Functional Test

Project _____

FT-   PACKAGED BOILER
And Boiler System Including HW Pumps 1 & 2

Related Tests: _____

1. Participants

<u>Party</u>   <u>Participation</u>

Party filling out this form and witnessing testing _____
Dates of tests _____
Dates of tests _____
Dates of tests _____

2. Test Prerequisites

a. __ The following have been started up and startup reports and prefunctional checklists submitted and approved ready for functional testing:

   __ Boiler   __ Heating water piping and valves
   __ Heating water pumps

b. __ All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules and with debugging, loop tuning and sensor and device calibrations completed. _____   _____

   Controls Contractor Signature or Verbal   Date

c. __ Piping system flushing complete and required report approved.
d. __ Water treatment system complete and operational.
e. __ Vibration control report approved (if required).
f. __ Test and balance (TAB) complete and approved for the hydronic system.
g. __ All A/E punchlist items for this equipment corrected.
h. __ These functional test procedures reviewed and approved by installing contractor.
i. __ Safeties and operating ranges reviewed.
j. __ Test requirements and sequences of operation attached.
k. __ Schedules and setpoints attached.
l. __ Sufficient clearance around equipment for servicing.

m. __ Have all energy savings control strategies, setpoints and schedules been incorporated that this boiler and control system are capable of? If not, list recommendations below.

<u>Notes:</u>

n. __ **BAS Program Review.** Review the BAS software control program(s) for this equipment.   Parameters, setpoints and logic sequences appear to follow the specified written sequences.

o. __ **Packaged Control Program Review.** Review the packaged control program(s) for this equipment. Parameters, setpoints and logic sequences appear to follow the specified written sequences.

p. __ Record made of All Values for Current Setpoints (SPt), Control Parameters, Limits, Delays, Lockouts, Schedules, Etc. Changed to Accomodate Testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Space Temp. Setpts		
Boiler enable OSAT setpoint		
Boiler-1: Low limit of firing rate control setpoint High limit of firing rate controlsetpoint Operating control setpoint Operating control setpoint differential		
Boiler-2: Low limit of firing rate control setpoint High limit of firing rate control setpoint Operating control setpoint Operating control setpoint differential		
Mixed HWT Reset	OSAT1_____ HWT1_____ OSAT2_____ HWT2_____	

3. Sensor Calibration Checks. Check the sensors listed below for calibration and adequate location. This is a sampling check of calibrations done during prefunctional checklisting.

"In calibration" means making a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) compared to the test instrument-measured value is within the tolerances specified in the prefunctional checklist requirements (_____). If not, install offset in BAS, calibrate or replace sensor. Use the same test instruments as used for the original calibration, if possible.

Sensor & Location	Location OK[1]	**1st** Gage or BAS Value	Instrument Measured Value	**Final** Gage or BAS Value	Pass Y/N?
OSAT					
HWST (bldg loop)					
HWRT (bldg loop)					
Boiler Packaged Controls (4 sensors)	B-1 B-2	B-1 B-2	B-1 B-2		
Gage temperature					
High limit control[2]					
Operating control[2]					

Notes:

Sensor & Location	Location OK[1]	**1st** Gage or BAS Value	Instrument Measured Value	**Final** Gage or BAS Value	Pass Y/N?
Firing rate control[2]					

[1]Sensor location is appropriate and away from causes of erratic operation.

[2]Rotate setpoint dial on each controller and compare temperature when controller clicks with the temperature gage value. Within 5F is acceptable.

4. Device Calibration Checks. The actuators or devices listed below checked for calibration. This is a spot check on a sample of the calibrations done during prefunctional checklisting and startup.

"In calibration" means observing a readout in the BAS and going to the actuator or controlled device and verifying that the BAS reading is correct. For items out of calibration or adjustment, fix now if easy, via an offset in the BAS, or a mechanical fix.

Device or Actuator & Location	**Procedure / State**	Expected Value	Site Observation	**Final Values**	Pass Y/N
3-way mixing valve	With one or both boilers ON, drive valve to full bypass (closed) , manually or by lowering the HWST resets.	HWST = HWRT (+/- 2F)	HWST=[_____] HRST=[_____]	HWST=[_____] HRST=[_____]	
3-way mixing valve	With both boilers ON, drive valve 100% open (0% bypass, all return thru boilers), manually or by lowering the HWST resets.	HWST = boiler temp. (gage) (+/- 2F)	HWST=[_____] Boiler =[_____]	HWST=[_____] Boiler =[_____]	

5. Verification of Misc. Prefunctional Checks.

Misc. site checks of the prefunctional checklist and startup reports completed successfully.   Pass? Y / N _____

General Conditions of Test and Seasonal Testing

The primary testing will occur during typical winter weather. Because the boiler will be operated year-round, Sequences 14-16; 20 will be trended again (Procedure 11), to ensure that boiler use is minimized during the off-season.

Notes:

6.   Testing Procedures and Record

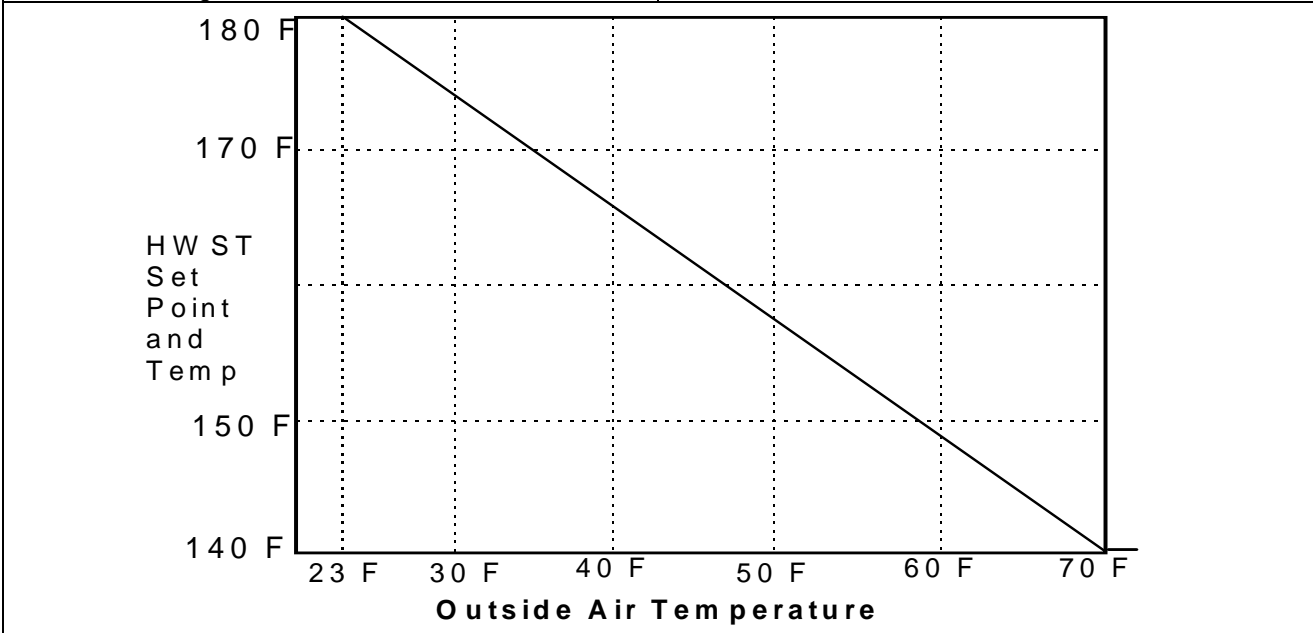| Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
Burner Control Sequencing and 3-Way Valve					
1 Seq. 1; 2, 13-14 Seq. 3 Seq 4		1) Manually shut OFF boilers and keep pumps running on manual to lower boiler water temperature to < 140F. 2) Lower the HWST reset parameters so the 3-way valve is providing 100% return. 3) If no gage, install a temperature sensor in a thermowell of the boiler. 4) With the boilers OFF, and boiler water temperature < 140F, lower the lag boiler OSAT setpoint so that the OSAT is 3F < the OSAT, so both boilers are enabled. Turn all systems to auto. Continue allowing water temp. to climb.	Observe the 3-way valve go to 100% return [_____]. After (4): Both boiler isolation valves open. Both boilers start, and both [_____] burners of both [_____] boilers fire up initially at high [_____] fire. When temp. = 150F [_____], one burner bed drops to low [_____] fire. At 160F [_____], the other bed drops to low [_____] fire. At 170F [_____], the boiler shuts OFF.		
2 Seq. 5 Seq. 6 Seq. 7		Raise the HWST resets, so that the 3-way valve is at 0% return water (all thru boiler, no mixing). Allow the water in the boiler to cool. Raise the HWST resets, and space temperature setpoints, as necessary, to keep boiler water cooling down.	Observe the 3-way valve go to 0% return (all thru boiler) [_____]. Upon cooling to 160F [_____], the boiler starts at low [_____] fire on both beds. Upon cooling to 150F [_____], one [_____] burner bed goes to high [_____] fire. Upon cooling to the lower setting of the Low Firing Rate Control 140F, [_____] the other burner goes to high fire.		
3 Seq. 14		With both boilers still running, lower the lag boiler OSAT setpoint to be 3F lower than the OSAT.	The lag boiler isolation valve closes and lag boiler and pump shuts OFF.		
Safeties					
4 Seq. 8		Loss of power. With boilers ON, shut OFF power to them.	Boiler burners shut OFF and an alarm is generated in the BAS.		
5 Seq. 9		Low water. Unhook the wire to the low water sensor to initiate an alarm.	Boiler burners shutt OFF and an alarm is generated in the BAS.		
6 Seq. 10		High limit. Lower the high limit setting to the current water temperature to initiate an alarm and shutdown.	Boiler burners shut OFF and an alarm is generated in the BAS.		
7 Seq. 12		Flame safety. Sufficiently tested during startup.	DONE		
BAS Controlled Sequences					
8 Seq. 14		Done with procedure for Sequence 1.			

Notes:

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
9 Seq. 13		Lead Boiler. Return all boiler settings and building parameters to normal. Change the lead boiler OSAT setpoint to be 3F > the OSAT.	Lead boiler starts. Only lead pump runs. Isolation valve to lag boiler is closed.		
10 Seq. 15		Continuing from the last procedure: Manually shut off the lead pump.	After 30 seconds [_____], the lag pump starts. No change in boiler isolation valves.		
11 Seq. 16		Return lead pump to auto. Lower the high limit setpt on boiler, until boiler goes OFF on high limit.	After 30 seconds [_____], the lag boiler isolation valve opens, lead valve closes and lag boiler should start.		
12 Seq. 13-14; 17; 18		**Trend Log.** Trend the OSAT, the status of both boilers and pumps, HWRT and the mixed HW supply temperature for 5 days, including a weekend at 10 minute intervals. Provide the occupied schedule for this period.	Verify Sequence 13. Verify Sequence 14. Verify Sequence 17. Verify Sequence 18.		
13 Seq. 17		Unoccupied Night Low Limit Mode. a) With RTU air handler (ASU) in normal mode, change the schedule so unoccupied mode will begin in 5 minutes. b) After the ASU shuts OFF, change the RA NLL setpoint to be 10F above current RA temp. Overwrite one of the polled perimeter zone space temp. to be 1Fabove the space NLL heating setpoint, currently _____F. c) Overwrite one of the polled perimeter zone space temp. to be 3Fbelow the space NLL heating setpoint. d) Change the RA NLL setpoint to be within the bias or deadband range of the current RA temp. e) Return schedules, NLL RA setpoint and space overwritten values to normal.	a) When the schedule is met, the ASU shuts OFF. b) ASU and boiler does not come ON. c) The ASU and boilers come ON. Heating coil valves operate normally. Economizer dampers are shut and exhaust fans are OFF. d) The ASU and boilers shut OFF. e) Values returned to normal.		
14 Misc.		Pump speed. With both boilers running, raise the space temperature setpoint in all zones to put all boxes in full heating. Wait 10 minutes to ensure that all valves are fully open. Check the amps on the pump motors. Repeat with 1 pump and 1 boiler.	Pump amps should be less than the rated full load amps x service factor of the pumps which is: _____. Actual (list each phase): [P-1_____, P-2_____]. One Pump, P-1: [_____] One Pump, P-2: [_____]		

Notes:

Proced. No. & Spec. Seq. ID[1]	Req ID No.[2]	Test Procedure[3] (including special conditions)	Expected and Actual Response[4] [Write ACTUAL response in brackets or circle]	Pass Y/N	Note #
15 Seq. 18		HWST reset. Using the trend log above, plot the trend data in a spreadsheet graph in the form below, or plot 20 values thru both ends of the range of trend data on the chart below.			

Notes:

HWST Reset Chart. For each observation, mark the mixed HWS temp with a dot. Note how many minutes after the call for a change was made, that readings were recorded.	All values should fall within 2F of the reset line specified in the sequences.

HWST Set Point and Temp

180 F
170 F
150 F
140 F

23 F   30 F   40 F   50 F   60 F   70 F

Outside Air Temperature

16	--	**Return all changed control parameters and conditions to their pre-test values[5]**	**Check off in table of Section 2 above when completed**		

MONITORING AND TREND LOGGING. Monitoring via BAS trend logs are required per test Procedures 12. Attach representative graphs or columnar data and explanatory analysis to this test report.

**Abbreviations: HWST = mixed hot water supply temperature, BWST = boiler hot water supply temperature, SPt = setpoint, BAS = building automation system.

[1]Sequences of operation attached to this test.
[2]Mode or function ID being tested from testing requirements section of the project Specifications.
[3]Step-by-step procedures for manual testing, trend logging or data-logger monitoring.
[4]Include tolerances for a passing condition. Fill-in spaces or lines not in brackets denote sequence parameters still to be specified by the A/E, conrols contractor or vendor. Write "Via BAS" for verifications of device position from BAS readout or "Via obs" for actual observation or from test instrument reading.
[5]Record any permanently changed parameter values and submit changes to Owner.

A summary of deficiencies identified during testing is attached

-- END OF TEST --

Notes: