve or Instrument Manifold Valve for each pressure device.
- B. Install Instrument Shutoff Valves (Type A1).

3.04 INSTRUMENT STANDS:

- A. Install Instrument Stands where indicated on the Instrument Location Plans.
- B. Install Instrument Stands with mounting plates, floor stands, brackets, and supports to provide rigid installation.
- C. Freestanding Instrument Stands shall be suitably braced and attached to the floor or supporting structure to provide a rigid mounting structure for the instruments. Mounting on asphalt or soil is prohibited.
- D. For mounting to concrete, stands shall be anchored, leveled, shimmed, and grouted with a minimum of one inch of grout.
- E. Instrument Stands and other mountings in boiler areas or other platform grating areas shall be attached to structural steel or rigid structures. For instrument stands on platforms, weld base plates to building steel.
- F. Furnish all anchors, channels, brackets, and supports for a secure, rigid, and complete installation for the Instrument Stands and installed instruments. Do not support Instrument Stands from grating or handrails.
- G. Mounting plates and miscellaneous supports shall be attached to structural steel or rigid structures.
- H. Instruments shall be mounted such that they are protected from physical damage, weather, heat, and vibration.
- I. Instruments shall be mounted to provide easy access for calibration, repair, disconnection, removal, and replacement.
- J. Install all tubing, fittings, valves, and seal kits required for a complete installation.

SECTION 40 91 00 – INSTRUMENTATION COMMON WORK

3.05 CONTROL DRIVES AND LINKAGES:

- A. Install control drives as indicated and specified. Furnish and install foundations, support steel, anchor bolts, and grout, as required to insure a secure and rigid complete installation.
- B. Assemble, connect, and adjust linkages as indicated and according to the manufacturer's recommendations. Remove and reinstall damper operating levers, and other linkage components already installed by others to provide proper angles and clearances for operation. Modify linkage to suit final location of control drive. Set and adjust all linkages to operate properly and freely, then lock in adjustment by welding or with dowel pins.
- C. Furnish Schedule 80 steel pipe, fittings and adapters, sizes and lengths long enough to make up and fit connecting components.
- D. Furnish clevis and pin type, ball and socket type, or other type end connections in order to provide smooth operation without binding. Provide at least one-inch length adjustment at each end.
- E. Furnish special adapters, bell cranks, and drive and drive arms and other components as part of a complete, workable linkage.
- F. Install all air sets shipped loose from control and actuated valves. Installation shall be according to the manufacturer's recommendations.

3.06 GROUT:

- A. Provide one inch of grout under concrete floor mounted supports.

3.07 THERMOWELLS:

- A. Threaded thermowells shall be installed in accordance with ASME B31.1, Para. 104.3.1 for branched connection minimum thread engagement.
- B. Install temporary plugs prior to steam blow or system flushing. Install thermowells after steam blowing or system flushing is completed, but prior to hydrostatic testing.

3.08 PRESSURE-SENSING INSTRUMENT ACCESSORIES:

- A. Install pulsation dampeners on all line-mounted pressure-sensing instruments where:
 - 1. Process fluid pulsing is detected.
 - 2. The instrument measures a pump's discharge pressure.

3.09 TEMPORARY INSTRUMENTATION:

- A. Furnish temporary gauges for pressure and temperature measurement during piping system flushes and hydrostatic testing.
- B. No permanent plant instrumentation shall be in service at this time.

3.10 PRESSURE TESTING:

- A. Leak Testing of Tubing Systems:
 - 1. Initial service leak testing shall be performed in accordance with ASME Power Piping on all sensing and signal line tubing systems. This includes all tubing,

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 piping, instrument shutoff valves, manifold valves, blowdown valves, and blowback valves, located after the root valve.

2. Hydrostatic testing of sensing or signal tubing is not required unless specified otherwise.

3.11 DEVICE CALIBRATION:

A. General:

1. Industry standards and manufacturers' recommendations shall be followed in the execution of this Work.
2. Whenever possible, devices shall be calibrated prior to installation according to the calibration procedures specified below.
3. Provide all test instruments, calibration standards, and devices required to perform calibration and testing procedures. Alternative test equipment must be approved by the Engineer.
4. Instrument calibration shall be witnessed by the Owner, Engineer or any other person assigned by the Owner or Engineer. Provide to the Engineer daily calibration Work schedule.
5. Coordinate the Work with others so that calibration is completed prior to equipment startup or system turnover dates or as directed by the Engineer.
6. Calibrate in strict accordance with manufacturers' recommendations. Instruction books are available from the Engineer for instruments furnished by others.
7. Power all transmitters from system power supplies for calibration. Allow manufacturer's recommended warm up time prior to start of calibration of device. Use of portable power supplies or batteries to power transmitters for Device Calibration is not allowed.
8. Calibrate all instruments to the calibration ranges and set points specified on the respective instrument datasheets or as indicated on vendor drawings.
9. If the instrument is of the "smart" family, verify the internal configuration data is as specified on the respective instrument datasheet.
10. Immediately after Device Calibration, attach a calibration label or self-adhesive calibration sticker to the device with the name of the person performing the calibration and date of calibration.
11. When devices are removed from equipment, ensure the connection is protected from contamination. Clean devices such that reinsertion or installation of the device does not contaminate the equipment.
12. Report defective equipment to the Engineer.
13. Assist and cooperate with Engineer at all times through the calibration of the instruments to ensure that such activities do not interfere with the planned operation of the plant.

B. Pressure or differential pressure devices:

1. All pressure devices shall be calibrated to read the pressure at the process root valve.
2. If pressure device does not have a Q4 calibration sheet:

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- a. Use certified dead weight tester, manometer, or Wallace and Tiernan pneumatic calibration unit to validate all certified calibration pressure gauges used in the calibration of all other non-calibrated devices.
 - b. Adjust zero and span of device to read the pressure at the process root valve.
 - c. Use a vacuum or pressure hand pump and certified calibration pressure gauge to verify and record device pressure output readings at 0, 25, 50, 75, and 100% of input value.
 - d. Record alarm point and failed sensor values.
 - e. Record device hysteresis.
 - f. Remove test equipment and verify that the instrument output reads the correct pressure.
3. A device provided with a factory calibration sheet can be considered calibrated unless it is in a service with a static liquid leg or similar application, calibrate the device with the procedure outline above to provide appropriate static liquid correction so zero is measured at the root valve.
- C. Temperature devices:
 1. Thermocouples and extension lead wire shall be checked for proper type polarity and grounding. The temperature element will be check with an ohm meter for continuity. Record the resistance.
 2. RTD wiring shall be checked for proper type polarity and grounding. The temperature element will be check with an ohm meter for continuity. Record the resistance.
 3. Temperature switches shall be checked by immersion in a temperature regulated oven or bath. Record actuation point and any deadband.
- D. Level controllers and liquid level switches:
 1. Fill the float chamber with water observe the operation of the device.
 2. Record the controller output over the entire range of the input, verify the correct controller response or the activation of the switch occurs at the level setpoint specified.
- E. Switches, other than liquid level:
 1. All switch positioning shall account for dimensional changes that may occur when the equipment is placed in service.
 2. Apply process input and adjust switch actuation points to specified value.
 3. Record if switches make and break with an electrical continuity check.
 4. Adjust dead band if applicable.
 5. Verify repeatability of switch actuation points after adjustments are completed.
- F. Other transmitters and signal converters:
 1. Apply power, input signal, and process input, as applicable.
 2. Adjust zero and span.
 3. Calibrate per manufacturer instructions for the applicable process measurement.
- G. Motor operated valves:
 1. Apply power to the motor.
 2. Use the control system to stroke the valve.

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3. Record valve position over the entire input signal range; confirm whether valve is direct acting or indirect acting as required by the application.
 4. Record readings or output of device at 0, 25, 50, 75, and 100% of input value.
 5. Record device hysteresis.
 6. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
 7. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the control valve.
 - H. Remotely operated dampers:
 1. Adjust air supply PRV on drive to output pressure desired.
 2. Apply power to control drive.
 3. Record damper for proper fail action. Energize and de-energize solenoid valves to verify proper switching of the instrument air power source and to prove the failure mode of the control drive.
 - a. Fail Closed - Damper closes on loss of power or air.
 - b. Fail Open - Damper opens on loss of power or air.
 - c. Fail Last - Damper remains in the last position it was in on loss of power or air.
 4. Record damper position over the entire input signal range; confirm whether valve is direct acting or indirect acting as required by the application.
 5. Record damper position at 0, 25, 50, 75, and 100% of input value.
 6. Record device hysteresis.
 7. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
 8. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the damper.
 - I. Magnetic flow meters:
 1. Apply power and allow the manufacturer's recommended warm-up time.
 2. Calibrate the meter using the manufacturers recommended procedure.
- 3.12 INSTALLATION VERIFICATION:
- A. Confirm the sensing lines are:
 1. Connected to the proper pipeline, vessel, or other equipment.
 2. Connected to the proper instrument connections, hi side or low side.
 3. Installed and adequately sloped in the appropriate direction with no pockets that would trap process material.
 - B. Confirm that the installation is properly supported, and there is no excessive vibration.
 - C. Confirm that level measuring devices are installed at the proper elevation.
 - D. Confirm instrument is rated for electrical power run to the device and that it is correctly terminated.
- 3.13 LOOP TESTING:
- A. General:

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1. Coordinate with BMS operator for the for all loop testing activities.
 2. After Device Calibration and Verification of Installation has been completed for all devices in a loop, perform Loop Testing to functionally check all signals and devices within the loop. Loop Testing shall be performed on all control loops.
 3. Verify operation of each instrument relative to transmitting and receiving devices in the loop.
 4. Verify calibration of each instrument within the loop.
 5. Functionally check that signal lines and signal wiring within the loop, as applicable, are completed and terminated.
 6. Verify performance of instruments that are part of electrical control schemes in order to assist the Equipment manufacturer's service representative or Owner. Testing and operating personnel shall functionally test the schemes.
 7. Recalibrate, replace, or repair all loop devices as required to obtain the stated accuracy.
- B. Modulating Loops:
1. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION or for smart transmitters manually control the output of the loop primary sensing device. Set the process to 50% of range and verify whether the loop is direct acting or indirect acting as required by the application.
 2. Apply process values equal to 0, 25, 50, 75, and 100% of range of primary sensing device. Record readings of all receiving devices at each of these input values. Also record value of primary sensing device output signal at each point.
 3. Adjust receiving device and transmitting device as required so that readout from receiving devices is within 1% of the value of the process input.
 4. Verify that the direction of response is consistent with the control system output.
 5. For output signal values of 0, 25, 50, 75, 100% from the control system, record the loop final element position in percent or degrees open.
 6. If loop contains a signal converter device, such as an I/P converter, record for each output signal value from the faceplate control station the value of the input and output signals of the converter.
 7. For control valve positioner or I/P converter recalibrate to obtain desired relationship between faceplate control station output and control valve position.
 8. Make adjustments as required to the control drive linkage, for control drive or I/P converter recalibrate to obtain desired relationship between faceplate control station output and damper position.
 9. For limit switches, verify that actuation point of limit switch is within 2% of the value specified. Adjust or recalibrate switch if required.
 10. For modulating output signals from the control system to receiving devices:
 - a. Have the DCS operator place the output signal in manual.
 - b. Apply signal values equal to 0, 25, 50, 75, and 100% of output signal range.
 - c. Record readout of receiving devices for each value of input signal above.
 - d. Adjust or recalibrate receiving device as required so that readout of device is within 1% of input signal value.

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11. For modulating loops containing transmitters, receiving devices and final control elements, proceed as follows:
 - a. Loop test transmitters and receiving devices in the loop.
 - b. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION or for smart transmitters manually control the output to loop transmitters. Verify that output of controllers is in the proper direction for process input values above and below controller set point.
 - c. Verify null calibration of controllers by setting process input to set point and increasing controller reset adjustment. Adjust or calibrate controller as required so that controller output does not change under these conditions.
 - d. Verify that direction of response of loop final control elements is in the direction specified for process input values above and below controller's set point.
 - e. Record reading of the position of final control elements for input signal values of 0, 25, 50, 75, and 100% to these devices. Adjust or recalibrate final control device to obtain desired relationship between input signal value and final control element position.
 - f. If final control devices have limit switches, verify that actuation point of limit switch is within 2% of value specified. Adjust or recalibrate switch if required.
- C. Discrete Loops:
 1. Assist the Owner's maintenance, testing and operating personnel to functionally test electrical control schemes designed for the purpose of controlling operation of power plant equipment, including motors, pumps, motor-operated valves, solenoid-operated pneumatic valves, and similar field equipment. By performing all of the functions described below. These functions shall be performed at the request and under the coordination and supervision of the Owner's maintenance, testing and operating personnel.
 - a. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION.
 - b. Verify that switch actuation point is within 1% of that specified. Verification of switch actuation shall be by electrical continuity test. Advise Owner's maintenance, testing and operating personnel that switch is activated so he may proceed with his work.
 - c. Remove process input from instrument, when requested, and verify switch returns to "on the shelf" state. Advise Owner's maintenance, testing and operating personnel.
 - d. Repeat a. and b. above as required for Owner's maintenance, testing and operating personnel to complete functional test of control scheme.
 - e. Assist Owner's maintenance, testing and operating personnel in verifying that pneumatically operated final control devices that are interfaced to an electrical control scheme through the use of solenoid valves or similar type device, operate as intended by the design of the control scheme. If final

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control device has limit switches, verify that these actuate within 2% of specified actuation value.

2. If a non-modulating type instrument is utilized to provide an input to any plant control system, perform a loop test as follows:
 - a. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION.
 - b. Verify that actuation point of switch is within 1% of that specified and that the input is received at the terminals of the plant control system.
Verification shall be by electrical continuity test.

3.14 TUNING:

- A. After Loop Testing or during start-up of the process system or equipment, tuning adjustments are required to obtain safe and smooth control action within the range of design limits of the equipment. Tuning of loops wired to the plant control system is the responsibility of the plant control system manufacturer, however pneumatic or local loops are the responsibility of this Contract.
- B. Verify that the instrumentation is operating within design limits and at design point.
- C. Vary the process load and verify that the plant control system or instrument response is within design limits over the entire range.
- D. Stroke remotely operated valves and dampers as required for loop tuning.
- E. Adjust controllers for optimum response. Adjust proportional band, reset, rate and set point as required to obtain safe and smooth control action within the range of design limits of the equipment.
- F. Provide expert attendance and labor to manufacturer's representative for adjustments to the plant control system.
- G. Record and submit all tuning constants to the Engineer and the Owner on the loop checkout sheets.

3.15 TESTING:

- A. Cooperate and coordinate with other contracts as required when the testing of all devices, as outlined below, involves such other contracts. This shall include, but not be limited to, coordinating the following:
 1. Scheduling as directed by the Engineer.
 2. Manpower requirements, including expert and common labor, specialized personnel, and supervision.
 3. All equipment and testing devices required.

3.16 SUBMITTAL REQUIREMENTS SCHEDULE

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SUBMITTAL REQUIREMENTS SCHEDULE

Item	Spec Section	Prod. Data	Shop Draw	Coord . Draw	O & M Man	Other
Submittal Schedule	40 91 00					
Instrumentation	40 91 10	X	X		X	
Instrument Wire and Cable	40 91 10	X				
Calibration Information	40 91 10	X				
Control Panels	40 94 00	X	X			X
SCADA Systems	40 94 00	X	X		X	X
Process Control Systems	40 94 00	X	X		X	X

END OF SECTION 40 91 00

SECTION 40 91 10 – INSTRUMENTATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. All project specifications, drawings, and general provisions apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and current installation. Any specific reference mentioned herein are for convenience only.
- B. See 40 91 10 A for Instrument List.

1.02 SUMMARY:

- A. The purpose of this specification is to define all requirements for the procurement, installation, and calibration of Instrumentation and specified Control equipment for IU's Chiller Replacement.
- B. Procure, install, and calibrate instrument air sub-headers, branches, and instrument air accessories for air operated devices (e.g., block valves, controls valves, etc.) as defined by the following:
 - 1. Piping & Instrumentation Diagrams
 - 2. Plan Drawings
 - 3. Other referenced Sections of this Specification
 - 4. Applicable Codes and Standards
 - 5. Manufacturer's Instructions
 - 6. Standard Industry Practice
- C. Contractor shall identify potentially conflicting or missing requirements and notify the Owner.
- D. Contractor shall provide all resources to execute the scope defined therein. This includes, but is not limited to, the following:
 - 1. Qualified personnel
 - 2. Tools and equipment
 - 3. Consumables
 - 4. Test instruments
 - 5. Calibration gas sources

1.03 REFERENCE STANDARDS:

- A. American Society of Mechanical Engineers (ASME)
 - 1. ASME B31.1, "Power Piping - Code for Pressure Piping"
 - 2. ASME PTC 19.3 TW 2010, "Temperature Measurement Instruments and Apparatus"
 - 3. ASME B40.100, "Pressure Gauges and Gauge Attachments"
 - 4. ASME B40.200, "Thermometers, Direct Reading and Remote Reading"
- B. American Welding Society (AWS).
- C. ASTM International (ASTM, formerly known as American Society for Testing and Materials)

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1. ASTM A182/A182M, “Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.”
 2. ASTM A269 – Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 3. ASTM A1016/A1016M, “General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless-Steel Tubes.”
 4. ASTM B33 Standard Specification for Tinned Soft Annealed Copper Wire for Electrical Purpose
 5. ASTM B75 Standard Specification for Seamless Copper Tube.
 6. ASTM D3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Material
 - D. International Society of Automation (ISA).
 - E. International Electrotechnical Commission (IEC):
 1. IEC 60529 - Degrees of Protection Provided by Enclosures
 - F. National Electrical Manufacturers Association (NEMA)
 1. NEMA 250, “Enclosures for Electrical Equipment (1000 Volts Maximum)”
 - G. National Fire Protection Association (NFPA)
 1. NFPA 70, “National Electric Code”
 - H. NIST National Institute of Standards and Technology
 - I. OSHA Occupational Safety and Health Association Regulations
 - J. UL Compliance
- 1.04 DEFINITIONS:
- A. None.
- 1.05 WARRANTIES AND GUARANTEES
- A. In addition to warranties called for in other sections of these specifications, work shall be guaranteed against defect due to faulty installation. Warranties and guarantees shall be for a period of one year, beginning on the later date of final acceptance by Owner, or equipment start-up.
 - B. Upon written notice from the Owner or Owner’s Representative, promptly remedy, without cost to the Owner, any defects occurring or discovered during the guarantee period.
- 1.06 SUBMITTALS:
- A. Bill of Materials
 - B. Manufacturers' Product Data Sheets, annotated for specific products furnished.
 - C. Outline Drawings for Instrument Stands (including TAG ID of instruments on stands); ‘rack’ is synonymous with ‘stand’ in this application
 - D. Calibration Procedure
 - E. Calibration Equipment Certification Records
 - F. Calibration Certificates
 - G. Calibration Date Records

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- H. Certificates of Completion of Factory Tests
- I. Device Tag Engraving List and 2 sample engraved tags prior to placing order
- J. Factory Welding Procedures
- K. Factory Welding Qualification Test Records
- L. Certified Material Test Reports and mill certification sheets for all tubing materials, except copper, in accordance with ASTM A1016/A1016M, DIVISION 28, including at least the following:
 - 1. ASTM specification and grade
 - 2. Chemical analysis
 - 3. Hardness test
 - 4. Tensile properties
- M. Submit a weekly report of instruments and control devices not received to the Owner and/or Engineer.
- N. Actual Instrument Stand Drawings to indicate:
 - 1. Construction features, bracing, brackets, device mounting holes, and all dimensions for assembly.
 - 2. Mounting locations for all devices to be mounted on the Instrument Stand or walls. Complete bill of material for all items required to fabricate the instrument stand or instrument rack.
 - 3. Listing of each instrument by tag number.
 - 4. Drawing of typical installations will be acceptable provided that the individual applications are listed.
- O. Field Welding Procedures.
- P. Field Welders Qualification Test Reports.
- Q. Operating and Maintenance Manuals

PART 2 - PRODUCTS

2.01 GENERAL:

- A. All Equipment and Material shall be new and free of defects.
- B. All Equipment and Material shall have an acceptable history of satisfactory reliable service in similar use for a period of at least three years at comparable pressure, temperature, voltage and design stress level.

2.02 INSTRUMENTS:

- A. General
 - 1. Procure instrumentation as specified in the Instrument List.
 - 2. Instruments shall not contain mercury.
 - 3. Instruments shall not utilize nuclear sources.
 - 4. Instruments and equipment provided and installed by the Contractor shall be new and free from defects.
 - 5. Field devices shall be rated for use in designated area classification.
 - 6. Cyber Security for Smart Instrumentation and Controllers:

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- a. Evaluate and incorporate equipment manufacturer security recommendations as applicable. Change manufacturer's equipment default passwords prior to installation in the system.
 - b. Unused device ports shall be disabled or hardened to protect from unauthorized access; WiFi features are to be disabled.
7. Instruments are preferred to be loop powered, if a separate power source is needed coordination will be required with electrical contractor.
8. Provide analog process gauge scales so that the expected normal operating value is approximately 50% of full-scale range. Working pressure in all cases shall be limited to 75% of full-scale range,
9. Provide a device tag for all instruments as defined in the Instrument List. Device tags shall meet the following requirements:
 - a. Device tags shall be stainless steel minimum 0.040-inch thickness with the correct tag number and service description as defined on the instrument data sheet, engraved, or laser etched clearly into the metal.
 - b. Device tags shall be permanently attached with minimum 18-gage stainless-steel wire to the stem or case of each device, use of string or tape is unacceptable.
 - c. Device tags shall be approximately 1.5 x 3 inches, with 3 lines for characters as shown in the detail on the I&C drawings. The instrument /device number shall be the first line of characters with 5/16-inch text height. The instrument/device's description or function shall be the second and third line of characters with 1/4-inch text height. The two/three character lines on the device tags shall have 1/8-inch border margins and lines to be equi-spaced. Characters are in capital letters using Arial font; this will allow approximately 15 characters on Line 1 and 17-19 characters on Lines 2 and 3.
 - d. Provide an Engraving List prior to ordering or installing any Device Tags. Engraving list shall use the TAG ID and description from the Instrument List; description on the device Tag shall use typical abbreviations subject to Owner approval. Example:

Device Tag -

Line 1: TT-004-01

Line 2: CHILLER 4 CHILLED WATER SUPPLY TEMPERATURE
TRANSMITTER

IO List Tag & Description -

Line 1: TI-004-01

Line 2: CHILLED WATER SUPPLY FROM CHILLER 4
TEMPERATURE TRANSMITTER

2.03 FLOW INSTRUMENTATION

- A. Magnetic Flowmeter

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1. General
 - a. Manufacturer: Badger
 - b. Model Number: M2000
 - c. NEMA Rating: 4
 - d. Hazardous Area Classification: Non-Classified
 - e. Instrument Tag: Stainless steel tag engraved with tag number permanently attached to the transmitter.
 - f. Straight Run Requirement: 3D up/2D down: 0.2% error
 - (1) If not achieved 1.0% error
2. Sensor
 - a. Style: Magmeter
 - b. Electrode Material: Hastelloy C
 - c. Electrode Type: Standard
 - d. Flange Material: Match piping per Section 48 59 01 – Piping Materials.
 - e. Wetted Material: PTFE
3. Transmitter
 - a. Signal Output: 4-20 mA
 - b. Mounting: With sensor
 - c. Display: LCD
 - d. Power Supply: 24 VDC
 - e. Electrical Connection: ½”-14 NPT Conduit
4. Options
 - a. Factory Calibration Certificate: Yes
 - b. Instrument Tag: Permanently attached stainless steel tag with tag number per P&ID engraved

2.04 PRESSURE INSTRUMENTATION

- A. Pressure Gauges
 1. General
 - a. Manufacturer: Ashcroft
 - b. Model Number: 1279
 - c. Case: Solid case, use Performance Plus for high pulsation conditions
 - d. Area Classification: None
 2. Gauge
 - a. Calibrated Range: Per Instrument List
 - b. Accuracy Class: 0.5% of Span
 - c. Wetted Components:
 - (1) 316 SS
 - d. Process Connection:
 - (1) Size: 1/2” NPT Male
 - (2) Location: Lower
 - e. Dial Type: Single

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- (1) Size: 4.5"
 - (2) Color: White with Black Lettering
 - (3) Pointer: Black
 - (4) Lens Material: Safety Glass
 - 3. Manifold
 - a. MFR/Model: Anderson Greenwood M9
 - b. Style: Inline
 - c. Type: 2 Way Valve
 - d. Material: 316SS
 - e. Process Connection: ½"-14 NPT Female
 - 4. Options
 - a. Instrument Tag: Permanently attached stainless steel tag with tag number per P&ID engraved
- B. Pressure Transmitters
 - 1. General
 - a. Manufacturer: SOR
 - b. Model Number: 1800PT
 - c. NEMA Rating: 4
 - d. Hazardous Area Classification: Non-Classified
 - 2. Transmitter
 - a. Type: Gage
 - b. Signal Output: 4-20 mA
 - c. Display: LCD
 - d. Power Supply: 24 VDC Loop Powered
 - e. Process Connection: In-line factory mounted to manifold
 - f. Electrical Connection: ½" NPT Conduit
 - 3. Manifold
 - a. Model: MF2
 - b. Style: Inline
 - c. Type: 2 Way Valve
 - d. Material: 316SS
 - e. Process Connection: ½"-14 NPT Female
 - 4. Options
 - a. Instrument Tag: Stainless steel tag engraved with tag number permanently attached to the transmitter.
- C. Differential Pressure Gauge
 - 1. General
 - a. Manufacturer: Ashcroft
 - b. Model Number: 1130
 - c. IP Rating: 65
 - d. Hazardous Area Classification: Non-Classified
 - 2. Gauge

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- a. Calibrated Range: Per Instrument List
- b. Accuracy Class: 0.5% of Span
- c. Wetted Components:
 - (1) 316 SS
- d. Process Connection:
 - (1) Size: 1/2" NPT Male
 - (2) Location: Sides
- e. Dial Type: Single
 - (1) Size: 4.5"
 - (2) Color: White with Black Lettering
 - (3) Pointer: Black
 - (4) Lens Material: Safety Glass
- 3. Manifold
 - a. MFR/Model: Anderson Greenwood M1
 - b. Style: Coplanar
 - c. Type: 3 Way Valve
 - d. Material: 316SS
 - e. Process Connection: 1/2"-14 NPT Female
- 4. Options
 - a. Instrument Tag: Stainless steel tag engraved with tag number permanently attached to the transmitter.

2.05 TEMPERATURE INSTRUMENTATION

A. Resistance Temperature Device (RTD)

- 1. General
 - a. Manufacturer: Moore Industries
 - b. Model Number: PT13
 - c. Hazardous Area Classification: None
 - d. Instrument Tag: Permanently attached stainless steel tag with tag number per P&ID engraved
- 2. Thermowell
 - a. Manufacturer: Moore Industries
 - b. Model Number: A-P2
 - c. Style: Tapered
 - d. Material: 316/316L SST
 - e. Process Connection: 1/2" NPT
 - f. Size: Varies
 - g. Bore Diameter: 0.26-in
 - h. Insertion Depth: Necessary to place tip of thermowell within 1/3 to 1/2 of pipe diameter.
 - i. Lag Extension (T): As required to clear insulation by 1".
- 3. Element
 - a. Type: 3-wire

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- b. Resistance: 100 Ohm
 - c. Material: Platinum
 - d. Number of Elements: Single Element
 - e. Accuracy: Class A or Class B
 - f. Length: To match thermowell
 - g. Spring Loaded: Yes
 - 4. Head
 - a. Type: Screw Cap with Chain
 - b. Material: Aluminum, AT1
 - c. Electrical Connection: ¾" FNPT
 - d. Extension Type: Nipple-Union
- B. Temperature Transmitters
 - 1. General
 - a. Manufacturer: Moore Industries
 - b. Model Number: TDZ
 - c. NEMA Rating: N/A
 - d. Hazardous Area Classification: Non-Classified
 - e. Instrument Tag: Permanently attached stainless steel tag etched/ engraved with instrument number per PI&D.
 - 2. Transmitter
 - a. Element Type: 3 Wire RTD
 - b. Signal Output: 4-20 mA
 - c. Display: Yes
 - d. Power Supply: 24 VDC Loop Powered
 - e. Electrical connection: ½" NPT Conduit
 - 3. Options
 - a. Wake frequency calculations required by vendor.
- C. Temperature Gauge
 - 1. General
 - a. Manufacturer: Ashcroft
 - b. Model Number: 50EI
 - c. NEMA Rating: 4X
 - d. Hazardous Area Classification: Non-Classified
 - e. Instrument Tag: Stainless steel tag engraved with tag number permanently attached to the indicator.
 - f. Wake frequency calculations required by vendor.
 - 2. Thermowell
 - a. Style: Tapered
 - b. Material: 316 Stainless Steel
 - c. Process Connection: Threaded (Steam system welded)
 - d. Size: 1/2"
 - e. Bore Diameter: 0.260"

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- f. Insertion Depth (U): As necessary to place tip of thermowell within 1/3 to 1/2 of pipe diameter.
 - g. Lag Extension (T): As required to clear insulation by 1”.
 - 3. Indicator
 - a. Dial Size: 5”, external adjustment
 - b. Glass: Shatter Proof
 - c. Connection: 1/2in NPT
 - d. Adjustment: EveryAngle model

2.06 CURRENT SWITCH

- A. Current Switch
 - 1. General
 - a. Manufacturer: Veris
 - b. Model Number: H608
 - c. Hazardous Area Classification: None
 - d. Instrument Tag: Permanently attached stainless steel tag with tag number per P&ID engraved
 - 2. Options
 - a. Measurement Type: AC
 - b. Current Range: 0.5 – 175 Amps
 - c. Output Specifications: NO 1A Contact rated for 24VDC

2.07 INSTRUMENT SHUTOFF VALVES:

- A. General
 - 1. Body sizes:
 - a. Same as connecting tubing or piping.
 - 2. End connections:
 - a. Tubing systems: Use integral tube fittings or adapter tubing fittings. Fittings shall be as specified in this Section PART 2 - TUBING FITTINGS.
 - b. Piping systems: As specified by the piping specification for the respective process pipeline.
- B. Type A1 Air Supply Shutoff Valves
 - 1. Type: Ball valve.
 - 2. Body: Bronze, rated 400 psig at 150°F.
 - 3. Packing: Reinforced Teflon.
 - 4. Seats: Reinforced Teflon.
 - 5. Trim: 316 stainless-steel ball and stem.
 - 6. End Connections: 1/2-inch FNPT.
 - 7. Approved Suppliers
 - a. Apollo, Series 70-100.
- C. Type A2 Process Fluid Shutoff Valves
 - 1. Body: 2,500-pound class ANSI 316 stainless steel.
 - 2. Packing: Grafoil.

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3. Seats: Metal to metal.
 4. Trim: 316 Stainless steel, with free-swiveling ball end stem.
 5. End Connections: 1/2-inch NPT.
 6. Valve: Constructed in compliance with the Power Piping Code.
 7. Furnish with 1/4-inch stainless-steel plug for test connection.
 8. Approved Suppliers
 - a. Anderson Greenwood & Co.
 - b. Swagelok.
- D. Type A3 Process Fluid Shutoff Valves
1. Body: 2,500-pound class ANSI 316 stainless steel.
 2. Packing: Grafoil.
 3. Seats: Metal to metal.
 4. Trim: 316 Stainless steel, with free-swiveling ball end stem.
 5. End Connections: 1/2-inch female tube inlet by flanged instrument.
 6. Valve: Constructed in compliance with the Power Piping Code.
 7. Furnish with 1/4-inch stainless-steel plug for test connection.
 8. Approved Suppliers
 - a. Anderson Greenwood & Co.
 - b. Swagelok.

2.08 INSTRUMENT MANIFOLDS:

- A. General
1. Provide 2 or 3 valve Instrument Manifolds pre-mounted in the factory by the Manufacturer as specified in the Instrument List.
 - a. For SOR Pressure transmitters MF2 are to be used for pipe mounted pressure transmitters.
 - b. For differential pressure gauges and pressure gauges Anderson Greenwood is the preferred manufacturer of manifold valves.
 - (1) 2-way valve: M25
 - (2) 3-way valve: M1
 2. Include all necessary flange bolts and flange seals.
 3. Provide 2-inch pipe mounting bracket.
 4. Provide metal to metal seats.
 5. Include plugged test connection on each process sensing line for calibration without removing manifold instrument valve.
 6. Furnish with 1/4-inch stainless-steel plugs for test connections.
- B. Body: 316 stainless steel.
- C. Packing: Grafoil.
- D. Trim: Stainless steel.
- E. Valve: Constructed in compliance with ASME B31.1 Power Piping Code.

2.09 INSTRUMENT STANDS:

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- A. Instrument stands are used to provide a mounting means for field installed instruments and their accessories:
 - 1. Shutoff valves.
 - 2. Blowdown valves.
 - 3. Blowdown tubing or piping.
 - 4. Process sensing tubing.
 - 5. Heated instrument enclosures (for instruments mounted outdoors).
 - 6. Other devices as indicated or specified on the Instrument Installation Drawings.
- B. Construct and assemble instrument stands as indicated on the Instrument Installation Drawings and Instrument Location Plans. Coordinate instrument stand configurations and final location with Owner.
- C. Construct to allow the instrument to be mounted 4 feet-6 inches from grade or platform elevation to centerline of the instrument.
- D. Instrument stands supporting multiple instruments shall be constructed to allow a minimum of 18 inches between the center lines of the instruments.
- E. For all pressure transmitters with instrument shutoff valves, furnish mounting brackets to mount the transmitter.
- F. For all pressure or differential pressure transmitters with instrument manifold valves, furnish mounting brackets to mount the instrument manifold valve, not the transmitter.

2.10 SIPHON TUBES:

- A. Approved Suppliers
 - 1. Anderson Greenwood Co.
 - 2. Ashcroft.
 - 3. SOR.

2.11 PULSATION DAMPENERS:

- A. Approved Suppliers
 - 1. Ashcroft type 1106S with stainless-steel construction and adjustable dampening rates.

PART 3 - EXECUTION

3.01 MANUFACTURING:

- A. All Equipment and Material to be manufactured in accordance with standard supplier methods and applicable Codes and Standards in this Specification.
- B. All Equipment and Material to be tested in accordance with standard supplier methods and applicable Codes and Standards in this Specification.

3.02 FACTORY CALIBRATION:

- A. Instrumentation shall be factory calibrated.
- B. Manufacturer shall calibrate instruments with verified test equipment.
- C. Utilize recognized standards for factory calibration.
- D. Manufacturer shall produce a calibration record for each instrument.

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3.03 SHIPPING, HANDLING, AND STORAGE:

- A. All Material and Equipment shall be shipped with packing lists verified by the shipping organization.
- B. All Material and Equipment shall be protected to prevent damage during shipping.
- C. Upon receipt, all Material and Equipment shall be inspected for damage.
 - 1. For damaged items purchased by the Contractor, the Contractor shall obtain replacements.
 - 2. For damaged items purchased by the Owner or Engineer, the Contractor shall notify the responsible party to obtain replacements.
- D. Store all Material and Equipment according to manufacturers' recommendations to protect from damage.
- E. Maintain a complete inventory of all items received, including tag numbers for tagged items.

3.04 INSTALLATION:

- A. General
 - 1. Piping and tubing, welding and fabrication shall be in accordance with SECTION 48 59 35.
 - 2. The following shall be used for Instrument Locations:
 - a. Instrument List – defined equipment instrument is mounted on.
 - b. Piping Plans – used to locate inline flow elements
 - c. P&IDs – used to locate relative location for process connections for instrumentation. Select final location based on the following:
 - (1) Maintain length of tubing from process connection to instrument < 50 ft.
 - (2) Avoid installation on elbows or tees.
 - d. General Arrangement Plans shall be used to determine approximate location of instrument stands and rack that remote instruments are mounted instruments to be installed.
 - 3. Contractor shall advise the Owner of interferences.
 - 4. Instruments not indicated on the Location Plan Drawings, but listed in the Instrument List, shall be field located by the Contractor with the assistance of the Owner and/or Engineer.
 - 5. Grout material shall be as specified in DIVISION 04 22 00.
 - 6. Instruments shall be mounted such that they are protected from physical damage, weather, heat, and vibration.
 - 7. Instruments shall be mounted to provide easy access for calibration, repair, disconnection, removal, and replacement.
 - 8. Apply lubricant to threads of screwed transmitter covers prior to installation.
- B. Instrument Stands
 - 1. Install Instrument Stands with mounting plates, anchors, channels, floor stands, brackets, and supports to provide rigid installation.

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2. Freestanding Instrument Stands shall be suitably braced and attached to the floor or supporting structure to provide a rigid mounting structure for the instruments. Mounting on asphalt or soil is prohibited.
 3. Instrument Stands and other mountings in platform grating areas shall be attached to structural steel or rigid structures. For instrument stands on platforms, weld base plates to building steel.
 4. Provide one inch of grout under concrete floor mounted instrument stands.
 5. Instrument Stands and other mountings in platform grating areas shall be attached to structural steel or rigid structures.
 6. For instrument stands on platforms, weld base plates to building steel.
 7. Do not support Instrument Stands from grating or handrails.
 8. Mounting plates and miscellaneous supports shall be attached to structural steel or rigid structures.
 9. Instruments shall be mounted such that they are protected from physical damage, weather, heat, and vibration.
 10. Instruments shall be mounted to provide easy access for calibration, repair, disconnection, removal, and replacement.
 11. Mount Instrument Blowdown Valves to the Instrument Stand with mounting plates, brackets, and clips.
- C. Pulsation Dampeners
1. Install pulsation dampeners on all line-mounted pressure-sensing instruments where:
 - a. Process fluid pulsing is detected.
 - b. The instrument measures a pump's discharge pressure.
 - c. Install siphon tubes on all line mounted steam pressure sensing instruments where the instrument is mounted above the process connection.
- D. Flow Elements
1. Install insertion magnetic meters per manufacturer specifications.
- E. Thermowells
1. Install temporary plugs prior to steam blow or system flushing.
 2. Install thermowells after steam blowing or system flushing is completed, but prior to hydrostatic testing.
 3. Seal weld screwed thermowells when:
 - a. The process fluid is greater than 500°F or 600 psig.
 - b. The process fluid is oil, fuel, or natural gas.
 - c. The process fluid is ever under a vacuum service.
 - d. Otherwise indicated.
- 3.05 INSTALLATION VERIFICATION:
- A. Confirm that the instrument is mounted as indicated on the Installation Details.
- B. Confirm the sensing lines are:
1. Connected to the proper pipeline, vessel or other Equipment.
 2. Connected to the proper instrument connections, hi side or low side.

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3. Installed and adequately sloped in the appropriate direction with no pockets that would trap process material.
- C. Confirm that the installation is properly supported, and there is no excessive vibration.
- D. Confirm that level measuring devices are installed at the proper elevation.
- E. Confirm that instrument air supplies are properly connected and adjusted to the correct pressure.
- F. Confirm that signal lines are properly connected to the correct receiving device.
- G. Confirm instrument is rated for electrical power run to the device and that it is correctly terminated.

3.06 COMMISSIONING:

- A. General:
 1. Perform all Commissioning activities per Commissioning Requirements.
- B. Field Calibration:
 1. General:
 - a. Industry standards and manufacturers' recommendations shall be followed in the execution of this Work.
 - b. Devices shall be field calibrated after installation according to the calibration procedures specified below.
 - c. Provide all test instruments, calibration standards, and devices required to perform calibration and testing procedures. Alternative test Equipment must be approved by the Owner. Test equipment shall be 4 times as accurate as the instrument being calibrated.
 - d. Instrument calibration shall be witnessed by the Owner or any other person assigned by the Owner. Provide to the Owner daily calibration Work schedule.
 - e. Coordinate the Work with others so that calibration is completed prior to Equipment startup or system turnover dates or as directed by the Owner.
 - f. Calibrate in strict accordance with manufacturers' recommendations. Instruction books are available from the Owner for instruments furnished by others.
 - g. Power all transmitters from system power supplies for calibration. Allow manufacturer's recommended warm up time prior to start of calibration of device. Use of portable power supplies or batteries to power transmitters for Device Calibration is not allowed.
 - h. Calibrate all instruments to the calibration ranges/scaling and set points specified on the respective instrument datasheets or as indicated on vendor drawings.
 - i. If the instrument is of the "smart" family, verify that the internal configuration data is as specified on the respective instrument datasheet' including ranges/scaling and setpoints.

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- j. Immediately after Device Calibration, attach a calibration label or self-adhesive calibration sticker to the device with the name of the person performing the calibration and date of calibration.
- k. Turnover calibration sheets to Owner at end of calibration work phase.
- l. When devices are removed from Equipment, ensure the connection is protected from contamination. Clean devices such that reinsertion or installation of the device does not contaminate the Equipment.
- m. Report defective Equipment to the Owner.
- n. Assist and cooperate with Owner at all times through the calibration of the instruments to ensure that such activities do not interfere with the planned operation of the plant.
- 2. Pressure or differential pressure devices:
 - a. All pressure devices shall be calibrated to read the pressure at the process root valve.
 - b. If pressure device does not have a calibration sheet:
 - (1) Use certified dead weight tester, manometer or Wallace and Tiernan pneumatic calibration unit to validate all certified calibration pressure gauges used in the calibration of all other non-calibrated devices.
 - (2) Adjust zero and span of device to read the pressure at the process root valve.
 - (3) Use a vacuum or pressure hand pump and certified calibration pressure gauge to verify and record device pressure output readings at 0, 25, 50, 75, and 100% of input value.
 - (4) Record alarm point and failed sensor values.
 - (5) Record device hysteresis.
 - (6) Remove test equipment and verify that the instrument output reads the correct pressure.
- 3. Temperature devices:
 - a. RTD wiring shall be checked for proper type and grounding. The temperature element will be checked with an ohm meter for continuity. Record the resistance.
- 4. Level controllers and liquid level switches:
 - a. Fill the float chamber with water observe the operation of the device.
 - b. Record the controller output over the entire range of the input, verify the correct controller response or the activation of the switch occurs at the level setpoint specified.
- 5. Switches, other than liquid level:
 - a. All switch positioning shall account for dimensional changes that may occur when the Equipment is placed in service.
 - b. Apply process input and adjust switch actuation points to specified value.
 - c. Record if switches make and break with an electrical continuity check.
 - d. Adjust dead band if applicable.

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- e. Verify repeatability of switch actuation points after adjustments are completed.
- 6. Other transmitters and signal converters:
 - a. Apply power, input signal, and process input, as applicable.
 - b. Adjust zero and span.
 - c. Calibrate per manufacturer instructions for the applicable process measurement.
- 7. Remotely operated dampers:
 - a. Adjust air supply PRV on drive to output pressure desired.
 - b. Apply power to control drive.
 - c. Record damper for proper fail action. Energize and de-energize solenoid valves to verify proper switching of the instrument air power source and to prove the failure mode of the control drive.
 - (1) Fail Closed - Damper closes on loss of power.
 - (2) Fail Open - Damper opens on loss of power.
 - (3) Fail Last - Damper remains in the last position it was in on loss of power.
 - d. Record damper position over the entire input signal range; confirm whether damper is direct acting or indirect acting as required by the application.
 - e. Record damper position at 0, 25, 50, 75, and 100% of input value.
 - f. Record device hysteresis.
 - g. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
 - h. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the damper.
- C. Loop Testing:
 - 1. General:
 - a. Coordinate with Control System operator for all loop testing activities.
 - b. After Device Calibration and Verification of Installation has been completed for all devices in a loop, perform Loop Testing to functionally check all signals and devices within the loop. Loop Testing shall be performed on all control loops.
 - c. Verify operation of each instrument relative to transmitting and receiving devices in the loop.
 - d. Verify calibration of each instrument within the loop.
 - e. Functionally check that signal lines and signal wiring within the loop, as applicable, are completed and terminated.
 - f. Verify performance of instruments that are part of electrical control schemes in order to assist the Equipment manufacturer's service representative or Owner's maintenance, testing and operating personnel to functionally test the schemes.
 - g. Recalibrate, replace, or repair all of the loop devices as required to obtain the stated accuracy.
 - 2. Modulating Loops:

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- a. Apply process input as specified in this Paragraph 3.06.B or for smart transmitters manually control the output of the loop primary sensing device. Set the process to 50% of range and verify whether the loop is direct acting or indirect acting as required by the application.
- b. Apply process values equal to 0, 25, 50, 75, and 100% of range of primary sensing device. Record readings of all receiving devices at each of these input values. Also record value of primary sensing device output signal at each point.
- c. Adjust receiving device and transmitting device as required so that readout from receiving devices is within 1% of the value of the process input.
- d. Verify that the direction of response is consistent with the control system output.
- e. For output signal values of 0, 25, 50, 75, 100% from the control system, record the loop final element position in percent or degrees open.
- f. If loop contains a signal converter device, such as an I/P converter, record for each output signal value from the faceplate control station the value of the input and output signals of the converter.
- g. For control valve positioner or I/P converter recalibrate to obtain desired relationship between faceplate control station output and control valve position.
- h. Make adjustments as required to the control drive linkage, for control drive or I/P converter recalibrate to obtain desired relationship between faceplate control station output and damper position.
- i. For limit switches, verify that actuation point of limit switch is within 2% of the value specified. Adjust or recalibrate switch if required.
- j. For modulating output signals from the control system to receiving devices:
 - (1) Have the BMS operator place the output signal in manual.
 - (2) Apply signal values equal to 0, 25, 50, 75, and 100% of output signal range.
 - (3) Record readout of receiving devices for each value of input signal above.
 - (4) Adjust or recalibrate receiving device as required so that readout of device is within 1% of input signal value.
- k. For modulating loops containing transmitters, receiving devices and final control elements, proceed as follows:
 - (1) Loop test transmitters and receiving devices in the loop.
 - (2) Apply process input as specified in Paragraph 3.06.B or for smart transmitters manually control the output to loop transmitters. Verify that output of controllers is in the proper direction for process input values above and below controller set point.
 - (3) Verify null calibration of controllers by setting process input to set point and increasing controller reset adjustment. Adjust or calibrate controller as required so that controller output does not change under these conditions.

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- (4) Verify that direction of response of loop final control elements is in the direction specified for process input values above and below controller's set point.
 - (5) Record reading of the position of final control elements for input signal values of 0, 25, 50, 75, and 100% to these devices. Adjust or recalibrate final control device to obtain desired relationship between input signal value and final control element position.
 - (6) If final control devices have limit switches, verify that actuation point of limit switch is within 2% of value specified. Adjust or recalibrate switch if required.
 - 3. Discrete Loops:
 - a. Functionally test electrical control schemes designed for the purpose of controlling operation of power plant Equipment, including motors, pumps, motor-operated valves, solenoid-operated pneumatic valves and similar field Equipment. By performing all of the functions described below. These functions shall be performed under the coordination and supervision of the Owner's maintenance, testing and operating personnel.
 - (1) Apply process input as specified in Paragraph 3.06.B.
 - (2) Verify that switch actuation point is within 1% of that specified. Verification of switch actuation shall be by electrical continuity test. Advise Owner's maintenance, testing and operating personnel that switch is activated so he may proceed with his work.
 - (3) Remove process input from instrument, when requested, and verify switch returns to "on the shelf" state. Advise Owner's maintenance, testing and operating personnel.
 - (4) Repeat (1) and (2) above as required for Owner's maintenance, testing and operating personnel to complete functional test of control scheme.
 - (5) Assist Owner's maintenance, testing and operating personnel in verifying that pneumatically operated final control devices that are interfaced to an electrical control scheme through the use of solenoid valves or similar type device, operate as intended by the design of the control scheme. If final control device has limit switches, verify that these actuate within 2% of specified actuation value.
 - b. If a non-modulating type instrument is utilized to provide an input to any plant control system, perform a loop test as follows:
 - (1) Apply process input as specified in Paragraph 3.06.B.
 - (2) Verify that actuation point of switch is within 1% of that specified and that the input is received at the terminals of the plant control system. Verification shall be by electrical continuity test.
- D. Loop Tuning:
 - 1. After Loop Testing or during start-up of the process system or Equipment, tuning adjustments are required to obtain safe and smooth control action within the range of design limits of the Equipment.

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2. Verify that the instrumentation is operating within design limits and at design point.
3. Vary the process load and verify that the plant control system or instrument response is within design limits over the entire range.
4. Stroke remotely operated valves and dampers as required for loop tuning.
5. Adjust controllers for optimum response. Adjust proportional band, reset, rate and set point as required to obtain safe and smooth control action within the range of design limits of the Equipment.
6. Provide expert attendance and labor to manufacturer's representative for adjustments to the plant control system.
7. Record and submit all tuning constants to the Owner on the loop checkout sheets.

END OF SECTION 40 91 10

Rev	Date	Description	Revised	Checked	Approved
0	05/12/2026	ISSUED FOR BID	AHB	AAD	JRL

40 91 10 A - IU CHILLER REPLACEMENT INSTRUMENT LIST

REV	TAG ID	Description	INSTRUMENT TYPE	PIPE SIZE	SIGNAL TYPE	SIGNAL LEVEL	CALIBRATED RANGE	ENG. UNITS	P&ID	INSTALL DWG	MFR	MODEL	FURNISHED BY	INSTALL BY	WIRED BY	NOTES
0	CHWR-P03-03-01	CHILLER 3 CHILLED WATER RETURN PUMP DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	12"	LOCAL READOUT	N/A	0 - 50	PSIG	MM701	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CHWR-T1-003-01	CHILLER 3 CHILLED WATER RETURN PUMP DISCHARGE SIDE TEMPERATURE GAUGE	BIMETAL THERMOMETER	12"	LOCAL READOUT	N/A	32 - 75	°F	MM701	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CHWR-P1-003-02	CHILLER 3 CHILLED WATER RETURN PUMP DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	12"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWR-P03-003-02	CHILLER 3 CHILLED WATER RETURN SUPPLY DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	12"	LOCAL READOUT	N/A	0 - 50	PSIG	MM701	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CHWS-T1T-003-01	CHILLER 3 CHILLED WATER SUPPLY TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	12"	AI	4-20mA	32 - 75	°F	MM701	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CHWS-T1-003-03	CHILLER 3 CHILLED WATER SUPPLY TEMPERATURE GAUGE	BIMETAL THERMOMETER	12"	LOCAL READOUT	N/A	32 - 75	°F	MM701	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CHWS-P1-003-04	CHILLER 3 CHILLED WATER SUPPLY PRESSURE GAUGE	BOURDON TUBE	12"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWS-F1T-003-01	CHILLER 3 CHILLED WATER SUPPLY FLOW TRANSMITTER	ULTRASONIC FLOWMETER	12"	AI	4-20mA	0 - 6000	GPM	MM701	IC-501-6	EXISTING	EXISTING	EXISTING	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	EXISTING, OWNER TO VERIFY INSTALLATION LOCATION
0	CHWR-T1T-003-04	CHILLER 3 CHILLED WATER RETURN PUMP DISCHARGE SIDE TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	12"	AI	4-20mA	32 - 75	°F	MM701	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CHWR-P1T-003-02	CHILLER 3 CHILLED WATER RETURN PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	12"	AI	4-20mA	0 - 160	PSIG	MM701	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CHWR-P1T-004-02	CHILLER 4 CHILLED WATER SUPPLY PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	12"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CHWR-P04-004-01	CHILLER 4 CHILLED WATER RETURN PUMP DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	12"	LOCAL READOUT	N/A	0 - 50	PSIG	MM701	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CHWR-T1-004-01	CHILLER 4 CHILLED WATER RETURN PUMP DISCHARGE SIDE TEMPERATURE GAUGE	BIMETAL THERMOMETER	12"	LOCAL READOUT	N/A	32 - 75	°F	MM701	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CHWR-P1-004-02	CHILLER 4 CHILLED WATER RETURN PUMP DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	12"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWR-P04-004-02	CHILLER 4 CHILLED WATER RETURN SUPPLY DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	12"	LOCAL READOUT	N/A	0 - 50	PSIG	MM701	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CHWS-T1T-004-01	CHILLER 4 CHILLED WATER SUPPLY TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	12"	AI	4-20mA	32 - 75	°F	MM701	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CHWS-T1-004-03	CHILLER 4 CHILLED WATER SUPPLY TEMPERATURE GAUGE	BIMETAL THERMOMETER	12"	LOCAL READOUT	N/A	32 - 75	°F	MM701	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CHWS-P1-004-04	CHILLER 4 CHILLED WATER SUPPLY PRESSURE GAUGE	BOURDON TUBE	12"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWS-F1T-004-01	CHILLER 4 CHILLED WATER SUPPLY FLOW TRANSMITTER	ULTRASONIC FLOWMETER	12"	AI	4-20mA	0 - 6000	GPM	MM701	IC-501-6	EXISTING	EXISTING	EXISTING	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	EXISTING, OWNER TO VERIFY INSTALLATION LOCATION
0	CHWR-T1T-004-04	CHILLER 4 CHILLED WATER RETURN PUMP DISCHARGE SIDE TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	12"	AI	4-20mA	32 - 75	°F	MM701	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CHWS-P1-014-01	CHILLED WATER SUPPLY PUMP 4 SUCTION SIDE PRESSURE GAUGE	BOURDON TUBE	20"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWS-P04-014-01	CHILLED WATER SUPPLY PUMP 4 DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	20"	LOCAL READOUT	N/A	0 - 50	PSIG	MM701	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CHWS-P14-014-02	CHILLED WATER SUPPLY PUMP 4 DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	20"	LOCAL READOUT	N/A	0 - 160	PSIG	MM701	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CHWS-T1-014-01	CHILLED WATER SUPPLY PUMP 4 DISCHARGE SIDE TEMPERATURE GAUGE	BIMETAL THERMOMETER	20"	LOCAL READOUT	N/A	32 - 75	°F	MM701	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CWS-T1T-003-02	CHILLER 3 CONDENSOR WATER SUPPLY DISCHARGE SIDE TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	18"	AI	4-20mA	50 - 100	°F	MM702	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CWS-P1-003-05	CHILLER 3 CONDENSOR WATER SUPPLY DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	18"	LOCAL READOUT	N/A	0 - 160	PSIG	MM702	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CWS-T1-003-04	CHILLER 3 CONDENSOR WATER SUPPLY DISCHARGE SIDE TEMPERATURE GAUGE	BIMETAL THERMOMETER	18"	LOCAL READOUT	N/A	50 - 100	°F	MM702	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CWS-P1T-003-01	CHILLER 3 CONDENSOR WATER SUPPLY DISCHARGE SIDE PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	18"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CWS-P03-003-03	CHILLER 3 CONDENSOR WATER SUPPLY RETURN DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	18"	LOCAL READOUT	N/A	0 - 50	PSIG	MM702	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CWR-T1T-003-03	CHILLER 3 CONDENSOR WATER RETURN TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	18"	AI	4-20mA	50 - 100	°F	MM702	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CWR-T1-003-05	CHILLER 3 CONDENSOR WATER RETURN TEMPERATURE GAUGE	BIMETAL THERMOMETER	18"	LOCAL READOUT	N/A	50 - 100	°F	MM702	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CWS-T1T-004-02	CHILLER 4 CONDENSOR WATER SUPPLY DISCHARGE SIDE TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	18"	AI	4-20mA	50 - 100	°F	MM702	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CWS-P1-004-05	CHILLER 4 CONDENSOR WATER SUPPLY DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	18"	LOCAL READOUT	N/A	0 - 160	PSIG	MM702	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CWS-T1-004-04	CHILLER 4 CONDENSOR WATER SUPPLY DISCHARGE SIDE TEMPERATURE GAUGE	BIMETAL THERMOMETER	18"	LOCAL READOUT	N/A	50 - 100	°F	MM702	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CWS-P1T-004-01	CHILLER 4 CONDENSOR WATER SUPPLY DISCHARGE SIDE PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	18"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CWS-P04-004-03	CHILLER 4 CONDENSOR WATER SUPPLY RETURN DIFFERENTIAL PRESSURE GAUGE	DIAPHRAGM	18"	LOCAL READOUT	N/A	0 - 50	PSIG	MM702	IC-501-4	ASHCROFT	1130	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M1 MANIFOLD
0	CWR-T1T-004-03	CHILLER 4 CONDENSOR WATER RETURN TEMPERATURE TRANSMITTER	3 WIRE PT 100 RTD	18"	AI	4-20mA	50 - 100	°F	MM702	IC-501-3	MOORE INDUSTRIES	TDZ/PT-131A-P2	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	TRANSMITTER/RTD/THERMOWELL INCLUDE LOCAL DISPLAY
0	CWR-T1-004-05	CHILLER 4 CONDENSOR WATER RETURN TEMPERATURE GAUGE	BIMETAL THERMOMETER	18"	LOCAL READOUT	N/A	50 - 100	°F	MM702	IC-501-3	ASHCROFT	EI BIMETAL	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE THERMOWELL
0	CWR-P1-022-01	COOLING TOWER CONDENSOR WATER RETURN PUMP 2 DISCHARGE SIDE PRESSURE GAUGE	BOURDON TUBE	20"	LOCAL READOUT	N/A	0 - 160	PSIG	MM702	IC-501-1	ASHCROFT	1279	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	N/A	INCLUDE ANDERSON GREENWOOD M25 MANIFOLD
0	CWR-F1T-019-01	COOLING TOWER 1B CONDENSOR WATER RETURN FLOW TRANSMITTER	MAGNETIC FLOWMETER	24"	AI	4-20mA	0 - 13000	GPM	MM702	IC-501-2	BADGER	M2000	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	00 HAS 1% ERROR
0	CWR-V5H-185-01	COOLING TOWER 1B CELL 5 VIBRATION SWITCH HIGH	MECHANICAL VIBRATION SWITCH	N/A	DI	24VDC	N/A	N/A	MM702	FROM MANUFACTURER	METRIX	5550	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	INTERLOCK TO VFD
0	CWR-P1T-185-01	COOLING TOWER 1B CELL 5 CONDENSOR WATER PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	18"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CWR-V5H-186-01	COOLING TOWER 1B CELL 6 VIBRATION SWITCH HIGH	MECHANICAL VIBRATION SWITCH	N/A	DI	24VDC	N/A	N/A	MM702	FROM MANUFACTURER	METRIX	5550	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	INTERLOCK TO VFD

0	CWR-PIT-186-01	COOLING TOWER 1B CELL 6 CONDENSOR WATER PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	16"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	CWR-VSH-187-01	COOLING TOWER 1B CELL 7 VIBRATION SWITCH HIGH	MECHANICAL VIBRATION SWITCH	N/A	DI	24VDC	N/A	N/A	MM702	FROM MANUFACTURER	METRIX	5550	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	INTERLOCK TO VFD
0	CWR-PIT-187-01	COOLING TOWER 1B CELL 7 CONDENSOR WATER PRESSURE TRANSMITTER	GAUGE PRESSURE TRANSMITTER	16"	AI	4-20mA	0 - 160	PSIG	MM702	IC-501-1	SOR	1800PT	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	
0	REF-IS-000-01	REFRIGERANT EXHASUT FAN (EF-1) CURRENT SWITCH	CURRENT SWITCH	N/A	DI	24VDC	N/A	N/A	MM702	N/A	VERIS	H608	MECHANICAL CONTRACTOR	MECHANICAL CONTRACTOR	ELECTRICAL CONTRACTOR	

FIELD	DESCRIPTION
REV	REVISION - BY LINE ITEM, NOT DOCUMENT
TAG ID	SYSTEM CODE/ISA FUNCTION/SEQ NO.
DESCRIPTION	SERVICE/DEVICE FUNCTION
INSTRUMENT	T PRESSURE XMTR, PRESSURE GAUGE, PIPE SIZE INCHES (FROM PID)
SIGNAL TYPE	AI, AO, DI, DO, COMM (COMM = DATA LINK)
SIGNAL LEVEL	4-20mA (ANALOG), 24VDC, 120VAC
RATED RANGE	LOW TO HIGH RANGE
ENG UNITS	PSIG, F, GPM, ETC
PID	PIPING & INSTRUMENT DIAGRAM SHOWS
INSTALL DWG	(FROM BMCD INSTRUMENT INSTALL DWG
MFR	MANUFACTURER
MODEL	BASE MODEL/SERIES
FURNISHED BY	WHO BUYS UNIT
INSTALL BY	WHO INSTALLS UNIT
NOTES	ADDITIONAL INFORMATION (E.G., ESI

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. All project specifications, drawings, and general provisions apply to this Section. It is each Contractor's responsibility to properly coordinate between all contract documents for a complete and correct installation. Any specific references mentioned herein are for conveniences only.
 - 1. 40 94 00 Appendix A I/O List

1.02 SUMMARY:

- A. Work by Contractor
 - 1. Work described within this specification is by the Control System Integrator (CSI) unless noted otherwise.
 - 2. Support the Owner in integrating feedback and alarms into IU's existing Siemens Desigo automation system.
 - a. Integration of new chillers shall match the graphics of those being replaced. This includes integrating, at a minimum, the replacement of existing controls points into the HMI for operator visibility.
 - 3. Furnish, test, deliver, store, handle, install and commission the material needed to integrate the IO needed from the new chillers into the BMS system including the following:
 - a. Control cabinets
 - b. Network cabinets
 - c. Human Machine Interface (HMI) equipment
 - d. Vendor skid data links and/or programming their operations based on vendor logics
 - e. VFDs
 - f. Instruments for control and trending
 - 4. Furnish, license, configure and test all system hardware, software, and firmware, (upgrading to the current level with all associated patches), including but not limited to the following:
 - a. System I/O
 - b. Controller logic
 - c. Network devices
 - d. Servers
 - e. HMI graphics
 - 5. Engineering support of construction work planning
 - 6. Field support for installation and commissioning as defined herein
 - 7. Training
- B. Work Distribution:
 - 1. Instrumentation, conduit, and cable furnished and installed by others.
 - 2. Control System Integrator (CSI) to provide BMS and network cabinets

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

3. Sensitive electronics that could be subject to damage by others handling the panels should be removed, shipped loose, and re-installed by the Control System Integrator (CSI).

1.03 DEFINITIONS

- A. Automatic: action is performed by the plant control system or local controller based on software programming.
- B. Interlock: either hardwired or via programming software; typically used to protect machine or system process from damaging itself by stopping the machine or process.
- C. Local Manual: action performed by the operator locally at a field control panel or field device.
- D. Remote Manual: action performed by the operator at the BMS with the field control panel or field device remaining in Auto.
- E. Remote: action performed by the operator via the plant control system.
- F. Separation: the distribution of equipment and field signals to increase the availability of system operations in case of a single failure.
- G. Single failure proof: failure of a single device or piece of equipment does not preclude the system from providing at least partial services.

1.04 REFERENCE STANDARDS:

- A. The Work described herein shall be performed in accordance with the following requirements (in order of precedence):
 1. Relevant requirements of the Federal Government
 2. Relevant requirements of the State of Indiana.
 3. Codes and Standards:
 - a. ANSI/ASHRAE Standard 135, BACnet – A Data Protocol for Building
 - b. Automation and Control Networks Factory Mutual (FM).
 - c. Insulated Cable Engineers Association (ICEA)
 - d. International Society of Automation (ISA).
 - e. International Society of Electrical and Electronics Engineers (IEEE)
 - (1) IEEE 800 Series – Ethernet
 - f. National Electrical Manufacturers Association (NEMA).
 - (1) NEMA 250 – Enclosures for Electrical Equipment.
 - g. National Fire Protection Association (NFPA).
 - (1) NFPA 70 – National Electric Code
 - (2) NFPA 79 – Electrical Standard for Industrial Machinery
 - (3) NFPA 85 – Boiler and Combustion Systems Hazards Code
 - h. Occupational Safety and Health Association (OSHA).
 - i. Underwriter’s Laboratories (UL).
 - (1) UL508: Industrial Control Panel
 - (2) UL916: Energy Management Systems
 4. Requirements of this Contract.

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

- 5. Owner preferences including hardware series types and software configuration practices.
- 6. Manufacturer's recommended standards and practices.
- B. The date for establishing code requirements shall be the contract award date.
- C. Notify the Owner and Engineer of any conflicting requirements. The Work shall not proceed until a resolution is approved by the Engineer and Owner.

1.05 QUALITY ASSURANCE:

- A. The Control System Integrator shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of similar projects in size, scope and complexity.
- B. The CSI shall have a local branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
- C. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this project.
- D. 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.
- E. Comply with ASHRAE 135 for system controllers, communication devices, and workstation/historian server.

1.06 SUBMITTALS

- A. Submit as specified in General specifications.
- B. Submittal Descriptions
 - 1. Quality Assurance Manual
 - a. Includes all quality assurance procedures to be followed by the Manufacturer as well as review points by Owner/Engineer.
 - 2. Bill of Material
 - a. Description and quantity of all provided Equipment and Material
 - b. Control System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, control panels, and operator interface equipment.
 - 3. Equipment Manuals
 - a. Contains relevant technical information including specifications, drawings, and approvals of all Equipment, including software.
 - 4. Network Architecture Drawing
 - a. Depicts the following, including but not limited to the following:
 - (1) The design package has a diagrammatic drawing that the CSI is to expand to provide complete details of system as configured and installed showing all system networked components and terminations

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

- (2) All interfaces to external devices with networked connections
 - (3) Point to point termination details for connecting cables
 - (4) Device addressing (e.g., BACnet MS/TP, BACnet IP, Ethernet, Modbus etc.)
 - (a) Note – CSI to coordinate with Owner on the assignment of IP addresses for external field devices
- 5. BAS Panels, Network Cabinets and any intermediary panels/junction boxes Layout Drawings
 - a. Depicts the following, including but not limited to the following:
 - (1) External enclosure dimensions
 - (2) Cabinet weights
 - (3) Arrangement of all cabinet internal components
 - (4) Location and dimension of cabinet penetrations
 - b. There shall be one drawing per cabinet – typical drawings not permitted.
- 6. New Panels/Cabinet Wiring Drawings (for all new or existing to be modified cabinets as part of this project defined in this Specification)
 - a. Depicts the following, including but not limited to the following:
 - (1) All cabinet internal components that have either internal or external wiring
 - (2) Emergency and trip push button relay circuits within the control cabinets.
 - (3) Internal cabinet wiring between cabinet components
 - (4) Terminal blocks showing connections to external wiring as follows, including but not limited to the following:
 - (a) Field IO
 - (b) Power supplies
 - (c) Grounding
 - (d) Network connections
 - (5) Power supply requirements in Watts
 - b. There shall be one drawing per cabinet – typical drawings not permitted.
- 7. Hardwired and Soft IO Data Lists
 - a. These lists include both Plant and Vendor Skid interfaces. Vendor skid interfaces include both hardwired and soft I/O points that are based on current information from the Vendors but may be subject to change; the Control System Integrator (CSI) shall allow for a 25% addition of soft I/O data points and 25% of hard I/O points. Current information is attached as Appendix A, certain data fields are for the Control System Integrator (CSI) to fill in and coordinate with the Owner, including but not limited to the following:
 - (1) Assigned controller
 - (2) Assigned IO module and point
 - (3) Assigned terminal blocks
 - (4) Port number

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

- b. The CSI shall maintain up-to-date Hardwired and Soft IO Data Lists throughout construction. Any changes to documents will be provided to the Engineer.
- 8. Plant Control System Narratives – Refer to 40 96 00 for Sequence of Operations
 - a. The Plant Control Narratives shall include:
 - (1) Refrigeration Leak evacuation and shutdown protocol
 - (2) Chiller operation and methodology
 - (3) Cooling tower operation and methodology (including heat tracing)
 - b. The CSI is responsible for maintaining current revision throughout the project's lifecycle. At the completion of the project, the CSI shall provide an as-built version of the Control System Narratives. These narratives shall be included in the manuals and Operator training.
 - c. Any control narratives not in the scope of this upgrade will be maintained through the BMS upgrade.
- 9. Software Logic Diagrams
 - a. If applicable, certain vendor equipment skids will have their control & monitoring logic programmed in the BMS in accordance with the vendor-provided logic and operations manuals.
 - b. Depicts all BMS control logic, including but not limited to the following:
 - (1) All external IO (hard and soft)
 - (2) Function blocks
 - (3) Function block parameters and settings
 - (4) Signal connections between IO and function blocks
- 10. Software Graphic Displays
 - a. Displays shall mimic the format, style and content of existing system graphics.
 - b. Depicts all BMS human-machine interface graphics, including but not limited to the following:
 - (1) Navigation hierarchy (will add new menu buttons to top of screen with others, coordinate with Owner for background color to distinguish these from the FHS buttons.)
 - (2) Arrangement of all graphic objects
 - (3) Colors
 - (4) Units of measurement/display of variables
 - (5) Faceplates
 - (6) Soft IO data points via communication links.
 - (7) Any IO not previously displayed, will be added to control graphics with coordination with Owner/Engineer.
- 11. Software and Firmware Operational Documentation: Include the following:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - c. Device address list.
 - d. Point address and configuration list.

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- e. Point alarm List
 - f. Printout of software application and graphic screens.
 - g. Software license required by and installed for workstations and control systems.
 - h. The warranty applies to both hardware and software.
- 12. Owner Factory Acceptance Test Plan & Procedure
 - a. Test plan for Factory Acceptance Test (FAT) and Site Acceptance Test (SAT)/Startup
 - b. Test procedure with step-by-step instructions of each test including the response parameters, settings, alarm and action setpoints.
 - c. Test report that summarizes the test results including any discrepancies/incidents and what corrective actions were taken to reconcile same.
- 13. Installation Manual
 - a. Includes all Manufacturer requirements and instructions for installation and startup, including but not limited to the following:
 - (1) Equipment storage
 - (2) Equipment handling
 - (3) Equipment mounting
 - (4) Equipment grounding
 - (5) Equipment power supply connections
 - (6) Equipment energization
- 14. Training Manual
 - a. Provide training manual that includes, at a minimum, the following:
 - (1) Course objective.
 - (2) Course outline.
 - (3) Theory of operation.
 - (4) Notes that supplement and enhance information provided in the manufacturer's operation and maintenance manuals.
 - b. Course outline and materials at least 8 weeks prior to first class to provide instruction on system operation, setpoint adjustments, adding or deleting points, placing equipment/points into maintenance mode.
 - c. Course shall be instructor led, with 2 sessions to accommodate shift workers and may be supplemented with computer-based or web-based training.
 - d. Provide a minimum of 4 hard copies of course materials and electronic versions of the course materials.
- 15. Network Migration Plan
 - a. Includes a complete step-by-step procedure for the following:
 - (1) Migration of existing Metasys network connections to the new Metasys network connection.
 - (2) Licensing information and subscription fee for owner.
- 16. Operation and Maintenance Manual
 - a. Provide O&M manual.

SECTION 40 94 00 – BUILDING MANAGEMENT SYSTEM (BMS)

- b. Includes description of all BMS processes and procedures for Operation and Maintenance, including but not limited to the following (vendors/suppliers shall provide O&M manuals for major and skid equipment):
 - (1) System startup
 - (2) System normal operation
 - (3) System abnormal operation
 - (4) System troubleshooting
 - (5) System shutdown
 - (6) System preventive maintenance
 - (7) System corrective maintenance
- C. Drawing Requirements - As-Built Documentation
 - 1. All prints shall be readable/legible when reduced to 11x17 size from the original CAD size and contain title block with drawing number and description.
 - 2. All prints shall be provided in electronic form using AutoCAD or an AutoCAD compatible format. If any imbedded objects are used, they shall also be given to the Owner/Engineer. No custom text format shall be used.
 - 3. Only one set of prints (working) shall be plotted out and used for the project. All red-line markups shall be noted on the working set.
 - 4. On phase completion the working set of prints shall be given to the Owner/Engineer. Copies shall be made, and red-line prints shall be immediately sent out for updates. One month (30 calendar days) shall be allowed for the completion of updates. Updated drawings in electronic form shall be returned to Owner/Engineer at the end of the 30 days.
 - 5. All prints shall be of column and line design. Wire numbers shall be derived from the column and line the wires are drawn on or in the case of a BMS print, the I/O point may be used for deriving the wire number. Wire numbers don't change when going through a terminal block. Wire numbers must change going through a device. If print format can't be made as column and line, then wire numbers shall start at 100. Each sheet shall be allotted 100 wire numbers. Example sheet 1 shall have wire numbers 100-199. Sheet two shall have wire numbers 200-299 etc.
 - 6. Prints shall be drawn from a maintenance point of view and not an engineering point of view. Wires shall not be drawn in bundles or cables, but individually. All prints shall be used for troubleshooting, so they need to be detailed.
 - 7. All coils and contacts shall be cross referenced by sheet number and location to show:
 - a. Coils: on what sheet its' contacts are located, and normal state of contact.
 - b. Contacts: on what sheet its' coil is located.
 - 8. All drawings must be colored for printing. No Yellow shall be used on any colored drawings. All text shall be black unless colored for highlighting purposes.
 - 9. All prints shall have title blocks with room for extra revision notations.
 - 10. All dimensions shall be called out in inches, feet, NPT etc. No metric dimensioning shall be allowed. All wire sizing shall be in AWG.
 - 11. A bill of materials shall be included in print package.

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12. A drawing index shall be included in print package.
13. As-built documents shall reflect the final installed conditions.
14. Provide 2 sets of hardcopies for drawings and electronic files for all dwgs and documents.

1.07 INFORMATIONAL SUBMITTALS

- A. Project schedule within 1 month of project award showing work tasks, start/finish date of each task, submittal dates, milestones (that indicate any potential restraints or coordination with other trades).
- B. Project progress status reports at project meetings.
- C. Data Communications Protocol Certificates: Certify that each proposed system controller complies with ASHRAE 135. Include PICS certificates, BIBBS, and device profile details.
- D. Qualification Data: For Installer.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Equipment shall be installed in an area which is subject to various backgrounds, RF signals. Protect system from interference within this environment and comply with FCC rules of CFR 47, ANSI C63.12, and ANSI C63.4.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.10 COORDINATION

- A. Coordinate with other Mechanical and Electrical Contractor for associated installation activities.
- B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Section 262413 "Switchboards" and 262416 "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- D. Coordinate equipment with Section 262923 "Variable Frequency Motor Controllers" to achieve compatibility with motor starters and annunciation devices.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project specific software and documentation shall become Owner's property:
 1. Display graphics.
 2. Record drawings and documents.
 3. Database
 4. Application programming code

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1.12 WARRANTY

- A. Products and accessories shall be guaranteed for 12 months from successful commissioning.
- B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance. During warranty period, the CSI shall respond to Owner's request for warranty service within 24hours.
- C. Provide quarterly inspections of the control system, of no less than 16 hours per visit. Document any abnormalities with the Owner, repair fault, and document outcome.
- D. Schedule visits at change of seasons (January, April, July and October) or there about as scheduled with the Owner. Submit scheduled events for maintenance with the closeout documentation.
- E. Hardware and software personnel supporting warranty items shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service by phone is 4 hours and if required, on site is 24hrs.
- F. Software upgrades and service patches shall be made available and installed by the CSI upon approval by the Owner at no cost to the Owner during the warranty period.
- G. The Owner shall retain all rights to the system hardware and software and other individuals under contract to the Owner may use the system for commissioning, servicing, modifying the system in the future per Owner direction.

1.13 MAINTENANCE

- A. Provide recommended spare parts list for the first 5 years of operation, including unit pricing.
- B. Provide latest software revisions and patches during the warranty period.

PART 2 - PRODUCTS

2.01 ACCEPTABLE CONTROL SYSTEM INTEGRATOR

- A. Manufacturers
 - 1. Siemens Building Technologies
 - 2. Owner Approved Equal

2.02 MATERIALS

- A. Products and materials installed in this system are to be new; used products are not allowed.
- B. CSI to maintain spare parts for this project and be available for at least 5 years.
- C. Verify operation of existing instruments and controls outside of demo scope. Replace any items that do not function.

2.03 SYSTEM DESCRIPTION

- A. The Control System Integrator (CSI) shall provide an integrated Plant Control System that is a Native BACnet (ASHRAE Std 135) based, peer-to-peer networked, distributed control system for the central utility plant upgrade. This system shall integrate into the

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- existing Johnson Controls system in the museum airside and shall include a local operator interface terminal, instrumentation and control devices, wiring, piping, and related systems to provide central plant monitoring and control functions.
- B. The CSI shall include items that are not specifically itemized in this specification that are necessary to implement, maintain, expand and operate the Central Utility Plant as a system in compliance of the functional intent of this specification and associated drawings.
 - C. The existing Central Utility Plant system shall be modified as necessary to accommodate the increased I/O (hardwired and data communication link points) and required services with respect to the historian and remote access functionality.
 - D. The upgraded system shall be configured to allow easy expandability, integration, and connection to multiple systems.
 - E. The upgraded control system shall have hardwired input/outputs and data communication links with local control skid equipment.
 - F. Provide necessary BACnet compliant hardware and software to meet the system's functional specifications and sequences of operation. Provide Protocol Implementation Conformance Statement (PICS) for software and system controllers.
 - G. Provide and/or update the office automation software in the existing system for the integration of the upgraded central utility plant system.
 - H. The control system shall provide open communications based on BACnet open communication protocol standard. Systems employing proprietary protocol will not be accepted. BACnet shall be implemented at the OWS and the primary controller level.
 - I. Update the graphical user interface at the existing Central Utility Plant for the installation of new equipment, access to real-time data for systems, ability for overrides, and access to monitoring and control functions at the new operator interface terminal.
 - J. The system shall take into account future expansion and incorporate 25% additional I/O spares for this phase.

2.04 SYSTEM PERFORMANCE

- A. System shall perform to the following minimum standards over the network connections and be tested using the system hardware and software:
 - 1. Graphic Displays: Display current data (20 dynamic points) within 10 sec.
 - 2. Graphic Refresh: Display current data (20 dynamic points) within 8 sec and then auto update every 15 sec.
 - 3. Configuration and Tuning Screens: Control logic updates for configuring, calibrating, or tuning points, PID loops to refresh every 6 sec.
 - 4. Object Command: devices to react to a binary command within 2 seconds; for analog command device to start to react within 2 seconds.
 - 5. Alarm Response time: an object that goes into alarm shall be annunciated on the display within 20 sec; multiple alarms shall be received and displayed within 5 sec of each other.
 - 6. Control loops shall maintain variable at setpoint within tolerances:
 - a. Temperature: +/- 1F

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- b. Flow: +/-1% of full scale
- c. Pressure: +/- 1% of full scale

2.05 CONTROL SYSTEM EQUIPMENT

A. Graphical Displays:

1. Graphical displays shall follow format and content that are presently installed on the existing Central Utility Plant control system.
2. The operator interface terminal shall select displays independently via keyboard or mouse commands.
3. Displays shall present information in a format and size to the operator in a clear and consistent manner that meets human factors design principles.
4. Display types include:
 - a. Site overview
 - b. Plant overview
 - c. System & Sub-Systems
 - d. Faceplate.
 - e. Loop.
 - f. Alarm.
 - g. Trend & Historical.
 - h. Configuration.
 - i. Diagnostics.
 - j. Report Generation.
5. Descriptive titles shall be shown on each display screen at the top and centered.
6. NO vendor names or logos or unnecessary information shall be shown on the display screens.
7. Alarm notification shall be shown as an icon on each display screen at the top.
8. Date and time shall be shown on each display screen at the lower right corner.
9. Develop graphical screens in conjunction with Owner approval.
10. Equipment status
11. Process variables in engineering units (English)
12. Indicate alarm status of process variable by changing the displayed value to yellow.

B. Alarm Displays:

1. Annunciation: visual and audible alarm shall be generated at the OWS. Audible alarm volume and frequency adjustable by Operator.
2. Alarm Summary Screen:
 - a. Date/Time of Receipt
 - b. Alarm Priority (Critical, Security, Notification or Maintenance)
 - c. Alarm Condition (Analog alarms shall have a high and low alarm condition defined by software; discrete alarms shall have a time delay period and alarm if the point has not reached the correct state in the allotted time)
 - d. Date/Time Silenced
 - e. Date/Time Acknowledged

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- f. Date/Time Reset
 - g. Operator Action
 - 3. Alarm Inhibit: provide inhibit function for individual process I/O points.
- C. Trending Displays: Operator shall be able to display continuous real-time and historical trends of no less than 6 variables; coordinate with Owner for up to 4 predefined trend plots.
- D. Data Reports: Operator shall be able to pre-configure reports to be produced on a timed or event driven basis. Coordinate with Owner for up to 4 predefined data reports.
- E. Security Protection:
 - 1. Passwords:
 - a. System is access via User ID/Password only.
 - b. 'Strong' passwords are required:
 - (1) Must not be found in English dictionary
 - (2) Must change every 90 days
 - (3) User account locks out after 3 (programmable) failed attempts.
 - (4) Minimum of 8 characters – cannot form a name, date, acronym, or a word and contain (in addition to lower case letters) at least two of the following characters: Upper case, number, special character (!, @, #, \$, %, &).
 - c. Deactivate passwords as soon as possible after personnel are no longer employed.
 - d. Auto user log off shuts down user access after 15 minutes (programmable) of inactivity.
 - 2. Virus and Malware Protection Software: install and configure for the new system; coordinate with Owner IT group for software to be used for consistent application across the site.
 - 3. Disable unused ports, protocols, and network services not required or used for this application.
 - 4. No remote access to the system by the integrator or manufacturer is allowed; updates and troubleshooting activities will be conducted on-site with Owner personnel monitoring all activities.
- F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
 - 4. Alarm contact to the BMS upon failure of the Power Supply.
- G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

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1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- 2.06 SUPERVISORY/NETWORK CONTROLLERS:
- A. General Supervisory Controller Requirements:
1. Supervisory controllers shall be the manufacturer's model listed by the BACnet Testing Lab, BTL, as a Building Controller using BACnet communications over IP or Ethernet and shall be BACnet Broadcast Messaging Devices (BBMDs)
 2. System shall consist of programmable, independent, standalone, microprocessor-based Supervisory controllers to manage global strategies indicated.
 3. Controller shall have enough memory to support its operating system, database, and programming requirements.
 4. Data shall be shared between networked controllers and other network devices.
 5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
 6. Controllers that perform scheduling shall have a real-time clock.
 7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
 8. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 9. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment
 10. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, with fine tuning, and trend logging.
 - b. Chiller Control Programs: Control function of chilled-water reset and equipment sequencing.
 - c. HVAC Control Programs: Optimal run time and supply-air reset.

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- d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
- B. Communication:
 - 1. Supervisory controllers shall perform routing, communicate with other devices in the network.
 - 2. Supervisory controllers shall communicate using both BACnet MS/TP and BACnet IP protocols.

2.07 FIELD CONTROLLERS

- A. Capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application. Expansion IO modules shall be added as needed.
 - 1. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
 - 2. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
 - 3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
 - 4. Enclosure: Waterproof rated for operation at 40 to 150 deg F for exterior applications or in unconditioned areas.
 - 5. Units monitor or control each I/O point, process information, and download from or upload to operator workstation, diagnostic terminal unit, or control units.
 - 6. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - 7. Local operator interface provides for download from or upload to operator workstation, diagnostic terminal unit, or control units.

2.08 INPUT/OUTPUT INTERFACE

- A. Input and output points shall be protected for shorting of the point to itself, another point or ground.
- B. Binary inputs shall provide a wetting current compatible with commonly available control devices or use interposing relays as needed for operation. Binary inputs shall be protected against contact bounce and noise; and sense dry contact closure without application of external power sources.
- C. Analog inputs shall monitor low voltage (0-10Vdc, 4-20mA) or RTD signals.

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- D. Binary Outputs shall provide for On/Off operation; have a 3 position (on-off-auto) override switch and status lights. Outputs can be selected for either normally open or closed operation.
- E. Analog outputs shall provide a modulating signal for control of end field devices (0-10Vdc or 4-20mA); have a 2 position (auto-manual) switch, manually adjustable potentiometer and status lights.
- F. Universal I/O are those that can be designated as either a binary or analog function.

2.09 AUXILARY DEVICES

- A. Control Relays: Plug in type, UL listed with dust cover and LED energized indicator. Contact rating, configuration and coil voltage shall be suitable for the application.
- B. Time Delay Relays: solid-state, UL listed and have adjustable time delay +/- 100% from setpoint. Contact rating, configuration and coil voltage shall be suitable for the application.
- C. Current transmitters: self-powered, combination split-core current transformer type with built in rectifier and high gain servo amplifier with 4-20mA output. Full scale ranges shall be from 10A to 200A with internal zero & span adjustment that meets ANSI/ISA S50.1 and be UL listed.
- D. Current Transformers: shall be UL listed and completely encased (except for terminals) in approved material. Be available in various current ratios, 1% accurate at 5A full-scale output.

2.10 CONTROLS PANELS

- A. Construction:
 - 1. Provide wall mounted UL rated, NEMA 4 panel to house control system equipment (controllers, I/O modules, power supplies, relays, etc). Front access only.
 - 2. Provide EMI/RFI gasket around door.
 - 3. Provide environmental controls for electronic equipment as required for this application to meet thermal limitations of the components using fans and filters or air conditioning system. Expected design conditions:
 - a. Normal Design Temperature Range: 60-85F
 - b. Normal Design Relative Humidity: 5-95%RH, non-condensing
 - c. Hazardous Area Classification: Non-Classified
 - 4. Cable entry may be via the top or bottom; if through the top seal conduits to protect against any water intrusion.
 - 5. Interior LED light, approximately the width of the panel, turns on automatically when the panel door is opened.
 - 6. Provide plastic data pocket to place documentation inside the panel.
 - 7. Provide keylock, with 4 keys each panel.
 - 8. Labels:
 - a. Material: Melamine
 - b. Color: White background with Black lettering

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9. Manufacturer:
 - a. SCE
 - b. Rittal
10. Terminal Blocks
 - a. Provide terminal blocks for termination of field cable conductors. One wire per terminal.
 - b. Soring or screw terminal blocks capable of accepting up to #12AWG conductors.
 - c. Terminal blocks shall be laid out so that only one wire is landed per terminal.
 - d. Terminal blocks shall be provided for all possible I/O in the panel. This includes installed IO modules and the total number of potential IO modules to be installed in the panel for future points.
 - e. Manufacturer: Wago or Phoenix Contact.
- B. Electrical:
 1. Provide On/Off power switch with overcurrent protection for control power sources.
 2. Provide separate power feeds to redundant power supplies with a redundancy power supply module.
 3. Provide power strips as needed for power distribution. Rated at 15Amps – 125VAC, surge protection metal oxide varistor, clamping voltage 400v, UL 1449 tested.
 4. Provide internal cable management system for routing and protection of wiring. Keep DC And AC wiring separated.
 5. Provide duplex 120VAC maintenance receptacle.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to starting work, inspect work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- B. Notify the Owner (or Representative) in writing of conditions that are detrimental to the proper and timely completion of this work.

3.02 PROTECTION

- A. Contractor shall protect work and material from damage upon receipt at site through the construction period.
- B. Coordinate work with other construction trades to avoid interference with work activities and possible damage to the system.

3.03 INSTALLATION

- A. Install equipment in accordance with Manufacturer's instructions.
- B. Provide nameplates for Control equipment; coordinate with Owner for tag designations. Identifiers shall match record documents.

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- C. Provide power line surge protection for ac circuits that meets IEEE C62.41; do not use TERMINAL for surge protection.
- D. Coordinate all IP addresses with Owner.
- E. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- F. Connect and configure equipment and software to achieve sequence of operation specified.
- G. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.
- H. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally.
- I. Provide cable and wiring identification labels at each end within 2 in of the termination of the wire.
- J. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.
- K. On completion of work each day, clean the area and keep the equipment free from dust, dirt, and debris. Collect waste and place in designated location.

3.04 PERFORMANCE VERIFICATION TESTING

- A. Manufacturer's Field Service: Engage the factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Including all test equipment required for service of the system instruments, controls, and accessory equipment. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform power and grounding checks for cable and components.
 - 2. Verify each I/O point as defined on the I/O list from the field device, to I/O card point, and HMI graphical display.
 - a. Analog Inputs/Outputs: 0%, 25%, 50%, 75%, and 100% of range up scale and then repeat going down scale.
 - b. Discrete Inputs/Outputs: 0V (off state) and 24V (on state)
 - 3. Tune the individual PID loops as needed for stability at all operating conditions.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 5. Test and adjust controls and safeties.
 - 6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 7. Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

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9. Test each system for compliance with sequence of operation.
10. Test software and hardware interlocks.
- C. Verification, check system as follows:
 1. Verify that BMS controller redundant power supply still provides power if either of the power supplies fail.
 2. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 3. Verify that spare I/O capacity has been provided.
 4. Verify that controllers are protected from power supply surges.
- D. Test Integration into Existing Site Control System Network and Database:
 1. After the controller's programs have been verified, the contractor shall test the integration to the existing site control system and shall verify the integration performance as follows:
 - a. BACnet data communications
 - b. Response time under fully loaded system.
 - c. Database configuration conformance
 - d. Alarm management configuration conformance.
 - e. Graphics displays of building system under monitoring and control.
 - f. The operator shall be able to integrate every BACnet point in the building Supervisory Controllers
 - g. System backup of building database and reloading
 - h. Global application programs configuration and testing at the Supervisory Controllers.
 2. BMS vendor shall develop and submit for approval a detailed system integration test procedure.
- E. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.05 DELIVERY, STORAGE, AND HANDLING:

- A. Package all Equipment and Material to prevent damage during shipment.
- B. Each individual package shall include a shipping list.
- C. Deliver all Equipment and Material to ACMAA in Ft. Worth, TX.
- D. Inspect all Equipment and Materials upon receipt. Notify Engineer and Owner of any damage. Damaged Equipment or Materials shall not be installed without written approval from the Owner and Engineer.
- E. Store and handle all Equipment and Material in accordance with specified factory requirements.

3.06 TRAINING

- A. Manufacturer to provide training in accordance with SECTION 01 79 00 – Demonstration and Training.
- B. Training shall be scheduled at times where the subject equipment is installed and startup has commenced such that the trainer can walk the system down while training.

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- C. Provide training so that the Owner can operate, maintain, change system configuration, and repair the complete system.
- D. Provide competent, factory authorized personnel to provide instruction to O&M personnel. Include sufficient hours of training to provide complete training for operation and maintenance of the equipment and system.
- E. Provide the name and resume of the proposed instructor; the instructor must have at least 10 years of experience as an instructor and 5 years of experience teaching the designated course.
- F. Owner reserves the right to reject the proposed instructor. Owner reserves the right to have the Construction Manager repeat portions of the training (at the Construction Manager's expense) if the Owner feels the training was inadequate.
- G. Provide one 4-hour Overview training session for Management personnel (up to 8) to describe the system architecture, interconnections, functions and capabilities:
 - 1. Network Architecture
 - 2. Workstation Interfaces
 - 3. Communication Interfaces with subsystems
 - 4. Review HMI screen displays, alarms, and trends
- H. Provide multiple (estimated four-4) training sessions to accommodate Operations staff shift schedule. Training sessions shall be a minimum of 8 hours over 2 sessions, for a max of 6 operators (each session). Owner shall determine the exact location and day/time for the training sessions. The course shall cover:
 - 1. Refresher for operators on the basic Metasys system
 - 2. Any changes or upgrades to the hardware or software functionality that may be new
 - 3. HMI graphical screen organization
 - 4. System alarms review
- I. Training shall be performed at a location designated by the Owner in Ft. Worth, TX.
- J. Training shall include all aspects of new system equipment, including both hardware and software.
- K. Training agenda and materials to be reviewed and approved by the Owner prior to training being provided.
- L. Provide pricing for additional days of Training as needed.

3.07 DEMONSTRATION

- A. Provide system demonstration by a qualified factory trained engineer to the Owner and include the following:
 - 1. General system architecture.
 - 2. System start-up and functional operations.
 - 3. Manual overrides at local controllers and via OWS.
 - 4. Display real time and historical trends for monitored points.
 - 5. Report generation.
 - 6. Time of day schedule configuration.
 - 7. Alarm reporting and acknowledgements.
 - 8. Program and database downloads.

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9. Diagnostics.

3.08 COMMISSIONING

- A. Commissioning support will cease once Site Acceptance Testing (SAT) is complete and all loops/graphics are functioning and approved by the Owner.

3.09 DOCUMENT TURNOVER PACKAGE

- A. On project completion, or project phase completion the working set of prints will be given to the Owner/Engineer. Copies will be made and red-line prints will be immediately sent out for any updates. One month (30 calendar days) will be allowed to complete updates. Updated drawings in electronic form will be returned to Owner/Engineer at the end of the 30 days.

END OF SECTION 40 94 00

Rev	Date	Description	Revised	Checked	Approved
0	06/12/2026	ISSUED FOR BID	AHB	AAD	JRL

40 94 00 A - IU CHILLER REPLACEMENT I/O LIST

REV	TAG ID	DESCRIPTION/SERVICE	PID	SIGNAL TYPE	SIGNAL LEVEL	CAL RANGE LO	CAL RANGE HI	ENG UNITS	CONTROL PANEL (*)	IOM (*)	ALARM ACTION SETPOINTS (*)					NOTES
											LO-LO	LO	HI	HI-HI	OTHER	
0	CHWS-YC-003-01	CHILLER 3 EVAPORATOR ISOLATION VALVE COMMAND CLOSE	MAV701	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-YC-003-01	CHILLER 3 EVAPORATOR ISQATION VALVE COMMAND OPEN	MAV701	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-ZC-003-01	CHILLER 3 EVAPORATOR ISQATION VALVE POSTION OPEN	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-ZC-003-01	CHILLER 3 EVAPORATOR ISQATION VALVE POSTION CLOSED	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-YC-004-01	CHILLER 4 EVAPORATOR ISQATION VALVE COMMAND CLOSE	MAV701	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-YC-004-01	CHILLER 4 EVAPORATOR ISQATION VALVE COMMAND OPEN	MAV701	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-ZC-004-01	CHILLER 4 EVAPORATOR ISQATION VALVE POSTION OPEN	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-ZC-004-01	CHILLER 4 EVAPORATOR ISQATION VALVE POSTION CLOSED	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-003-04	CHILLER 3 CHILLED WATER RETURN TEMPERATURE	MAV701	AI	4-20mA	32	75	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-S-003-01	CHILLER 3 CHILLED WATER RETURN PUMP VFD SPEED PERCENT	MAV701	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-AB-004-02	CHILLER 3 CHILLED WATER RETURN PUMP VFD FAULT	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-R-003-02	CHILLER 3 CHILLED WATER RETUN PUMP DISCHARGE SIDE PRESSURE	MAV701	AI	4-20mA	0	150	PSIG	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-003-01	CHILLER 3 ENABLED	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-003-02	CHILLER 3 RUNNING STATUS	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						SIGNAL WIRED THROUGH RELAY
0	CHWS-AB-003-01	CHILLER 3 ALARM	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						SIGNAL WIRED THROUGH RELAY
0	CHWS-FACT-003-01	CHILLER 3 PERCENT LOAD	MAV701	AI	2-8VDC	0	100	%	BY CONTRACTOR	BY CONTRACTOR						%/4A COMPRESSOR OUTPUT
0	CHWS-FI-003-01	CHILLER 3 CHILLED WATER SUPPLY FLOW	MAV701	AI	4-20mA	0	6000	GPM	BY CONTRACTOR	BY CONTRACTOR						EXISTING
0	CHWS-T-003-01	CHILLER 3 CHILLED WATER SUPPLY TEMPERATURE	MAV701	AI	4-20mA	32	75	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-S-004-01	CHILLER 4 CHILLED WATER RETURN PUMP VFD SPEED PERCENT	MAV701	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-S-004-01	CHILLER 4 CHILLED WATER RETURN PUMP VFD FAULT	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-AB-004-02	CHILLER 4 CHILLED WATER SUPPLY TEMPERATURE	MAV701	AI	4-20mA	32	75	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-004-01	CHILLER 4 ENABLED	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-004-01	CHILLER 4 RUNNING STATUS	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						SIGNAL WIRED THROUGH RELAY
0	CHWS-T-004-01	CHILLER 4 ALARM	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						SIGNAL WIRED THROUGH RELAY
0	CHWS-AB-004-01	CHILLER 4 PERCENT LOAD	MAV701	AI	2-8VDC	0	100	%	BY CONTRACTOR	BY CONTRACTOR						%/4A COMPRESSOR OUTPUT
0	CHWS-FACT-004-01	CHILLER 4 CHILLED WATER SUPPLY FLOW	MAV701	AI	4-20mA	0	6000	GPM	BY CONTRACTOR	BY CONTRACTOR						EXISTING
0	CHWS-FI-004-01	CHILLER 4 CHILLED WATER RETURN TEMPERATURE	MAV701	AI	4-20mA	32	75	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-T-004-04	CHILLER 4 CHILLED WATER RETUN PUMP DISCHARGE SIDE PRESSURE	MAV701	AI	4-20mA	0	150	PSIG	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-R-004-02	CHILLED WATER SUPPLY PUMP 4 SPEED PERCENT	MAV701	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CHWS-AB-014-01	CHILLED WATER SUPPLY PUMP 4 VFD FAULT	MAV701	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-SI-009-02	CONDENSOR WATER SUPPLY PUMP 3 SPEED PERCENT	MAV702	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-AB-003-03	CONDENSOR WATER SUPPLY PUMP 3 VFD FAULT	MAV702	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-TI-003-02	CONDENSOR WATER SUPPLY TO CHILLER 3 TEMPERATURE	MAV702	AI	4-20mA	50	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-P1-003-01	CONDENSOR WATER SUPPLY TO CHILLER 3 PRESSURE	MAV702	AI	4-20mA	0	150	PSIG	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-T-003-08	CONDENSOR WATER RETURN FROM CHILLER 3 TEMPERATURE	MAV702	AI	4-20mA	50	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-SI-004-02	CONDENSOR WATER SUPPLY PUMP 4 SPEED PERCENT	MAV702	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-AB-004-03	CONDENSOR WATER SUPPLY PUMP 4 VFD FAULT	MAV702	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-TI-004-02	CONDENSOR WATER SUPPLY TO CHILLER 4 TEMPERATURE	MAV702	AI	4-20mA	50	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	CVS-P1-004-01	CONDENSOR WATER SUPPLY TO CHILLER 4 PRESSURE	MAV702	AI	4-20mA	0	150	PSIG	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-T-004-08	CONDENSOR WATER RETURN FROM CHILLER 4 TEMPERATURE	MAV702	AI	4-20mA	50	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-S-027-01	CONDENSOR WATER RETURN PUMP 2 SPEED PERCENT	MAV702	AI	4-20mA	0	100	%	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-AB-027-01	CONDENSOR WATER RETURN PUMP 2 VFD FAULT	MAV702	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-FI-018-01	COOLING TOWER 18 CONDENSER WATER RETURN FLOW	MAV702	AI	4-20mA	0	13000	GPM	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-VECC-185-01	COOLING TOWER 18 CELL 5 INLET VALVE COMMAND CLOSE	MAV702	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-VECC-185-01	COOLING TOWER 18 CELL 5 INLET VALVE COMMAND OPEN	MAV702	DO	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-ZC-0185-01	COOLING TOWER 18 CELL 5 INLET VALVE POSTION OPEN	MAV702	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						
0	OWR-ZC-185-01	COOLING TOWER 18 CELL 5 INLET VALVE POSTION CLOSED	MAV702	DI	24VDC	-	-	-	BY CONTRACTOR	BY CONTRACTOR						

0	CVR-YC-185-01	COOLING TOWER 1B CELL 6 INLET VALVE COMMAND CLOSE	MM702	DO	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-185-01	COOLING TOWER 1B CELL 6 INLET VALVE COMMAND OPEN	MM702	DO	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-186-01	COOLING TOWER 1B CELL 6 INLET VALVE POSITION OPEN	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-186-01	COOLING TOWER 1B CELL 6 INLET VALVE POSITION CLOSED	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-187-01	COOLING TOWER 1B CELL 7 INLET VALVE COMMAND CLOSE	MM702	DO	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-187-01	COOLING TOWER 1B CELL 7 INLET VALVE COMMAND OPEN	MM702	DO	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-187-01	COOLING TOWER 1B CELL 7 INLET VALVE POSITION OPEN	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-YC-187-01	COOLING TOWER 1B CELL 7 INLET VALVE POSITION CLOSED	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVR-P-185-01	COOLING TOWER 1B 5 CONDENSOR WATER RETURN PRESSURE	MM702	AI	4-20mA	0	150	PSIG	BY CONTRACTOR								
0	CVR-P-185-01	COOLING TOWER 1B 6 CONDENSOR WATER RETURN PRESSURE	MM702	AI	4-20mA	0	150	PSIG	BY CONTRACTOR								
0	CVR-P-187-01	COOLING TOWER 1B 7 CONDENSOR WATER RETURN PRESSURE	MM702	AI	4-20mA	0	150	PSIG	BY CONTRACTOR								
0	CVS-S1-185-01	COOLING TOWER 1B 5 SPEED PERCENT	MM702	AI	4-20mA	-	-	-	BY CONTRACTOR								
0	CVS-AB-185-01	COOLING TOWER 1B 5 VFD FAULT	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVS-S1-186-01	COOLING TOWER 1B 6 SPEED PERCENT	MM702	AI	4-20mA	-	-	-	BY CONTRACTOR								
0	CVS-AB-186-01	COOLING TOWER 1B 6 VFD FAULT	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVS-S1-187-01	COOLING TOWER 1B 7 SPEED PERCENT	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	CVS-AB-187-01	COOLING TOWER 1B 7 VFD FAULT	MM702	DI	24VDC	-	-	-	BY CONTRACTOR								
0	REF-YA-200-01	REFRIGERANT ALARM LEVEL 1	MM701	DI	24VDC	-	-	-	BY CONTRACTOR								ACTIVATE REFRIGERANT EXHAUST FAN AND HORN(S) STORES FOR CHILLER 3 & 4
0	REF-YA-200-02	REFRIGERANT ALARM LEVEL 2	MM701	DI	24VDC	-	-	-	BY CONTRACTOR								GLOBAL ALARM FOR ALL REFRIGERANTS BASED ON LOWEST ASHRAE 34 EPORSE REQUIREMENT FOR R- 1234A. ACTIVATE REFRIGERANT EXHAUST FAN AND HORN(S) STORES FOR CHILLER 3 & 4
0	REF-YA-200-03	REFRIGERANT ALARM LEVEL 3	MM701	DI	24VDC	-	-	-	BY CONTRACTOR								GLOBAL ALARM FOR ALL REFRIGERANTS BASED ON HIGHEST DETECTIBLE LIMIT FOR REFRIGERANT MONITOR. ACTIVATE REFRIGERANT EXHAUST FAN AND HORN(S) STORES FOR CHILLER 3 & 4
0	REF-YC-200-01	REFRIGERANT EXHAUST FAN (EF-1) RUN COMMAND	MM701	DO	24VDC	-	-	-	BY CONTRACTOR								
0	REF-YC-200-01	REFRIGERANT EXHAUST FAN (EF-1) RUN STATUS	MM701	DI	24VDC	-	-	-	BY CONTRACTOR								SWITCH FOR RUN STATUS OF EF-1

(*) TO BE FILLED IN BY SUBCONTRACTOR