



Scott Partney Construction, Inc.
598 Chappell Parkway
North Bend, OR 97459

(541) 756-7060
FX (541) 756-7067
CCB#162882

Bid Invitation Table of Contents

March 1, 2021

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March 1, 2021

Attn: Interested Parties

RE: Madison Elementary School Renovation Bid Invitation

Scott Partney Construction, Inc. has been selected as the General Contractor for the Madison Elementary School Renovation in Coos Bay, OR. We are currently requesting bid proposals from subcontractors for all applicable trades.

Bids are due March 25, 2021 at 4:00pm

Project Name: Madison Elementary School Renovation

Location: 400 Madison St, Coos Bay, OR 97420

Owner: Coos Bay School District

Architect: HGE Architects, Inc.

Project Description: The Project consists of major renovations to the existing Madison Elementary School Building. The existing building area, not including modular classroom buildings scheduled to be removed, nor the scheduled demolition are of the infill portion of the building between the Gym and Main Classroom Building is 38,281 sf. Building addition at the East side of the Main Classroom Building is approximately 9,295 sq and the East side replacement restroom/connecting hallway/elevator addition is approximately 2,591 sf. Total project area is 50,167 sf. Site Improvement include reconfiguration of East side vehicle and pedestrian access including paving and walkways, landscaping and irrigation.

Project Schedule: Start June 2021 - Completion August 2022

Job walk on March 12, 2021 at 10:00am, Face masks required for all visitors.

Bid Documents: Bid documents will be available electronically on HGE's website, www.hge1.com, by following the 'Bidding Area' tab in the upper righthand corner of the Home page.

Bidding: Bid proposals will only be accepted on the provided Bid Form. Acknowledgment of all Addenda, the Instructions to Bidders, and a completed Bidders Checklist are all required for a complete proposal. All proposals should be sent via email to Jeremy@partneyconstruction.net, faxed to (541) 756-7067, or received in the General Contractor's office no later than the date and time provided above.

Questions: RFIs with specific questions relating to this project should be directed to the Project Estimator on the provided RFI Form, via email to Jeremy@partneyconstruction.net and must be received no later than **March 22, 2021**.

Thank you for your interest in this project.



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Bid Package List: Each Bid Form must list only one (1) Bid Package from the attached list. Submit additional Bid Forms if bidding more than one Bid Package.

Bid Package Number	Description	GC to Bid	Project Specification Reference
MBP-1	Asbestos Abatement		Abatement Design by PBS
MBP-2	Demolition	X	02-4100
MBP-3	Concrete	X	03-1000, 03-2000, 03-3000
MBP-4	Unit Masonry		04-2000
MBP-5	Metals	X	05-5000, 05-5133
MBP-6a	Carpentry	X	06-1000, 06-1733, 06-1800, 06-2000
MBP-6b	Architectural Wood Casework		06-4100
MBP-7a	Sheet Waterproofing	X	07-1300
MBP-7b	Water Repellents	X	07-1900
MBP-7c	Thermal Insulation		07-2100
MBP-7d	Weather Barriers	X	07-2500
MBP-7e	Metal Wall Panels	X	07-4213
MBP-7f	PVC Thermoplastic Single-Ply Roofing		07-5419
MBP-7g	Sheet Metal Roofing		07-6100
MBP-7h	Sheet Metal Flashing and Trim	X	07-6200
MBP-7i	Roof Accessories	X	07-7200
MBP-7j	Joint Sealers	X	07-9005
MBP-8a	Hollow Metal Doors and Frames, Flush Wood Doors and Door Hardware SUPPLY ONLY		08-1113, 08-1416, 08-7100
MBP-8b	Hollow Metal Doors and Frames, Flush Wood Doors and Door Hardware INSTALL ONLY	X	08-1113, 08-1416, 08-7100
MBP-8c	Overhead Coiling Grilles		08-3326
MBP-8d	Automatic Entrances, Aluminum Storefronts and Glazing		08-4229, 08-4313, 08-8000
MBP-8e	Vinyl Windows	X	08-5313
MBP-9a	Gypsum Board Assemblies, Acoustical Ceilings Direct-Applied Acoustical Ceilings		09-2116, 09-5100, 09-5153
MBP-9b	Tiling, Resilient Flooring and Tile Carpeting		09-3000, 09-6500, 09-6813
MBP-9c	Sound-Absorbing Wall and Ceiling Units	X	09-8430
MBP-9d	Painting and Coating		09-9000
MBP-10a	Signage	X	10-1400



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MBP-10b	Plastic Toilet Compartments	X	10-2113.19
MBP-10c	Wall and Door Protection	X	10-2600
MBP-10d	Toilet, Bath, and Laundry Accessories	X	10-2800
MBP-10e	Fire Protection Specialties	X	10-4400
MBP-12	Roller Window Shades		12-2413
MBP-13a	Metal Building Systems SUPPLY ONLY		13-3419
MBP-13b	Metal Building Systems INSTALL ONLY	X	13-3419
MBP-14	Machine Room-less Hydraulic Elevators		14-2400
MBP-21	Fire Suppression		21-1300
MBP-22	Plumbing		22-0500, 22-0700, 22-1000, 22-3000, 22-4000
MBP-23	Heating, Ventilating, and Air-Conditioning		23-0500, 23-0548, 23-0590, 23-0700, 23-0923, 23-0993, 23-1000, 23-2300, 23-3000, 23-3400, 23-7000, 23-7400, 23-8000, 23-8050
MBP-26a	Electrical		26-0000, 26-0509, 26-0519, 26-0526, 26-0529, 26-0533, 26-0534, 26-0543, 26-0553, 26-0573, 26-0900, 26-0920, 26-0923, 26-0924, 26-2413, 26-2416, 26-2713, 26-2726, 26-2816, 26-5100
MBP-26b	Photovoltaic Systems and Central Battery Equipment		26-3100, 26-3323
MBP-27	Communications		27-0000, 27-0528, 27-1101, 27-1300, 27-1500, 27-5123, 27-5319
MBP-28	Electronic Safety and Security		28-0000, 28-1000, 28-2300, 28-3100
MBP-31a	Earthwork		31-1000, 31-2200, 31-2316, 31-216.13, 31-2319, 31-2323, 31-4100
MBP-31b	Steel Pipe Piles		31-6200
MBP-31c	Small Diameter Steel Pipe Piles		31-6250
MBP-32a	Aggregate Base Courses and Asphalt Paving		32-1123, 32-1216
MBP-32b	Concrete Paving	X	32-1313
MBP-32c	Parking Bumpers		32-1713
MBP-32d	Painted Pavement Markings		32-1723.13
MBP-32e	Tactile Warning Surfacing	X	32-1726
MBP-32f	Chain Link Fence and Gates		32-3113
MBP-32g	Decorative Metal Fences and Gates		32-3119
MBP-32h	Site Furnishings	X	32-3300



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MBP-32i	Site Bicycle Racks	X	32-3313
MBP-32j	Landscape Irrigation, Seeding and Plants		32-8423, 32-9200, 32-9300
MBP-33	Utilities		33-0513, 33-1113, 33-1200, 33-1300, 33-3111, 33-4113, 33-4400
MBP-34	Transportation	X	34-4113.10, 34-4113.20, 34-4113.30



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INSTRUCTIONS TO BIDDERS

March 1, 2021

1. THE WORK

Madison Elementary School Renovations
For Coos Bay School District
400 Madison St
Coos Bay, OR 97420

2. THE DOCUMENTS

Copies of the Contract Documents are available from the General Contractor (GC), Scott Partney Construction, Inc. (SPC), at their office in North Bend, OR. Electronic documents can be downloaded from our website at www.partneyconstruction.net under the 'Bidders' tab. For further information see the Invitation to Bid.

3. EXAMINATION OF DOCUMENTS AND SITE OF WORK

Before submitting a quotation to the GC, each bidder shall examine the drawings carefully, read the specifications and other contract documents, and if necessary, visit the site of the work. All bidders shall fully inform themselves prior to bidding as to existing conditions and limitations under which the work is to be performed, and include in their bid a sum to cover the cost of items necessary to perform the work as set forth in the contract documents.

Your scope of work may be modified with value engineering items assigned to specific divisions.

No allowance will be made to bidders because of a lack of knowledge or failure on their part to consider the above. The submission of a bid will be considered as conclusive evidence that the bidder has made such an examination of all contract documents

4. TIME OF COMPLETION AND LIQUIDATED DAMAGES

The successful bidder will be issued a "Letter of Intent" by the GC by which a Subcontract will be prepared. The notified bidder is expected to immediately begin securing and submitting any and all required submittal data as required by the GC for the areas of work for which they were the successful bidder. The successful bidder shall be prepared to begin work immediately and pursue the work at the direction of the GC. The intent of the Owner is to start construction on **June 28th, 2021**, and have the project completed in **400** days. The GC is currently developing a project schedule that may not be available in its final form prior to posted bid dates. It is not the intent to impose liquidated damages on any subcontractors or suppliers; however, the right is reserved to impose costs against any subcontractor or supplier who causes delays or costs to the project that are not identified as an attachment to bid form.



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5. INTERPRETATION OF DOCUMENTS

No interpretation of the meaning of the contract documents will be made verbally. All requests for interpretation of the documents shall be submitted to the GC on the attached "Request for Information" with attachments thereto at least 72 hours prior to bid time. All requests shall be submitted to the GC for forwarding to the Owner and Consultants. Bidders are required to use this procedure; no permission is given to contact HGE Architects. In the event that a bidder chooses to contact the Architect or a Consultant directly, the bidder is warned that any verbal clarifications made will not remain valid.

The Owner, Consultant, and the GC will issue formal addenda prior to bid time. Bidders will be required to acknowledge receipt of any clarification documents on the bid form.

6. ARCHITECTS, CONSULTANTS and the OWNERS.

No bidder is authorized to contact the Architect, HGE Architects, or consultants without the permission of the GC. There are no cases where any bidder is authorized to contact the Owner.

7. CHANGES AND SUBSTITUTIONS

Bidders shall base their proposals on the materials and equipment specified, and options for value engineering items need to be noted separately. If a bidder chooses to quote a product that is not indicated on the plans or in the specifications, or requested on the value engineering options, the bidder shall bear all expenses for providing the contract document specified material and/or equipment if the bidder's substitution is denied. Substitution requests must be approved prior to bid day.

8. THE PROPOSAL

Bid Forms will be supplied to each Bidder by the GC and are attached hereto. **ALL BIDS SHALL BE SUBMITTED ON THESE FORMS.** If a bidder wishes to submit additional information, it can be attached to the Bid Form. All bids will be submitted in original form. The GC will accept fax copies of bids on the bid date with the originals to follow. No alteration to the Bid Form can be made after the fax copy has been delivered. There will not be a public opening of the bids. Bidders will receive a "Bid Status Letter" after the bids have been reviewed by the Owner.

All bids shall be signed by an authorized agent of the firm submitting the proposal. Do not make any changes to the Bid Form. If clarifications or exclusions are necessary, use the appropriate spaces on the Bid Form or attach documents to the Bid Form. Alterations to the Bid Form may cause a bid to be rejected.

All Bids shall be delivered to the Office of Scott Partney Construction, Inc., 598 Chappell Parkway, North Bend, OR 97459, or emailed to jeremy@partneyconstruction.net, or faxed to (541) 756-7067 on the dates and times as listed in the Invitation to Bid. It is the sole responsibility of the bidders to deliver their bids on time to be considered.



9. WITHDRAWAL OF BIDS

A bidder may withdraw a proposal personally, by written request, or by fax memo at any time prior to the scheduled time and date of their bid package. No bidder can withdraw a bid for a period of 30 days after the bid date.

10. COMPETENCY OF BIDDERS

The Owner and GC reserve the right to investigate any bidder and reserve the right to request financial statements or any other data as deemed appropriate or necessary to assess the competency of a bidder. They further reserve the right to disqualify any bidder that has the appearance of debt or default.

11. BONDS

Subcontractors may be required to provide performance & payment bonds. Please provide a separate line item cost.

12. BASIS OF AWARD

The following procedure will be used to select and award work:

All bids will be reviewed by the GC and evaluated for completeness and exclusions. After the bids have been reviewed, they will be tabulated, analyzed and compared.

The GC will present the tabulated bids to the Owner along with recommendations as to award.

The Owner reserves the right to reject the recommendation of the GC and authorize award to an alternate bidder or reject any bid completely.

It is the intent of the GC to recommend the lowest responsible bidder to the Owner and it is the intent of the Owner to award to the lowest responsible bidder.

13. EXECUTION OF AGREEMENT

Once the Owner and GC have agreed upon an award of a portion of work, the GC will issue a Letter of Intent to the successful bidder. This will serve as notice that the bidder, now subcontractor or supplier, should begin their submittal process. All submittals will be due within 30 days of the Letter of Intent.

Within 30 days of the Letter of Intent, the GC will issue a formal Subcontract or Purchase Order. Within 10 days after receiving the agreement, the subcontractor or supplier shall return the document along with all other contract documents including insurance certificates. A copy of the standard subcontract which you will be expected to sign is attached.

14. SPECIAL CONDITIONS OF BIDDING

Below is a list of items of clarification the bidders shall consider during the preparation of the bids:

- A. Trash: All trash will be removed from the site by the creating subcontractor unless written arrangements are made with the GC. If the GC is forced to remove trash, without such arrangements, the cost will be charged to the responsible parties.



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- B. Clean-Up: Each Subcontractor shall leave his work area in a broom clean condition each day. All material will be stored neatly at the end of each work day. All exterior trash and/or materials will be secured and protected in staging areas established by the GC.
- C. Layout: Layout of the work will be performed or arranged and paid for by the subcontractor that first requires the layout.
- D. Temporary Utilities:
 - Water: Provided by Owner.
 - Electric: Provided by Owner.
- E. Safety: All bidders will be required to be in strict compliance with all standards as set forth by OSHA. Any non-complying Subcontractor that causes the GC or the Owner to receive fines will be assessed those fines and any costs associated with defending them. Repeated failure to comply with OSHA requirements will be grounds for dismissal from the project and/or cancellation of subcontract.
- F. Protection: All subcontractors are expected to protect their work and the work of others. Failure to protect your work may be cause for rejecting that work if it becomes damaged. Subcontractors who damage the installed work of others should expect to compensate that subcontractor to replace said work.
- G. Payments: Written payment requests will be required in the home office of the GC on or before the 20th of the month. The billing should be for work projected through the end of that month.

Payments will be made for 95% of that billing on or about the 20th day of the following month, assuming that the work status has been accepted and the Owner has issued payments accordingly.
- H. Warranty: All work shall be warranted for one (1) year following acceptance by the Owner. For extended or other warranties, see contract documents and individual specification sections.
- I. Scheduling: The project schedule for this project will be done on Microsoft Project. Successful bidders shall be prepared to assist in the preparation and management of this scheduling tool.
- J. Insurance: All bidders will be required to be in conformance with insurance requirements per contract documents for this project.

END OF INSTRUCTIONS TO BIDDERS, THIS INSTRUCTION TO BIDDERS WILL BECOME PART OF THE BID DOCUMENTS AND MUST BE TURNED IN WITH BID FORM.



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Subcontractor Name: _____

Signature: _____ Date: _____

Printed Name/Title: _____



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BID FORM

SUBMITTED TO:

Scott Partney Construction, Inc.
598 Chappell Parkway
North Bend, OR 97459
Phone: (541) 756-7060
Fax: (541) 756-7067
Email: Jeremy@partneyconstruction.net

Madison Elementary School Renovation
For Coos Bay School District
400 Madison St
Coos Bay, OR 97420

DATE: March 25th, 2021 TIME: 4:00pm (Private Bid Opening)

PROJECT:

Madison Elementary School Renovation
For Coos Bay School District
400 Madison St, Coos Bay, OR 97420

SUBMITTED BY (Firm Name): _____

Phone: _____ Fax: _____

Email Address: _____

The undersigned bidder, having carefully read and examined the contract documents as prepared by HGE Architects, the Bid Invitation, the Instructions to Bidders, issued Addenda, the Bid Form (this document) and having visited the site does declare that, for the price as stated below, they do agree to perform the work as listed, to include all labor, materials, equipment and all other items as required to install a complete and satisfactory installation per the contract documents hereby propose as follows:

THIS BID SHALL BE FOR THE INCLUSIONS LISTED BELOW:

1. **BASE BID**

Bid Package #: _____ List only one (1) Bid Package per Bid Form. Submit additional Bid Forms if bidding more than one Bid Package.

For the Sum of: _____ Dollars

And _____ Cents (\$ _____)



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2. **ALTERNATE BID NUMBER 1:** Covered Play Structure.

Covered Play Structure as indicated in the Drawings and Specifications.

For the Sum of: _____ Dollars

And _____ Cents (\$_____)

3. **ALTERNATE BID NUMBER 2:** Upgrade of Single User Restrooms in Gym.

Upgrade both restrooms for ADA compliance and finishes as indicated in the Drawings and Specifications.

For the Sum of: _____ Dollars

And _____ Cents (\$_____)

4. **ALTERNATE BID NUMBER 3:** Track Surfacing.

Prep and pace replacement playground walking/running track in existing Play Field as indicated in the Drawings and Specifications.

For the Sum of: _____ Dollars

And _____ Cents (\$_____)

5. **ALTERNATE BID NUMBER 4:** Classroom Sink Upgrade.

Remove and replace existing classroom sinks and countertops in specific classrooms, Kindergarten Rooms, for a more usable and accessible fixture for students. Refer to Drawings and Specifications.

For the Sum of: _____ Dollars

And _____ Cents (\$_____)



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6. **BOND RATE**

Cost to provide a Payment and Performance Bond for the Bid Package and any applicable Alternate Bids listed above.

For the Sum of: _____ Dollars

And _____ Cents (\$ _____)

EXCLUSIONS: _____

ADDENDA: The undersigned bidder acknowledges the receipt of the following Addenda and the modifications to the Bid Documents have been considered and all costs are included in the bid amount.

Acknowledge Letters of Clarifications & Addendums: _____ through _____.

SIGNATURE:

Signed By: _____ Date: _____

Printed Name and Title: _____



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Bidders Checklist & Prequalification

March 1, 2021

Check Each Box

- Bidder acknowledges that they have examined the Project Drawings carefully, read the Specifications and all other contract documents, and if necessary, visit the site of the work. All bidders shall fully inform themselves prior to bidding as to existing conditions and limitations under which the work is to be performed, and include in their bid a sum to cover the cost of items necessary to perform the work as set forth in the contract documents.
- Bidder acknowledges receipt of the Bid Invitation.
- Bidder acknowledges receipt of the Instructions to Bidders and has included a signed copy with their signed Bid Form.
- Bidder acknowledges receipt of the provided Preliminary Construction Schedule and has adjusted their proposal to incorporate quantities of materials, items of equipment, possible difficulties, and conditions of work potentially affected by the proposed schedule.
- Bidder acknowledges receipt of the Commissioning Documents as they relate to their specific scope of work.
- Bidder has provided one (1) signed Bid Form for every Bid Package they wish to provide a proposal.
- By signing this Bidders Checklist, the Bidder certifies the provisions required by ORS 279C.800-279C.870 relating to prevailing wage rates are included with their proposal and will be complied with. Bidder also certifies that they will comply with the provisions of 40 U.S.C. 276a and ORS 279C.840 regarding the Davis-Bacon Act or prevailing wages.
- By signing below the bidder declares that they are registered with the Construction Contractors Board as required by ORS 701.35-701.55.

Subcontractor Name: _____

Signature: _____ Date: _____

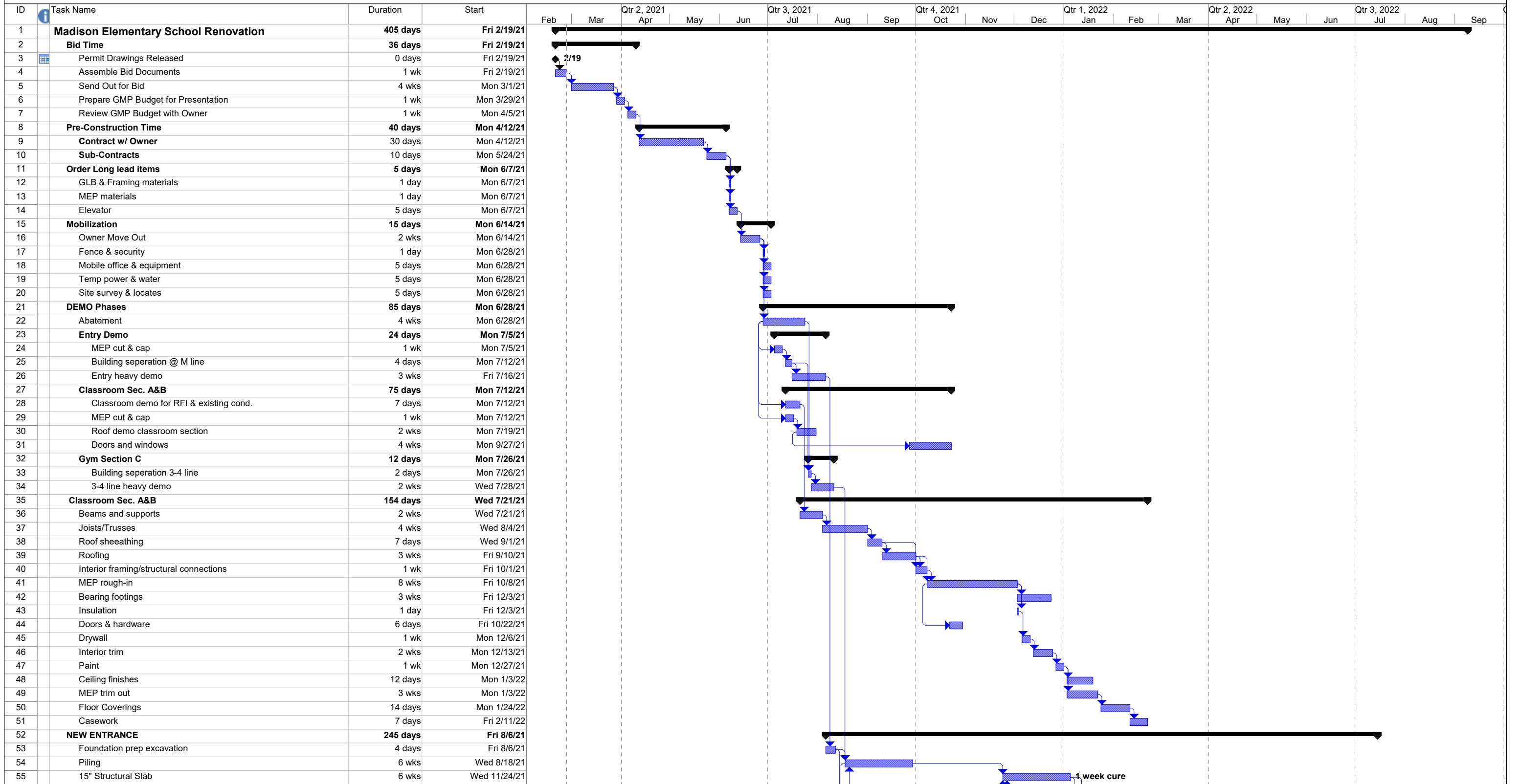
Printed Name/Title: _____



Madison Elementary School Renovation

Scott Partney Construction, Inc.

598 Chappell Parkway
North Bend, OR 97459



Project: NBMC New Entry Date: Fri 2/26/21	Task		Project Summary		Inactive Milestone		Duration-only		Finish-only		Deadline	
	Split		External Tasks		Inactive Milestone		Manual Summary Rollup		External Tasks		External Milestone	
	Milestone		External Milestone		Inactive Summary		Manual Summary		External Milestone		External Milestone	
	Summary		Inactive Task		Manual Task		Start-only		Progress		Progress	

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DIVISION 01 - GENERAL REQUIREMENTS

01 9113 GENERAL COMMISSIONING REQUIREMENTS

DIVISION 22 - PLUMBING

22 0800 COMMISSIONING OF PLUMBING

DIVISION 23 - HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

23 0800 COMMISSIONING OF HVAC

DIVISION 26 - ELECTRICAL

26 0800 COMMISSIONING OF ELECTRICAL

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 3101 COMMISSIONING OF FIRE ALARM

GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Scope of systems and equipment to be commissioned.
2. Commissioning duties and procedures at the site.

1.2 RELATED SECTIONS

- A. Division 01, General Requirements applies to this Section.
- B. Contents of Division 22, 23, 26, and 28 apply to this Section.
- C. In addition, reference the following:
1. 22 08 00, Commissioning of Plumbing
 2. 23 08 00, Commissioning of HVAC
 3. 26 08 00, Commissioning of Electrical
 4. 28 08 00, Commissioning of Fire Alarm

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by:

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical
5. 28 08 00, Commissioning of Fire Alarm

B. In addition, meet the following:

1. Current edition of the ASHRAE Guideline 0, The Commissioning Process.

1.4 SUBMITTALS

A. Submittals as required by:

1. Division 01, General Requirements.

GENERAL COMMISSIONING REQUIREMENTS

2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical
5. 28 08 00, Commissioning of Fire Alarm

B. In addition, provide:

1. Use the following procedure to ensure quick and effective turnaround of submittals for systems to be commissioned.
 - a. The Architect forwards one set of submittals for systems to be commissioned to the Commissioning Authority at the same time as the design team.
 - b. The Commissioning Authority forwards comments to the design team for consideration in their submittal response.
 - c. The design team sends a consolidated response to the submittals and copies the Commissioning Authority.

1.5 QUALITY ASSURANCE

A. Quality assurance as required by:

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC
4. 26 08 00, Commissioning of Electrical
5. 28 08 00, Commissioning of Fire Alarm

1.6 WARRANTY

A. Warranty of materials and workmanship as required by Division 01, General Requirements.

1. Division 01, General Requirements.
2. 22 08 00, Commissioning of Plumbing
3. 23 08 00, Commissioning of HVAC

GENERAL COMMISSIONING REQUIREMENTS

4. 26 08 00, Commissioning of Electrical
5. 28 08 00, Commissioning of Fire Alarm

1.7 DEFINITIONS

- A. Commissioning Authority: The Commissioning Authority is the person or entity referred to throughout the Contract Documents as if singular in number who works with the Owner's Authorized Representative under a separate Contract.
- B. Commissioning:
 1. Commissioning is a process for achieving, verifying, and documenting that performance of a building and its various energy consuming systems meets the Design Engineer's design intent and the Owner's operational needs.
 2. Commissioning includes tests for the operation of equipment and building systems to ensure that they operate as designed by the Design Engineer, and meet the needs of the building throughout the entire range of operating conditions.
 3. Commissioning is a cooperative effort that requires participation by the Owner's Authorized Representative, General Contractor, system and equipment installers, building automation system installer, Testing and Balancing Agency, equipment manufacturers' representatives, Architect, Architect's design engineers, and Commissioning Authority.
- C. Owner's Project Requirements (OPR): Document that details the functional requirements and expectations of how the building will be used and operated. This may include project location, goals, cost considerations, equipment manufacturers, and environmental control requirements.
- D. Basis of Design (BoD): A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines.
- E. Commissioning Procedures:
 1. Inspection and testing procedures that are written by the Commissioning Authority for equipment and systems within the scope of commissioning.
 2. Inspection checklists typically address items of installation compliance with design intent and approved submittals.
 3. Functional performance test procedures typically address all sequences for normal and emergency equipment and system operation. These procedures consist of a mix of One-Time Tests and Continuous Measurement.

GENERAL COMMISSIONING REQUIREMENTS

4. One-Time Tests: Functional performance tests of equipment and systems that are performed by forcing specific conditions that are intended to trigger specific responses, per the design intent.
- F. Continuous Measurements:
1. Functional performance tests of equipment and systems that are performed by observing parameters of normal operation over an extended period. This is typically accomplished by means of the BAS trend logging capabilities, by monitoring with stand-alone data logging equipment, or by some combination of both.
 2. Temperature conditions in occupied spaces, control stability, and lighting levels in areas with daylighting controls are three typical subjects of continuous measurement.
- G. Commissioning Plan: The document, provided by the Commissioning Authority, that states the required tests for all equipment and systems within the scope of commissioning.
- H. Commissioning Meetings: Issues related to commissioning will be discussed as required during regularly scheduled progress meetings.

1.8 PERFORMANCE REQUIREMENTS

- A. Testing, inspecting and performance monitoring tasks specified in this Section and in Sections 22 08 00, 23 08 00, 26 08 00, and 28 08 00 are the responsibility of the Commissioning Authority, unless specifically indicated otherwise, and not part of the General Construction Contract. These tasks are included in these Sections for the Contractor's information, so the Contractor can understand the standards of system performance that are required and more effectively coordinate with the process of commissioning.
- B. The Commissioning Authority will verify for the Owner's Authorized Representative that commissioned mechanical, plumbing, electrical, and controls system function interactively and in compliance with the Project design intent, and to facilitate orderly and efficient transfer of building operating systems to the Owner.
- C. Commissioning does not relieve the Contractor of Contract obligations.

1.9 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED

- A. Systems:
1. HVAC Equipment
 2. HVAC Controls.
 3. Domestic Hot Water Equipment

GENERAL COMMISSIONING REQUIREMENTS

4. Automatic Lighting Controls (LCP, Daylighting, Occupancy Sensors)
5. Fire Alarm

1.10 COMMISSIONING DUTIES

- A. Duties of Owner: Provide the OPR to the Architect/Engineer and Commissioning Authority prior to design development.
- B. Duties of Architect:
 1. Attend commissioning portion of Progress Meetings as necessary.
 2. Lead the design team in assisting the resolution of deficiencies.
- C. Duties of Architect's Mechanical Engineer:
 1. Attend commissioning portion of Progress Meetings as necessary.
 2. At the request of either the Owner's Authorized Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Authorized Representative.
 3. Assist in resolution of problems and deficiencies that are discovered during commissioning.
 4. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
- D. Duties of Architect's Electrical Engineer:
 1. Attend commissioning portion of Project Meetings as necessary.
 2. At request of either the Owner's Authorized Representative or the Commissioning Authority, review Commissioning Procedures and submit comments to Owner's Authorized Representative.
 3. Assist in resolution of problems and deficiencies that are discovered during commissioning.
 4. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
- E. Duties of Commissioning Authority:
 1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.

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2. Review the design set documents for the commissioned systems at 75 percent construction set document submission.
3. Review Contractor's and Control Contractor's submittals related to commissioned systems, and make comments through Architect.
4. Provide plan to Owner's Authorized Representative for review and comment.
5. Utilize web based Commissioning software to manage all commissioning related checklists, tests, issues, and observation reports.
6. Prepare commissioning procedures for each commissioned system based on actual system configuration.
7. Commissioning Procedures written by Commissioning Authority will include, in field data collection format, the detailed test procedures, test conditions, and criteria for acceptance of test results.
8. Submit any commissioning procedures that are written by Commissioning Authority to the Owner's Authorized Representative for review and approval at least 1 week prior to scheduled field testing.
9. Provide personnel experienced in technical aspects of each system to be commissioned for execution of tests.
10. BAS Sequence Demonstration:
 - a. Witness the Control Contractor's demonstration of their sequence tests.
 - b. If any of the demonstrated sequences fails to operate per the controls submittal, witness the repeat demonstration after corrective action has been taken.
11. Execute the Commissioning Procedures.
12. Prepare and submit Observation Reports and Deficiency Reports as required, but within 3 days of noting any deficiency.
13. Submit to Owner's Authorized Representative a weekly written report of commissioning progress, unresolved deficiencies, and projected inspection, and test schedule during field testing.
14. Take the lead in timely evaluation of deficiencies, and advise Owner's Authorized Representative on resolution.
15. Assist in resolving commissioned system disputes by performing research to determine the scope of the dispute, and informing the involved parties on possible solutions to disputes.

GENERAL COMMISSIONING REQUIREMENTS

16. During the systems warranty period(s) CxA to retest any systems that had their full testing deferred during the initial functional testing due to the lack of peak season conditions. This testing must ensure that all system sequences of operations and capacity have been verified.
 17. Verify that the Owner's maintenance personnel are adequately trained as per the Contract Documents and the OPR.
 18. Prepare a Commissioning Report that includes a summary of overall commissioning process, including deficiencies found, deficiency corrections, unresolved deficiencies, approved equipment and systems, discrepancies between final design intent and as-built systems, completed commissioning checklists, test documentation, and other commissioning documentation.
- F. Duties of General Contractor:
1. Attend commissioning portion of Project Meetings as necessary, minimum four meetings.
 2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
 3. Coordinate and direct system installers in executing their commissioning tasks.
 4. Direct subcontractors to participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid. A desktop, laptop, tablet or iPad will be required.
 5. Coordinate with Commissioning Authority on integration of construction and commissioning schedules.
 6. Oversee and perform documentation requirements for all Pre-Functional Checklists.
 7. Notify Commissioning Authority when all the following has been achieved. It is permissible, with prior approval by Commissioning Authority, to provide notification for individual systems as the following are all completed for each system.
 - a. All controls point-to-point and sequence checkout is complete.
 - b. All test and balancing is complete.
 - c. Normal equipment schedules have been activated.
 - d. All control overrides and temporary valves have been returned to normal automatic' control.

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- e. All manual isolation valves have been left open.
 - f. Piping and duct systems have been cleaned and tested.
 - g. Heating water system is fully operational under normal automatic operation.
 - h. Luminaires are installed with operational daylighting controls and occupancy sensors.
 - i. Distribution boards, including overcurrent devices, containing breakers over 600 amps, are installed.
 - j. Building inspector acceptance of emergency lighting system following their site inspection.
8. Provide all startup, flushing, pressure testing, etc results/reports for commissioned systems.
- G. Duties of Installer's and Manufacturer's Representatives:
- 1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
 - 2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
 - 3. Within three months of the award of the Contract, as part of the required submittals for the contract, Contractor submits manufacturer's startup and installation procedures as well as controls point-to-point and sequence checkout and provides in checkset format for each piece of equipment and controls.
 - 4. Demonstrate proper system operation in the presence of the Commissioning Authority.
 - 5. Commissioning does not relieve installers from obligations to complete Work as required by Contract Documents.
- H. Duties of BAS Installer:
- 1. Attend commissioning portion of project meetings as necessary, minimum two meetings.
 - 2. Participate and respond to commissioning related issues by using the Commissioning Authority's web based commissioning software Facility Grid.
 - 3. Review and approve Commissioning Procedures as relevant to controls work.

GENERAL COMMISSIONING REQUIREMENTS

4. Point-to-Point Checkout:
 - a. Perform point-to-point checkout and calibration of all energy management system points.
 - b. Document checkout and calibration on forms as approved by mechanical designer, and/or Commissioning Authority.
 - c. Submit three copies of the completed point-to-point checkout forms to the Owner's Authorized Representative within five working days of completion of field checkout. Distribute copies to the Commissioning Authority and the designer.

5. Control Sequence Testing:
 - a. Prepare control sequence test procedure forms to a degree of rigor comparable to the Commissioning Authority's Commissioning Procedures.
 - b. Submit test procedure forms to the Commissioning Authority for approval at least two weeks prior to intended sequence testing. At the contractor's option, it is acceptable to use the Commissioning Authority's Commissioning Procedures, substituting one-time tests for continuous measurement wherever applicable. However, it is still necessary to submit any edited Commissioning Authority Commissioning Procedures as least two weeks prior to intended sequence testing.
 - c. Submit the completed sequence testing forms to the Owner's Authorized Representative. The Owner's Authorized Representative distributes copies to the Commissioning Authority and the designer.

6. Submit to Commissioning Authority, prior to Sequence Demonstration, two copies of installed control Drawings, sequence narratives, control wiring diagrams, and program code or block diagrams.

7. Sequence Demonstration:
 - a. After completing and documenting all required sequence tests with own staff, demonstrate sequence tests to the Commissioning Authority. Demonstration is to be performed by the BAS installer's programmer who programmed the control system for this specific project.
 - b. If any of the demonstrated sequences fails to operate per the controls submittal, take corrective action and demonstrate the failed sequence tests to the Commissioning Authority a second time.
 - c. If the Control Contractor fails to demonstrate proper sequence operation in any of the second round of sequence tests, the Commissioning Authority's costs for witnessing all further demonstration of that sequence

GENERAL COMMISSIONING REQUIREMENTS

may be assigned to the Control Contractor by the Owner as a deduct to their contracted price. The Control Contractor will not be responsible for costs related to failure due to design or to other factors beyond their control, though it is expected to call any design concerns (and other factors beyond their control that might cause failure) to the attention of the Commissioning Authority and the Owner's Authorized Representative.

8. Assist Commissioning Authority with programming of the energy management system for trend logs to support functional performance testing during field testing.
 9. Assist Commissioning Authority with execution of the Commissioning Procedures. Commissioning Authority will present test schedule at Progress Meeting at least one week ahead of scheduled tests.
 10. The Commissioning Authority, acting with Owner authority, may request the Control Contractor to assist with or perform minor loop tuning adjustments, set point and schedule changes, and other similar minor field corrections.
 11. Recommended changes to the controls sequences, program code, and recommendations for additional points must go through the Owner's Authorized Representative and the designer. The designer is the final authority on all recommended sequence changes, and will submit such changes to the Owner's Authorized Representative for implementation.
 12. Submit to Owner's Authorized Representative, at least two weeks prior to Final Completion, two copies of as-built version of points list, including I/O and virtual points, controls Drawings, program printout, and sequence narratives.
 13. Participate in resolution of problems and deficiencies that are discovered during commissioning.
- I. Duties of Balancer:
1. Attend commissioning portion of Project Meetings as necessary, minimum two meetings.
 2. Participate in resolution of problems and deficiencies that are discovered during commissioning.
 3. Assist Commissioning Authority with execution of commissioning procedures.
 4. Demonstrate accuracy of final balance report in the presence of the Commissioning Authority. This will be a 10 percent spot check.

GENERAL COMMISSIONING REQUIREMENTS

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMISSIONING PROCEDURES AT THE SITE

A. Testing Techniques:

1. Each testing procedure may use a variety of techniques. Generally it is preferred to observe new and existing equipment and systems during normal operation.
2. When functional and emergency modes of operation occur rarely or seasonally, if possible, simulate the conditions that trigger these operational modes.
3. Simulation of conditions may involve changing set points, changing schedules, simulating pneumatic system pressures or energy management system voltages and currents, disconnecting power, jumpering contacts, or other such procedures.
4. Whenever temporary adjustments are made, restore the system to its original condition once tests are completed.
5. When testing requires observing equipment operation over an extended period, use the building energy management system's trend logging capabilities or independent monitoring equipment.
6. Do not use the building automation system trend logging in the commissioning process prior to point-to-point checkout by Controls Contractor and approval of point-to-point checkout by Commissioning Authority.
7. Measurement of room lighting levels during evening hours with only artificial lighting, during mid-morning, around noon and mid-afternoon with only natural lighting and with both natural and artificial lighting. Repeat same measurements following calibration of room daylighting sensor.

B. Commissioning Documentation:

1. The Contractors are required to perform startup and checkout of their systems (prefunctional testing) and document the results in Facility Grid. The Commissioning Authority will provide electronic forms that may be used by the Contractors. The Contractors may use their own forms if they contain all the required information on the Commissioning Authority's forms, but prior approval must be obtained.
 - a. Where numeric data is required, a narrative entry or simple check-off is not acceptable.

GENERAL COMMISSIONING REQUIREMENTS

- b. Annotate trend logs and monitored data as necessary to clarify meaning, and attach to relevant test reports.
 - c. Do not attach irrelevant data to test reports.
 2. The Contractor sends the startup and checkout forms to the Commissioning Authority when they are complete and functional. The Contractor sends a "Certificate of Readiness" with the forms which will signal that functional testing can begin.
 3. The technician who performed the pretesting and checkout of the system completes the Pre-Functional Checklists using the web based commissioning software Facility Grid.
 4. E-mail an "issues log" weekly to inform the design and construction team of issues that need resolution. The "issues log" will open and close items as they are discovered and resolved until all items are closed.
 5. The Commissioning Authority will assemble all the information from the Commissioning Plan (test forms, trend logs, issues log, and basis of design) into a final Commissioning Report.
- C. Coordination of Commissioning and Equipment Startup: Do not initiate functional performance testing for equipment or systems in advance of their startup and checkout by affected equipment or system installers and manufacturers' representatives.
- D. Test Acceptance Criteria:
 1. Acceptance Criteria are the test results that are required before the mode of performance or inspection item in question will be considered acceptable.
 2. Any procedures in Specification Sections 22 08 00, 23 08 00, 26 08 00, or 28 08 00 that begin with "Verify that...." have an implied acceptance criterion that the sequence as stated is proven to occur and is documented with visual observation notes, measurements, trend logs, and/or monitored data.
 3. Acceptance criteria for other functional modes and checklist items are as stated in each section of the Commissioning Plan.
 4. Input will be sought when necessary from the Architect's Engineer to determine if test results indicate compliance with Design Intent.
 5. The Commissioning Authority will recommend acceptance or rejection of commissioned system work based on test results.
- E. Resolution of Deficiencies:

GENERAL COMMISSIONING REQUIREMENTS

1. Adjust, repair, or replace defective equipment and systems to meet Commissioning Procedure Acceptance Criteria as directed by Owner's Authorized Representative.
 2. Inform the Owner's Authorized Representative and Commissioning Authority of the date for completion of corrective activities.
 3. If the date for completion of corrective work passes without resolution of deficiencies, Owner's Authorized Representative reserves the right to obtain supplementary services and equipment to correct the problem as indicated in General Conditions.
- F. Rechecking and Retesting Charges:
1. In the event of a second failure of a specific commissioning procedure item or test, the responsible party may be assessed charges by Owner's Authorized Representative.
 2. Charges will be based on each party's actual expenses, including normal hourly billing rates for preparation, testing, and travel time, and materials, equipment rental, and travel expenses as applicable.
- G. Construction and Acceptance Milestones for Tasks Related to Commissioning:
1. Equipment, ductwork, and piping installation.
 2. Equipment startup.
 3. Pre-functional checklists.
 4. Substantial completion.
 5. Point-to-point checkout and sequence testing of controls.
 6. Test and balance.
 7. Commissioning field testing.
 8. Owner training.
 9. Occupant move-in.
 10. Final completion.
 11. Seasonal testing.
 12. Commissioning report submittal.

END OF SECTION

GENERAL COMMISSIONING REQUIREMENTS

COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. See Division 01, General Requirements for overall objectives and comply with requirements.
 - a. This section covers the Contractor's responsibilities for commissioning; installer responsible for installation of a particular system or equipment item to be commissioned is responsible for commissioning activities relating to that system or equipment item.
 - b. Plumbing systems to be commissioned will include the following:
 - (1) Domestic water heaters.
 - (2) Domestic hot water circulating pumps.
 - c. Pre-Functional Checklist and Functional Test requirements specified in this Section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.2 RELATED SECTIONS

- A. Contents of Division 22, Plumbing and Division 01, General Requirements apply to this section.

1.3 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. Meet requirements of ASHRAE Guideline 0, The Commissioning Process.

1.4 SUBMITTALS

- A. Submittals as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide Pressure Tests, Flushing Reports, and Startup Reports. Submit for approval of Commissioning Authority.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.

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1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 22 00 00, Plumbing Basic Requirements and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Commissioning, inspecting, and testing will not modify terms or time periods of mechanical equipment, systems, and controls warranties including related equipment and system, and adjacent work.
 - 2. Control system warranty period starts from date of Commissioning Agent acceptance.

1.7 COORDINATION

- A. Reference Section 01 91 13, General Commissioning Requirements for requirements pertaining to coordination during the commissioning process.

1.8 PURPOSE

- A. Purpose of commissioning process is to provide Owner assurance that systems have been installed in prescribed manner and will operate within performance guidelines. Commissioning is intended to enhance quality of system startup and aid in orderly transfer of systems to beneficial use by Owner.
- B. Commissioning procedures and results will be observed by Commissioning Authority or Owner's staff. Contractor is expected to verify functional readiness of systems to be tested prior to performing the tests in presence of Owner's witness. A high rate of test failure will indicate that Contractor has not adequately verified readiness of systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become property of Owner.
- B. Specialized tools, test equipment, and instruments required to execute Start-up, checkout, and testing of equipment are to be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances. A testing laboratory must have calibrated its test equipment within the previous 12 months. Calibration to be NIST traceable. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.

COMMISSIONING OF PLUMBING

- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become property of Owner.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cooperate with Commissioning Authority in development of the Pre-Functional Checklists and Functional Test Procedures.
- B. As part of required submittals for contract, within three months of award of contract, submit for each piece of equipment and controls, manufacturer's startup and installation procedures as well as controls point-to-point and sequence checkout and provide in check list format.
- C. Furnish additional information requested by the Commissioning Authority.
- D. Prepare a preliminary schedule for plumbing pipe systems testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update schedule as appropriate.
- E. Notify Commissioning Authority when pipe system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that Commissioning Authority has scheduling information needed to efficiently execute commissioning process.
- F. Put equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- G. Provide temperature and pressure taps in accordance with Contract Documents.
- H. Provide a pressure/temperature plug at each water sensor which is an input point to control system.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the Commissioning Authority.
- B. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Commissioning Authority.
- C. Provide information requested by the Commissioning Authority for final commissioning documentation.

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- D. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- E. Prepare preliminary schedule for Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup, testing and balancing and task completion for Owner. Distribute preliminary schedule to commissioning team members.
- F. Update schedule as required throughout the construction period.
- G. During the startup and initial checkout process, execute the related portions of the Pre-Functional Checklists for commissioned equipment.
- H. Contractor to participate and complete checklists using the Commissioning Authority's web based commissioning software Facility Grid. A desktop, laptop, tablet, or iPad will be required.
- I. Assist the Commissioning Authority in verification and Functional Performance Tests.
- J. Gather operation and maintenance literature on equipment and assemble in binders as required by the Specifications. Submit to Commissioning Authority 45 days after substantial completion.
- K. Coordinate with the Commissioning Authority to provide 48 hour advance notice so that the witnessing of equipment and system startup and testing can begin.
- L. Notify the Commissioning Authority a minimum of one week in advance of the time for the start of the balancing work.
- M. Participate in, and schedule vendors and contractors to participate in the training sessions.
- N. Provide written notification to the CM/GC and Commissioning Authority that the following work has been completed in accordance with the Contract Documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. Plumbing equipment including domestic water heaters, pumps, plumbing fixtures, and other equipment furnished under this Division.
 - 2. Gas piping, sanitary waste and vent piping, storm drainage piping, sump pumps and automatic sprinkler system.
- O. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- P. Reference Section 01 91 13, General Commissioning Requirements, for additional contractor responsibilities.

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3.3 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Reference Section 01 91 13, General Commissioning Requirements for the Architect, Mechanical, Electrical, and Plumbing Engineer's responsibilities.

3.4 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Reference Section 01 91 13, General Commissioning Requirements for the Commissioning Authority's responsibilities.

3.5 TESTING PREPARATION

- A. Certify, in writing, to the Commissioning Authority that plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pre-test setpoints have been recorded.
- B. Certify, in writing, that discrepancies discovered during the test and balance process have been resolved and that testing, adjusting, and balancing is completed.
- C. Set systems, subsystems, and equipment into operating mode to be tested (e.g. normal auto position, normal manual position, unoccupied mode, emergency power and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified on checklists.
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode operation.

3.6 TAB COORDINATION

- A. TAB: Testing, adjusting, and balancing of Plumbing.
- B. Coordinate commissioning schedule with TAB schedule.
- C. Review the TAB plan to determine capabilities of the control system toward completing TAB.
- D. Provide necessary unique instruments and instruct TAB technicians in their use; such as handheld control system interface, etc.
- E. Have required Pre-Functional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by Commissioning Authority prior to starting TAB.
- F. Provide a qualified control system technician to operate controls to assist TAB technicians or provide sufficient training for TAB technicians to operate system without assistance.

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3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of Commissioning Authority.
- B. Scope of Plumbing testing to include entire Plumbing installation. Testing to include measuring capacities and effectiveness of operational and control functions.
- C. Test 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 Commissioning Authority along with the Plumbing contractor, balancing subcontractor to prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever applicable.
- 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 Commissioning Authority and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Commissioning Authority may direct that setpoints be altered when simulating conditions is not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.8 PLUMBING SYSTEMS, SUBSYSTEMS AND EQUIPMENT TESTING PROCEDURES

- A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: Test requirements are specified in Division 22, Plumbing Piping sections. Plumbing Contractor to prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the Commissioning Authority. Plan should include the following.
 - 1. Sequence of testing procedures for each section of pipe to be tested, identified by pipe zone or sector identifications marker. Markers to 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 to be formatted to allow each section 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.

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3. Minimum flushing velocity.

- B. Functional Performance Tests: Tests will be fully documented with test procedures, expected results for each procedure, and documented in either pass or fail. Tests are written by the Commissioning Authority and performed by the Contractor. The Commissioning Authority documents the results of the test.

3.9 DEFICIENCIES / NON-CONFORMANCE AND COST OF RETESTING

- A. The Commissioning Authority documents the results of the tests. Corrections of minor deficiencies identified are made during the tests at the discretion of the Commissioning Authority. The Commissioning Authority documents the testing results on the Functional Performance Testing document. Deficiencies or non-conformance issues are noted and reported to the GC and Owner via the Master Cx Issues/Resolutions Log. The Contractor will then correct deficiencies, notify the Commissioning Authority of the correction, and then schedule retesting of the issue with the GC and Commissioning Authority. For areas in dispute of the issue between the Commissioning Authority and Contractor to go directly to the A/E. A/E to provide direction of the design intent and expected result to clear up the dispute.
- B. If the Plumbing contractor fails to demonstrate proper sequence of operation in any of the second round of Functional Performance Tests, the Commissioning Authority's costs for witnessing further demonstration of that test procedure may be assigned to the Plumbing contractor by the Owner as a deduct to their contracted price. The Plumbing contractor will not be responsible for costs related to failure due to design or other factors beyond their control, though it is expected to call any design concerns (and other factors beyond their control that might cause failure) to the attention of the GC and Commissioning Authority.
- C. Reference Section 01 91 13, General Commissioning Requirements for additional contractor responsibilities

3.10 OPERATION AND MAINTENANCE MANUALS

- A. See Division 01, General Requirements for additional requirements.
- B. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- C. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.11 DEMONSTRATION AND TRAINING

- A. See Division 01, General Requirements for additional requirements.
- B. Demonstrate operation and maintenance of Plumbing systems to Owner's personnel; if during any demonstration, system fails to perform in accordance with information included

COMMISSIONING OF PLUMBING

in Operations and Maintenance (O&M) manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Pre-Functional Checklists and demonstrations to Commissioning Authority during Functional Testing.

D. Training:

1. Submit a written training plan to the Owner and Commissioning Agent for review and approval. Contractor's training plan to cover the following elements:

a. Equipment included in training.

(1) Intended audience.

(2) Location of training.

(3) Objectives.

b. Subjects covered.

c. Duration of training on each subject.

d. Instructor for each subject.

e. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written hand outs, etc.).

f. Instructors and qualifications.

2. Contractor is to have the following training responsibilities:

a. Provide a training plan ten calendar days prior to the scheduled training, in accordance with Division 01, General Requirements.

b. Provide Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned mechanical equipment or system.

c. Training to start with classroom sessions, if necessary, followed by hands-on training on each piece of equipment, which will illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm, power failure, etc.

d. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

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- e. The appropriate trade or manufacturer's representative will provide the instructions on each major piece of equipment. This representative may be the Start-up technician for the piece of equipment, the installing contractor, or the manufacturer's representative. Practical building operating expertise, as well as in-depth knowledge of modes of operation of the specific piece of equipment, is required. More than one party may be required to execute the training.
- E. Provide the services of manufacturer representatives to assist instructors where necessary.

END OF SECTION

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Definitions, warranties, test equipment requirements, and mechanical commissioning requirements.

1.2 RELATED SECTIONS

A. Contents of Division 23, HVAC and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 01 91 13, General Commissioning Requirements.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, meet the following:

1. Current edition of ASHRAE Guideline 0, The Commissioning Process.

1.4 SUBMITTALS

A. Submittals as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

B. In addition, provide:

1. Certificates of readiness.
2. Certificates of completion of installation, prestart, and startup activities.
3. Operation and Maintenance Manuals.
4. Test reports.
5. Control Drawings Submittal
 - a. Provide a key to abbreviations.
 - b. Provide graphic schematic depictions of the systems and each component.

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- c. Include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
- d. Provide a full points list with at least the following included for each point:
 - (1) Controlled system
 - (2) Point abbreviation
 - (3) Point description
 - (4) Display unit
 - (5) Control point or set point (Yes / No)
 - (6) Monitoring point (Yes / No)
 - (7) Intermediate point (Yes / No)
 - (8) Calculated point (Yes / No)
- 6. Architect forwards one set of submittals for systems to be commissioned to Commissioning Agent at same time as design team.
- 7. Commissioning Agent forwards comments to design team for consideration in their submittal response.
- 8. Design team sends consolidated response to submittals and copies to Commissioning Agent.

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.
- B. Test Equipment Calibration Requirements: Contractors will comply with test manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately after instruments have been repaired resulting from being dropped or damaged. Affix calibration tags to test instruments. Furnish calibration records to Commissioning Authority upon request.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Section 23 00 00, HVAC Basic Requirements and Division 01, General Requirements.

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- B. In addition, provide:
 - 1. Commissioning, inspecting, and testing will not modify terms or time periods of mechanical equipment, systems, and controls warranties including related equipment and systems, and adjacent work.
 - 2. Control system warranty period starts from date of Commissioning Agent acceptance.

1.7 COORDINATION

- A. Reference Section 01 91 13, General Commissioning Requirements, for requirements pertaining to coordination during the commissioning process.

1.8 PURPOSE

- A. Purpose of commissioning process is to provide Owner assurance that systems have been installed in prescribed manner and will operate within performance guidelines. Commissioning is intended to enhance quality of system startup and aid in orderly transfer of systems to beneficial use by Owner.
- B. Commissioning procedures and results will be observed by Commissioning Authority or Owner's staff. Contractor is expected to verify functional readiness of systems to be tested prior to performing the tests in presence of Owner's witness. A high rate of test failure will indicate that Contractor has not adequately verified readiness of systems.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the mechanical contractor of Division 23, HVAC will ultimately be responsible for standard testing equipment for the HVAC&R system and controls system in Division 23, HVAC, except for the equipment specific to and used by TAB in their commissioning responsibilities. Provide a sufficient quantity of two-way radios by each subcontractor.
- B. Include special equipment, tools and instruments (specific to a piece of equipment and only available from vendor) required for testing in the base bid price to the Owner and leave on site, except for stand-alone data logging equipment that may be used by the Commissioning Authority.
- C. Manufacturer of equipment to provide proprietary test equipment and software required for programming and/or start-up, whether specified or not. Manufacturer provides the test equipment, demonstrates its use, and assists in the commissioning process as needed. Proprietary test equipment (and software) become the property of the Owner upon completion of the commissioning process.

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- D. Data logging equipment and software required to test equipment will be provided by the Commissioning Authority, and will not become the property of the Owner.
- E. Use only testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers have a certified calibration within the past year to an accuracy of 0.5 degree F and a resolution of plus or minus 0.1 degree F. Pressure sensors have an accuracy of plus or minus 2.0 percent of the value range being measured (not full range of meter) and have been calibrated within the last year.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the Commissioning Authority will prepare prefunctional checklists for commissioned components, equipment, and systems
- B. Red-Lined Drawings:
 - 1. Verify equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
 - 4. The contracted party, as defined in the Contract Documents will create the as-built drawings.
- C. Operation and Maintenance (O&M) Data:
 - 1. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for commissioned equipment and systems.
 - 2. The Commissioning Authority will review the O&M literature once for conformance to project requirements.
 - 3. The Commissioning Authority will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training:

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1. Contractor will provide demonstration and training as required by the specifications.
2. A complete training plan and schedule must be submitted by the contractor to the Commissioning Authority four weeks prior to any training.
3. A training agenda for each training session must be submitted to the Commissioning Authority one week prior the training session.
4. Notify the Commissioning Authority at least 72 hours in advance of scheduled tests so that testing may be observed by the Commissioning Authority and Owner's Authorized Representative. Provide a copy of the test record to the Commissioning Authority, Owner, and Architect.
5. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
7. Review data in O&M Manuals.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23, HVAC are as follows (references apply to commissioned equipment only):
 1. Perform commissioning tests at the direction of the Commissioning Authority.
 2. Attend construction phase controls coordination meetings.
 3. Attend testing, adjusting, and balancing review and coordination meetings.
 4. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Commissioning Authority.
 5. Provide information requested by the Commissioning Authority for final commissioning documentation.
 6. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or subcontract written.
 7. Prepare preliminary schedule for mechanical system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing

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and task completion for owner. Distribute preliminary schedule to commissioning team members.

8. Update schedule as required throughout the construction period.
 9. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for commissioned equipment.
 10. Contractor to participate and complete checklists using the Commissioning Authority's web based commissioning software Facility Grid. A desktop, laptop, tablet, or iPad will be required.
 11. Assist the Commissioning Authority in verification and functional performance tests.
 12. Gather operation and maintenance literature on equipment, and assemble in binders as required by the specifications. Submit to Commissioning Authority 45 days after submittal acceptance.
- B. Coordinate with the Commissioning Authority to provide 48 hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- C. Notify the Commissioning Authority a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.
- D. Participate in, and schedule vendors and contractors to participate in the training sessions.
- E. Provide written notification to the Construction Manager/General Contractor (CM/GC) and Commissioning Authority that the following work has been completed in accordance with the Contract Documents, and that the equipment, systems, and sub-system are operating as required.
1. HVAC&R equipment including fans, air handling units, ductwork, dampers, terminals, and other equipment furnished under this Division.
 2. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 3. Fire detection and smoke detection devices furnished under other divisions of the specification.
- F. Equipment supplier to document the performance of his equipment.
- G. Test, Adjust and Balance Contractor:
1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.

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2. Participate in verification of the testing and balancing report, which will consist of repeating measurements contained in the testing and balancing reports. Assist in diagnostic purposes when directed.
- H. Provide training of the Owner's operating staff using expert qualified personnel, as specified.
- I. Equipment Suppliers:
1. Provide requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 2. Assist in equipment testing per agreements with contractors.
 3. Provide information requested by Commissioning Authority regarding equipment sequence of operation and testing procedures.
- J. Reference Section 01 91 13, General Commissioning Requirements for additional contractor responsibilities.

3.3 DESIGN PROFESSIONAL'S RESPONSIBILITIES

- A. Reference Section 01 91 13, General Commissioning Requirements for Design Professional's Responsibilities.

3.4 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

- A. Reference Section 01 91 13, General Commissioning Requirements for Commissioning Authority's Responsibilities.

3.5 TESTING PREPARATION

- A. Certify in writing to the Commissioning Authority that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the Commissioning Authority 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 in writing 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. Place 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).

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- 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 Commissioning Authority.

3.6 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the Commissioning Authority.
- B. Notify the Commissioning Authority at least 10 days in advance of testing and balancing Work, and provide access for the Commissioning Authority 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 Commissioning Authority.
 - 1. The Commissioning Authority will notify testing and balancing subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. Testing and balancing subcontractor to 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 percent. Failure of more than 10 percent of selected items to result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB to result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the Commissioning Authority so verification of failed portions can be performed.

3.7 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the Commissioning Authority.
- B. Scope of HVAC&R testing to include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing to include measuring capacities and effectiveness of operational and control functions.

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- C. Test 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 Commissioning Authority along with the HVAC&R contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor to 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 Commissioning Authority and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Commissioning Authority may direct that set points be altered when simulating conditions is not practical.
- H. 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.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.8 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 23, HVAC Sections. Provide submittals, test data, inspector record, and certifications to the Commissioning Authority.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23, HVAC Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the Commissioning Authority with preparation of testing plans.
- C. Pipe System Cleaning, Flushing, Hydrostatic Tests, and Chemical Treatment: Test requirements are specified in Division 23, HVAC Piping Sections. HVAC&R Contractor to prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the Commissioning Authority. Plan to 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 keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Provide drawings keyed to pipe zones or sectors formatted to allow each

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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 pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of components, systems and sub-systems. Evaluate the following equipment and systems:

1. HVAC Equipment and Systems (all)
2. Building Automation System

3.9 DEFICIENCIES/NONCONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

A. Reference Division 01, General Requirements for requirements pertaining to deficiencies/nonconformance, cost of retesting, or failure due to manufacturer defect.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals to conform to Contract Documents requirements as stated in Division 23, HVAC.
- B. Provide an updated as-built version of the control drawings and sequences of operation in the final controls O&M manual submittal.

3.11 TRAINING OF OWNER PERSONNEL

A. Mechanical Contractor's Training Responsibilities:

1. Provide the Commissioning Authority with a training plan two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, HVAC equipment (i.e., pumps, heat exchangers, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.).
3. Training starts with classroom sessions followed by hands-on training on each piece of equipment to illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

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4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 5. The appropriate trade or manufacturer's representative provides the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 6. Controls contractor to attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 7. The training sessions follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 8. Training Includes:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. Training to include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals and the location of plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 9. Schedule training after functional testing is complete, unless approved otherwise by the Owner.
- B. Controls Contractor's Training Responsibilities:
1. Provide the Commissioning Authority and A/E with a training plan four weeks before the planned training.

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2. Provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on the capabilities of the control system.
3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals include detailed description of the subject matter for each session. Manuals to cover control sequences and have a definitions section that fully describes relevant words used in the manuals and in software displays. Manuals will be approved by the Commissioning Authority and A/E. Deliver copies of audiovisuals to the Owner.
4. The trainings will be tailored to the needs and skill-level of the trainees.
5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. Owner to approve the instructor prior to scheduling the training.
6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes: Definitions, warranties, test equipment requirements, and electrical commissioning requirements as required by the Owner's Project Requirements.

1.2 RELATED SECTIONS

- A. Contents of Division 26, Electrical and Division 01, General Requirements apply to this section.
- B. Reference Section 01 91 13, General Commissioning Requirements.

1.3 WARRANTY

- A. Manufacturer's Warranty:
 - 1. Commissioning, inspecting, and testing not to modify terms or time periods of electrical equipment, systems, and controls warranties including related equipment and systems, and adjacent work.
 - 2. Electrical system warranties to start from date of Commissioning Agent acceptance.

1.4 REFERENCES AND STANDARDS

- A. References and Standards as required by Section 26 00 00, Electrical Basic Requirements and Division 01, General Requirements.
- B. In addition, reference:
 - 1. ASHRAE Guideline 0, The Commissioning Process.
 - 2. NECA 90, Commissioning Building Electrical Systems.

1.5 SUBMITTALS

- A. Reference Section 01 91 13, General Commissioning Requirements, for specific submittal requirements.
- B. In addition, submit the following:
 - 1. Certificates of readiness.
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. Operations and Maintenance (O&M) manuals.

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4. Test reports.

1.6 COORDINATION

- A. Reference Section 01 91 13, General Commissioning Requirements, for requirements pertaining to coordination during the commissioning process.

1.7 DEFINITIONS

- A. Commissioning Authority: Commissioning Agent, representing the Owner and directing commissioning activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested under Division 26, Electrical. Furnish two-way radios for each testing participant.
- B. Furnish special equipment, tools and instruments (specific to tested equipment and only available from vendor) required for testing. At conclusion of commissioning, turn equipment over to the Owner except for stand-alone data logging equipment that may be used by the Commissioning Authority.
- C. Manufacturer: Furnish proprietary test equipment and software required by equipment manufacturer procedures for programming and/or start-up. Demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) to become the property of the Owner upon completion of the commissioning process.
- D. Data logging equipment and software required to test equipment will be furnished by the Commissioning Authority during commissioning.
- E. Testing equipment to be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the Commissioning Authority will prepare Pre-Functional Checklists for commissioned components, equipment, and systems.
- B. Red-lined Drawings:

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1. Verify equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 2. Record the red-lined drawing changes, as a result of Functional Testing and incorporate into the final as-built drawings.
- C. Operation and Maintenance Data:
1. Submit a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for commissioned equipment and systems.
 2. The Commissioning Authority will review the O&M literature once for conformance to project requirements.
 3. The Commissioning Authority will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training:
1. Provide demonstration and training as required by the specifications.
 2. Submit complete training plan and schedule to the Commissioning Authority four weeks prior to training.
 3. Submit training agenda for each training session to the Commissioning Authority one week prior the training session.
 4. Notify the Commissioning Authority at least 72 hours in advance of scheduled tests so that testing may be observed by the Commissioning Authority and Owner's Authorized Representative. Submit copies of the test record to the Commissioning Authority, Owner, and Architect.
 5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
 6. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
 7. Review data in O&M Manuals.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the Commissioning Authority.
- B. Attend construction phase controls coordination meetings.
- C. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the Commissioning Authority.

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- D. Provide information requested by the Commissioning Authority for final commissioning documentation.
- E. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.
- F. Prepare preliminary schedule for Electrical system orientation and inspections, operation and maintenance manual submissions, training sessions, equipment start-up and task completion for owner. Distribute preliminary schedule to commissioning team members.
- G. Update schedule as required throughout the construction period.
- H. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for commissioned equipment.
- I. Contractor to participate and complete checklists using the Commissioning Authority's web based commissioning software Facility Grid. A desktop, laptop, tablet, or iPad will be required.
- J. Assist the Commissioning Authority in verification and functional performance tests.
- K. 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.
- L. Gather operation and maintenance literature on equipment, and assemble in binders as required by the specifications. Submit to Commissioning Authority 45 days after submittal acceptance.
- M. Coordinate with the Commissioning Authority to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.
- N. Participate in, and schedule vendors and contractors to participate in the training sessions.
- O. Provide written notification to the CM/GC and Commissioning Authority that the following work has been completed in accordance with the Contract Documents, and that the equipment, systems, and sub-system are operating as required.
 - 1. Electrical equipment including switchgear, panel boards, motor control centers, lighting, receptacles, dimmers and other equipment furnished under this Division.
 - 2. Automatic Lighting Controls.
 - 3. Fire Alarm System.
- P. Obtain performance documentation from equipment supplier.
- Q. Provide training of the Owner's operating staff using expert qualified personnel.

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- R. Equipment Suppliers
 - 1. Submit requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner, to keep warranties in force.
 - 2. Assist in equipment testing per agreements with contractors.
 - 3. Provide information requested by Commissioning Authority regarding equipment sequence of operation and testing procedures.

3.3 TESTING PREPARATION

- A. Certify in writing to the Commissioning Authority that Electrical systems, subsystems, and equipment have been installed and started and are operating according to the Contract Documents.
- B. Certify in writing to the Commissioning Authority that Electrical instrumentation and control systems have been completed and that they are operating according to the Contract Documents.
- C. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the Commissioning Authority.

3.4 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the Commissioning Authority.
- B. Scope of Electrical testing includes the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing includes measuring, but is not limited to resistance, voltage, and amperage of system(s) and devices.
- C. Test 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 Commissioning Authority along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor to prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.

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- 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 Commissioning Authority and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The Commissioning Authority may direct that set points be altered when simulating conditions is not practical.
- H. The Commissioning Authority 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 Electrical 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.

3.5 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in individual Division 26, Electrical Sections. Provide submittals, test data, inspector record and certifications to the Commissioning Authority.
- B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of components, systems and sub-systems. Evaluate the following equipment and systems:
 - 1. Automatic Lighting Controls (LCP, Occupancy Sensors, Daylighting Controls)

3.6 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Reference Section 01 91 13, General Commissioning Requirements, for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

3.7 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The Operation and Maintenance Manuals to conform to Contract Documents requirements as stated in Division 26, Electrical.

3.8 TRAINING OF OWNER PERSONNEL

- A. Electrical Contractor's training responsibilities:

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1. Provide the Commissioning Authority with a training plan two weeks before the planned training.
2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
3. Training starts with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which illustrates the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative provides the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
6. The training sessions follows the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training includes:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training includes start-up, operation in modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discuss relevant health and safety issues and concerns.
 - d. Discuss warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of plans and manuals in the facility.
 - g. Discuss any peculiarities of equipment installation or operation.

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8. Hands-on training includes start-up, operation in modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of pieces of equipment.
9. Fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
10. Schedule training after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION

COMMISSIONING OF FIRE ALARM

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Test Equipment

B. Summary:

1. Fire alarm commissioning requirements are included in this Section.
2. Commissioning is the process of reviewing system installation and operation to confirm the systems are installed and operating per the design intent and contract documents. It does not replace the official testing and acceptance of the authority having jurisdiction.

C. Definitions:

1. Reference Division 28, Electronic Safety and Security and Division 01, General Requirements.
2. Commissioning Authority: Commissioning Agent, representing the Owner and directing commissioning activities.

1.2 RELATED SECTIONS

A. Contents of Division 28, Electronic Safety and Security and Division 01, General Requirements apply to this Section.

B. In addition, reference the following:

1. Section 01 91 13, General Commissioning Requirements.

1.3 REFERENCES AND STANDARDS

A. References and Standards as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.

B. In addition, meet the following:

1. ASHRAE Guideline 0 - The Commissioning Process
2. NFPA 3 - Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems

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1.4 SUBMITTALS

- A. Submittals as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Reference Section 01 91 13 General Commissioning Requirements, for specific Commissioning submittal requirements.
 - 2. In addition, submit the following:
 - a. NFPA 72 Record of Completion
 - b. Smoke Detector Sensitivity Report
 - c. Alarm Signal Audibility (dB) Levels Report
 - d. Emergency Voice/Alarm Communication System Intelligibility Report

1.5 QUALITY ASSURANCE

- A. Quality assurance as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.

1.6 WARRANTY

- A. Warranty of materials and workmanship as required by Division 28, Electronic Safety and Security and Division 01, General Requirements.
- B. In addition, provide:
 - 1. Manufacturer's Warranty.
 - 2. Commissioning, inspecting, and testing not to modify terms or time periods of fire alarm equipment, systems, and controls warranties including related equipment and systems, and adjacent work.
 - 3. Fire Alarm system warranties to start from date of Commissioning Agent acceptance.

1.7 COORDINATION

- A. Coordination as required by Division 28, Electronic Safety and Security and Division 01, General Requirements. Reference Section 01 91 13 General Commissioning Requirements, for requirements pertaining to coordination during the commissioning process.
- B. In addition, reference the following:

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1. Section 01 91 13 General Commissioning Requirements for requirements pertaining to coordination during the commissioning process.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Provide testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested under Division 28, Electronic Safety and Security. Furnish two-way radios for each testing participant.
- B. Testing equipment to be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the Commissioning Authority will prepare Pre-Functional Checklists for commissioned systems.
- B. Red-Lined Drawings:
 1. Verify equipment, devices and wiring are shown correctly on red-lined drawings.
 2. Record the red-lined drawing changes, as a result of Functional Testing and incorporate into the final As-Built Drawings.
- C. Operation and Maintenance Data:
 1. Submit a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for commissioned equipment and systems.
 2. The Commissioning Authority will review the O&M literature once for conformance to project requirements.
 3. The Commissioning Authority will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.
- D. Demonstration and Training:
 1. Provide demonstration and training as required by the specifications.
 2. Submit complete training plan and schedule to the Commissioning Authority four weeks prior to training.

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3. Submit training agenda for each training session to the Commissioning Authority one week prior the training session.
4. Notify the Commissioning Authority at least 72 hours in advance of scheduled tests so that testing may be observed by the Commissioning Authority and Owner's Authorized Representative. Submit copies of the test record to the Commissioning Authority, Owner, and Architect.
5. Engage a Factory-authorized service representative to train Owner's maintenance personnel to operate and maintain specific equipment.
6. Train Owner's maintenance personnel on procedures and schedules for trouble shooting, servicing, and maintaining equipment.
7. Review data in O&M Manuals.

3.2 CONTRACTOR'S RESPONSIBILITIES

- A. Provide submittals to the Commissioning Authority for review.
- B. Provide information requested by the Commissioning Authority for final commissioning documentation.
- C. Prepare preliminary schedule for fire alarm system orientation and inspections, operation and maintenance manual submissions, training sessions and functional performance testing for owner. Distribute preliminary schedule to commissioning team members.
- D. With input from the Commissioning Authority, update the construction schedule as required with detailed commissioning tasks throughout the construction period.
- E. During the startup and initial checkout process, execute the related portions of the prefunctional checklists for commissioned equipment.
- F. Provide ladders, radios, smoke sound level meter, and intelligibility meter to facilitate the commissioning process.
- G. Gather operation and maintenance literature on equipment, and assemble in binders as required by the specifications. Submit to Commissioning Authority 45 days after submittal acceptance.
- H. Provide any proprietary equipment required to verify the fire alarm functionality.
- I. Pretest all fire alarm components and controls and correct all deficiencies prior to scheduling the Commissioning Authority for functional performance testing.
- J. Coordinate with the Commissioning Authority to provide 48-hour advance notice so that the witnessing of equipment and system testing can begin.

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- K. Perform commissioning tests at the direction of the Commissioning Authority.
- L. Participate in, and schedule vendors and contractors to participate in the training sessions.

3.3 TESTING PREPARATION

- A. Provide written notification to the CM/GC and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.
- B. Detection devices are installed, powered, programmed, labeled and pre-tested.
- C. Notification appliances are installed, powered, synchronized, and pre-tested.
- D. Smoke/fire dampers are powered and pre-tested and provided with access panel for visual inspection.
- E. Fire alarm associated supply and/or exhaust fan shutdown are programmed and pre-tested.
- F. Fire door releases are powered, programmed, adjusted and pre-tested.
- G. Fire alarm control panel programmed per fire alarm sequence of operation.
- H. Communication between the FACP and Central Station verified.
- I. Emergency power systems pre-tested and labeled.
- J. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- K. Prior to scheduling the Commissioning Authority for commissioning tests, certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.

3.4 GENERAL TESTING REQUIREMENTS

- A. Functional performance testing of the fire alarm system, as observed by the Commissioning Authority, may not begin until the Fire Alarm contractor has completed all required pre-testing checklists and documentation.
- B. The Commissioning Authority along with the fire alarm contractor to prepare detailed testing plans, procedures, and checklists for fire alarm systems, subsystems, and devices.
- C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the Commissioning Authority.

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- D. Scope of fire alarm testing includes the entire fire alarm installation, from the incoming power throughout the entire distribution system. Testing includes detection, monitoring, activation, annunciation, programming, and communications.
- E. Test operating modes, interlocks, control responses, and responses to abnormal or trouble conditions, and verify proper response of fire alarm system control equipment and devices.
- F. If tests cannot be completed because of a deficiency outside the scope of the fire alarm system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.5 FIRE ALARM SYSTEMS, SUBSYSTEMS AND EQUIPMENT TESTING PROCEDURES

- A. Functional Performance Testing Procedures shall include the following components and parties involved:
- B. Fire Alarm Control Panel: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all initiating devices, alarming devices and programming associated with the fire alarm control panel operate per the fire alarm sequence of operation and contract documents.
- C. Fire Alarm Remote Annunciator: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all initiating devices, alarming devices and programming associated with the fire alarm control panel operate per the fire alarm sequence of operation and contract documents.
- D. Initiation Devices: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all initiating devices are located, labeled, annunciate correctly at the FACP and function per the fire alarm sequence of operation and contract documents.
- E. Manual Pull Stations: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all manual pull stations are located, labeled, annunciate correctly at the FACP and function per the fire alarm sequence of operation and contract documents.
- F. Smoke Detectors: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all smoke detection devices are located, labeled, annunciate at the FACP and function per the fire alarm sequence of operation and contract documents. This may be conducted using either a listed canned aerosol smoke approved by the manufacturer or other method approved.
- G. Duct Mounted Smoke Detectors: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all duct smoke detection devices are located, labeled, annunciate at the FACP and function per the fire alarm sequence of operation and contract documents. Verify air flow through detector by using a manometer or other manufacturer approved test.

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- H. Heat Detectors: The Commissioning Authority will witness the Fire Alarm contractor perform field tests using a heat gun as described in the Functional Performance Tests to ensure all heat detection devices are located, labeled, annunciate at the FACP and function per the fire alarm sequence of operation and contract documents. Do not use application of heat to test non-restorable fixed temperature detectors.
- I. Magnetic Door Holders: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all magnetic door holders are provided and function per the fire alarm sequence of operation and contract documents. This test will include verifying the door completely closes and latches as required.
- J. Fire Alarm Notification Appliances: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all notification devices are located, labeled, and operates in sync with each other per the contract documents.
- K. Fire Suppression Flow and Tamper Switches: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all flow and tamper detection switches are located, labeled, annunciate at the FACP and function per the fire alarm sequence of operation and contract documents.
- L. Emergency Voice Alarm Communication: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure the automatic voice evacuation activates upon fire alarm activation and verify each speaker annunciates per the contract documents. Perform intelligibility test per NFPA 72 requirements.
- M. Elevator Interface: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure the elevators recall to the appropriate floor upon fire alarm activation per the contract documents.
- N. Air Sampling Type Smoke Detector: The Commissioning Authority will witness the Fire Alarm contractor perform field tests as described in the Functional Performance Tests to ensure all detection devices are located, labeled, annunciate at the FACP and function per the fire alarm sequence of operation and contract documents. This may be conducted using canned aerosol smoke approved by the manufacturer, pressure testing and testing of relay devices.

3.6 DEFICIENCIES/NON-CONFORMANCE, COST OF RETESTING, FAILURE DUE TO MANUFACTURER DEFECT

- A. Reference Section 01 91 13 General Commissioning Requirements for requirements pertaining to deficiencies/non-conformance, cost of retesting, or failure due to manufacturer defect.

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3.7 OPERATION AND MAINTENANCE MANUALS

- A. The Operation and Maintenance Manuals to conform to Contract Documents requirements as stated in Division 28, Electronic Safety and Security and Division 01, General Requirements.

3.8 TRAINING OF OWNER PERSONNEL

- A. Fire Alarm Contractor Training Responsibilities:
 - 1. Provide the Commissioning Authority with a training plan four weeks before the planned training.
 - 2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
 - 3. Training starts with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which illustrates the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
 - 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 - 5. The appropriate trade or manufacturer's representative provides the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.
 - 6. The training sessions follows the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals and record drawings for reference.
 - 7. Training Includes:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions.
 - c. Discuss warranties and guarantees.
 - d. Cover common troubleshooting problems and solutions.

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- e. Explain information included in the O&M manuals and the location of plans and manuals in the facility.
 - f. Discuss any peculiarities of equipment installation or operation.
 - 8. Fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
- B. Schedule training after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION