

## **SECTION 220800**

### **COMMISSIONING OF PLUMBING SYSTEMS**

#### **PART 1 - GENERAL**

##### **1.1 SUMMARY**

- A. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 019100 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 019100 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Owner Affairs will manage the commissioning process.
- B. Systems to be commissioned:
  - 1. Domestic Hot Water System
  - 2. Cold Water Emergency Supply Tank

##### **1.2 RELATED DOCUMENTS**

- A. Section 019100 Commissioning General Requirements

##### **1.3 DEFINITIONS**

- A. For complete list of definitions, Refer to Section 019100 "General Commissioning Requirements."
- B. CxA: Commissioning Authority, as defined in Section 019100 "General Commissioning Requirements."
- C. CxC: Commissioning Coordinator, as defined in Section 019100 "General Commissioning Requirements." A qualified individual appointed by the Contractor to manage the commissioning process on behalf of the Contractor.
- D. CxR: Commissioning Representative, as defined in Section 019100 "General Commissioning Requirements." An individual appointed by a sub-contractor to manage the commissioning process on behalf of the sub-contractor.

##### **1.4 SUBMITTALS**

- A. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 019100 GENERAL.
- B. Commissioning Representative (CxR) Assignment and Qualifications. The contractor shall submit the qualifications and resume for proposed persons to be assigned as the project CxRs, with responsibilities and minimum experience outlined below:
  - 1. The Plumbing CxR Responsibilities are to perform Plumbing System Verification Checklists, Functional Performance Testing, and Functional Performance Test Demonstration, and other work required for commissioning
  - 2. The Plumbing CxR shall have the following minimum qualifications:
    - a. Journey level or equivalent skill level; vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field.

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023

- b. Degree may be offset by three years' experience in installing, servicing and operating plumbing systems in the plumbing industry. Generally, required knowledge includes plumbing systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of equipment, assemblies, and systems.
- C. Training Plan:
1. The contractor shall submit a comprehensive Training Plan. Specific Training requirements per item are specified in Section 3 of this specification and 019100.
- D. Training Verification: After training has been completed the Contractor shall submit the following information to the Owner and the Commissioning Agent:
1. Training Agenda: For each training module submit the agenda that was used during the training session.
  2. Attendance Record: For each training module, submit list of participants and length of instruction time.
  3. Training Recording: For Training Modules which require videography (see Technical Specifications) provide the final edited video to the CxA for review.
- E. O&M Manuals:
1. Prepare O&M manuals according to the contract documents,
  2. Include the Final As-Built Control Drawings
  3. Submit O&M manuals to CxA for review prior to O&M personnel training.
  4. Provide O&M Manuals to the CxA for inclusion in the Systems Manual
- F. System Verification Checklists
1. The Commissioning Agent will prepare and submit System Verification Checklists based on the Systems to be Commissioned.
  2. The contractor shall complete the SVCs and submit completed forms to the CxA.
- G. Startup
1. The Contractor shall submit the Startup Plan as specified in Section 019100.
  2. The Contractor shall submit Startup Reports as specified in 019100.
- H. Functional Performance Test:
1. The Commissioning Agent will prepare and submit Functional Performance Test Procedures. The Contractor shall execute FPT and submit completed forms to the CxA.
  2. The contractor shall complete the FPTs and submit completed forms to the CxA.
- I. As Built Drawing Review:
1. The CxA shall provide a list of as built drawings relevant to the Cx Process to the contractor.
  2. The contractor shall provide the indicated as built drawings to the CxA for review concurrently with the Design Professionals.
  3. The CxA shall review selected As built drawings and provide review comments.
- J. Systems Manual: The contractor shall provide the following information to the CxA for use in the Systems Manual. The final System Manual shall be compiled and submitted by the CxA:
1. As-built drawings (by CxC)
  2. Table of Original Setpoints (by CxC)
  3. Table of Original Programmed Time Schedules (by CxC)
  4. Recommended schedule of maintenance requirements and frequency per manufacturer's recommendations (by CxC)
  5. Recommended schedule for calibrating sensors and actuators (by CxC)
  6. Equipment O&M (by CxC)
  7. Equipment Preventative Maintenance Schedules (by CxC)

- 8. Confirmation of Training (by CxC)

**PART 2 - PRODUCTS**

**2.1 TOOLS**

- A. Division 22 shall provide all test equipment necessary to fulfill the testing requirements of this Division. Refer to 019100.
- B. Testing Equipment and Instrumentation Quality and Calibration:
  - 1. Capable of testing and measuring performance within the specified acceptance criteria.
  - 2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
  - 3. Be maintained in good repair and operating condition throughout duration of use on Project.
  - 4. Be recalibrated/repared if dropped or damaged in any way since last calibrated.
- C. Equipment Manufacturer's Proprietary Instrumentation and Tools :
  - 1. Contractor shall provide all Manufacturer's Proprietary Instrumentation and Tools required for execution of FPTs.
  - 2. Test instrumentation and tools prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
    - a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    - b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.

**PART 3 - EXECUTION**

**3.1 COMMISSIONING PROCESS**

- A. Perform all commissioning activities as defined and specified in section 019100.

**3.2 Cx ACTIVITY COMMON TO PLUMBING SYSTEMS**

- A. The following activities are a summary of the required Commissioning Process. Additional requirements for each activity and responsible parties are found in Section 019100. All requirements for Section 019100 apply.

<b>COMMISSIONING PROCESS</b>		
<b>ACTIVITY</b>	<b>Responsible Party</b>	<b>Description</b>
COMMISSIONING PLAN	CxA	The document that specifies the project specific commissioning process, commissioning scope commissioning team responsibilities, schedules, and documentation requirements of the Commissioning Process.
SUBMITTAL REVIEW	CxA	Contractor Provides Submittals to the CxA concurrently with the Design Professionals. CxA reviews and provides comments.
SYSTEM VERIFICATION CHECKLISTS (SVC)	Authored by CxA Completed by Contractor	SVC forms are generated by the CxA and executed by the contractor to verify that Commissioned Systems are installed, started up, functional and ready for FPT.

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023

START-UP VERIFICATION	Installing Contractor	CxA to verify that the startup activities specified in the contract documents have been executed and deficiencies corrected. Contractor to provide startup forms & reports to CxA for review & comment.
FUNCTIONAL PERFORMANCE TEST (FPT)	Authored by CxA Executed by Contractor	CxA to author FPT forms. Contractor to conduct physical testing of 100% of commissioned systems following the written protocol and provide the results to the CxA. Contractor to correct any issues or deficiencies.
FUNCTIONAL PERFORMANCE TEST (FPT) DEMONSTRATION	Directed by CxA Executed by Contractor	Contractor to demonstrate operation of a sample of commissioned systems in the presence of the CxA. CxA to direct the demonstration in accordance with the FPT forms. CxA to document demonstration results on the FPT forms.
SYSTEMS MANUAL	Supporting Docs by Contractor Manual by CxA	Compilation and writing of the Systems manual by CxA. Contractor to provided specified supporting documents
AS BUILT DRAWING VERIFICATION	As Built Drawings by Contractor Verification by CxA	Contractor Provides As Built drawings to the CxA concurrently with the Design Professionals. CxA reviews and provides comments.
TRAINING VERIFICATION	Training by Contractor Verification by CxA	Contractor to provide records of training conducted to CxA for their verification.
COMMISSIONING REPORTING	CxA	Reports on Cx activity and results prepared by the CxA

**3.3 Cx TESTS COMMON TO PLUMBING SYSTEMS**

- A. In accordance with the approved SVC and FPT document, test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response in accordance with acceptance criteria.
- B. Provide technicians, instrumentation, tools, and equipment to perform and document the required testing.
- C. Coordinate schedule with, and perform Cx activities at the direction of, CxA
- D. CX TEST PREPARATION - Prior to Cx Testing:
  - 1. Contractor shall Certify that Plumbing systems, subsystems, and equipment to be tested have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
  - 2. Contractor shall Certify that Plumbing instrumentation and control systems to be tested have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and all systems are set to and maintaining set points as required by the design documents.

**Commissioning of Plumbing Systems**

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023

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3. Contractor shall Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and final report accepted by MEOR.
  4. Contractor shall Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
- F. If seasonal testing is specified, complete appropriate initial performance tests and documentation, and schedule seasonal tests.

**PART 4 - SYSTEM VERIFICATION CHECKLIST EXAMPLE - These examples are not the final system verification checklists used for this project and are intended to represent the typical rigor of checklists of this type.**



Project Name

Equipment Tag

**Domestic Water Heaters**

Date: \_\_\_\_\_

**System Verification Checklist**

1. Revision				
Revision No.	Name	Company	Date	Reason for Revision

2. General Notes, Directions, & Abbreviations
<p><b>NOTES:</b></p> <ol style="list-style-type: none"> <li>This checklist does replace the manufacturer's recommended checkout and start-up procedures or report(s).</li> <li>This checklist does not comprehensively address fire and life safety or basic equipment safety controls.</li> <li>Items that do not apply shall be noted with the reasons on this form (N/A = not applicable)</li> <li>Each contractor is to find their designated sections of this checklist and complete it accordingly with respect to their discipline.</li> </ol> <p><b>DIRECTIONS:</b></p> <ol style="list-style-type: none"> <li>System verification checklist to be completed by the sub-contractor(s) prior to the factory startup process. Each discipline is to initial or N/A each item on each list.</li> <li>Contractors are to 100% complete the checklist before requesting <del>CxA</del> to inspect.</li> </ol> <p><b>ABBREVIATIONS:</b>                      Commissioning Agent (<del>CxA</del>), Commissioning Coordinator (<del>CxC</del>), General Contractor (GC), Plumbing Contractor (PC), Mechanical Contractor (MC), Electrical Contractor (EC), Control Contractor (CC), Landscape Contractor (LC), Not Applicable (N/A)</p>

3. Commissioning Agent Final Sign-Off		
The commissioning agent has reviewed and verified the completeness of this checklist. Missing items are noted on the issues log.		
Name	Signature	Date

4. Responsible Party Sign-Off				
The equipment listed here is complete and ready for startup. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor.				
Discipline	Company	Initials	Signature	Date

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set  
Construction Documents - June 23, 2023



Project Name

Equipment Tag

5. Issues		
Record any non-conformance items.		
No.	Item	Date Resolved / By
1		Init: _____
2		Init: _____
3		Init: _____
4		Init: _____

6. NOTES	
CxA to record deviations from this form noted items due to RFI/ ASI or other clarifications	
No.	Item
A	
B	
C	
D	

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023



Project Name

Equipment Tag

7. Prerequisite Verification		
Verify that the following prerequisites have been provided prior to beginning equipment installation.		
Deliverable/Submittal	Provided (Y/N)	Issue No
Approved Submittals		
Shop Drawings		

8. Equipment				
Equipment Tag	Location	Serves	Per Plan (Y/N)	Issues No.

9. Equipment Data				
	As Designed	As Submitted	As Found	Issue No.
<b>TAG: Equipment Tag</b>				
Manufacturer				
Model No.				
Serial No.				
Storage Capacity (GAL)				





Project Name

Equipment Tag

<b>10. Plumbing – Water Heaters</b>			
Verify that each of the following items are completed by checking the columns below. Note any discrepancies. The CxA will spot check some of the line items for verification			
No	Item	Plumbing Contractor	
		Equip ID	Equip ID
	<b>General Installation</b>		
1	Water Heater is labeled		
2	Piping labeled		
3	Water and drain piping installed and connected per plans and specifications		
4	Thermometer installed		
5	Temperature pressure relief valve installed		
6	Water treatment completed		
7	Drains installed per plans		
8	Adequate service clearance verified		
9	Local valving set for normal operation		
10	Seismic supports are installed properly		
11	Verify check valves installed per details		
12	Expansion tank installed		
13	Isolation valves installed per detail 6 – P0.4.1		
14	Second low water cutoff and water gage fixtures for expansion tank		
15	Thermostatic mixing valves installed per the diagrams		
<b>CxA had verified the equipment noted by initials</b>			
<b>End of Plumbing System Verification Checklist</b>			



Project Name

Equipment Tag

<b>11. Electrical – Water Heaters</b>			
Verify that each of the following items are completed by checking the columns below. Note any discrepancies. The CxA will spot check some of the line items for verification			
No	Item	Electrical Contractor	
		Equip ID	Equip ID
<b>General Installation</b>			
16	All associated cabinets, panels, disconnects, including local disconnect & raceways complete & contractor tested		
17	Power wiring & grounding properly sized, installed, & contractor tested		
18	All electric connections tight		
19	Power disconnects installed and labeled		
<b>CxA had verified the equipment noted by initials</b>			
<b>End of Electrical System Verification Checklist</b>			

<b>12. Controls – Water Heaters</b>			
Verify that each of the following items are completed by checking the columns below. Note any discrepancies. The CxA will spot check some of the line items for verification			
No	Item	Controls Contractor	
		Equip ID	Equip ID
<b>General Installation</b>			
20	Control panel(s) and feeds (local disconnects) energized		
21	Water temperature monitoring sensors installed		
<b>CxA had verified the equipment noted by initials</b>			
<b>End of Controls System Verification Checklist</b>			

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023

**PART 5 - FUNCTIONAL PERFORMANCE TESTING EXAMPLE - These examples are not the final FPT scripts used for this project and are intended to represent the typical rigor of checklists of this type.**



Project Name

Equipment Tag

**Domestic Hot Water System**

Date: \_\_\_\_\_

FUNCTIONAL PERFORMANCE TEST

1. Revision				
By signing the below, you acknowledge that you have reviewed this test script and reported any comments.				
Revision No.	Name	Company	Signature	Date

2. Pre-Requisite Verification				
By signing the below, you acknowledge that the pre-requisite document has been submitted to the Commissioning Agent. CxA Agent acknowledges receipt				
Item	Plumbing Contractor	General Contractor	Commissioning Agent	Date
Installation Verification				
Start-up Report				

3. Test Attendees
See sign-in sheet

4. Execution of Functional Tests
Prior to the execution of functional tests, the CxA has provided a copy of the primary equipment tests to the installing subcontractor (via the GC) who has reviewed the tests for feasibility, safety, warranty, and equipment protection. The CxA oversees, witnesses, and documents the functional testing of all equipment and systems. The subcontractors execute the tests.

5. Basis of Test
The following document(s) were used to develop this test:

6. Equipment		
Equipment Tag	Location	Comments



Project Name

Equipment Tag

1. Control Points				
Verify that the following points are reported to the BMS. For measurement devices, verify reported values against independently measured values. Note any unexpected or failed results.				
Point Description/Type	Verification	Graphics	Trend	Note

2. Test Procedures				
Perform each of the steps below and record the results. Note any unexpected or failed results.				
#	Procedure and Expected Result	Equip ID	Equip ID	Note
Hot water heater function				
1	Verify the water heater is on and set to the correct setpoint of 140 °F.			
2	Confirm discharge hot water temperature reaches the setpoint			
3	The water heater shuts off automatically when the tank temperature reaches the setpoint			
4	The heating element activates as water temp drops below setpoint _____°F			
5	Demand stopped by turning the Red handle to the OFF position in Sink.			
6	Once temp in the tank reaches the setpoint, the heating gas heating stops.			
7	Test the TPR valve and verify appropriate drainage			
8	Use table below to record temperature out of fixtures.			
<b>End of Test - Release any overridden or adjusted values</b>				

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023



Project Name

Equipment Tag

<b>3. Fixture Water Temperature</b>					
Use below for reference of HW to fixtures					
Fixture	Location	Setpoint	Temperature	Time to Reach Temperature	Note



Project Name

Equipment Tag

<b>4. Test Procedures (Circulating Pump)</b>				
Perform each of the steps below and record the results. Note any unexpected or failed results.				
#	Procedure and Expected Result	Equip ID	Equip ID	Note
<b>Circulation Pump</b>				
Circulation pump and aquastat function test				
9	Simulate Circulating Pump to run by allowing the return water temperature going below 10 °F			
10	Aquastat enables circulating pump ON			
11	Verify the circulation pump is running without noise and vibration			
12	Aquastat shuts pump OFF when return temp is 3 °F above setpoint.			
13	BMS monitoring output temperature of the water heater and the output temperature downstream of water heater and mixing valve.			
<b>Alarms</b>				
Verify the following alarms				
14	The leaving hot water temperature is 10°F (ADJ) above setpoint for more than 5 minutes			
15	The leaving hot water temperature is 10°F (ADJ) below setpoint for more than 5 minutes			
16	Mixing valve leaving hot water temperature is 10°F (ADJ) above or below setpoint for more than 5 minutes (ADJ).			
<b>End of Test - Release any overridden or adjusted values</b>				

**Seneca Critical Access Hospital and Skilled Nursing Facility**

Core and Shell Increment 1 OSHPD No. I230007-32-01

Core and Shell Increment 2 OSHPD No. I230007-32-02

Tenant Improvements Increment 3 OSHPD No. I230007-32-03

Conformed Set

Construction Documents - June 23, 2023



Project Name

Equipment  
Tag

5. Notes		
Record any negative, N/A, or other abnormal responses below. Indicate if the note is an issue (Y/N)		
#	Item	Issue
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

END OF SECTION