HEATING PLANTS

ACCEPTANCE TESTING

CONTENTS

1. GENERAL

1.01 This section is issued to serve as a guide for personnel engaged in the installation and acceptance of all new heating plants. It is general by design. Specific data concerning particular heating plant equipment and controls can be found by consulting manufacturers' manuals.

1.02 Whenever this section is reissued, the reason(s) for reissue will appear in this paragraph.

1.03 This section recommends tests for the pressure vessel, burner efficiency, combustion safeguards, operating controls, limit controls, and safety and relief valves that should be conducted prior to the acceptance of all new heating plants. These tests are considered to be the minimum required. Additional tests may be required by local authorities having jurisdiction.

1.04 Additional information concerning the testing of heating plants and associated equipment is found in the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code—Recommended Rules for Care and Operation of Heating Boilers, Section VI, and in the following sections:

SECTION	TITLE
760-530-108*	Heating Plant Controls — Description and Installation
770-210-301	Hot Water Heating Boilers — Operation and Maintenance
770-210-302	Steam Heating Boilers — Operation and Maintenance
770-210-305	Fuel Oil Combustion Process, Analysis and Testing of Oil Fired and Natural Gas Burners.

RESPONSIBILITIES

1.05 It should be the responsibility of the building engineer to coordinate and witness all testing performed on new heating plants to assure compliance with project specifications and safe operation. It is recommended that building operations personnel be invited to witness the acceptance testing.

1.06 The heating plant contractor should be responsible for conducting all acceptance test-

*Check Divisional Index 760 for availability.

ing. Only trained and qualified personnel should be assigned to perform these tests.

1.07 The contractor should be responsible for completion of the following work prior to conducting any test:

(a) Installing the heating plant and all applicable controls and appurtenances as outlined in the specifications and/or drawings.

(b) Attaching all wiring permanently; do not permit temporary wiring and/or connections while performing acceptance testing.

(c) Cleaning and boiling out the entire heating plant to remove mill scale and oil.

(d) Adjusting all controls to manufacturers' recommendations.

1.08 Local company policy may require the presence of Hartford Steam Boiler Inspection, other insuring agencies, or local authorities having jurisdiction.

DOCUMENTATION

1.09 Make reports of all testing and test results a part of the permanent project file. Forward copies to the building operations organization and make appropriate entries to the heating plant log. The documented test results provide for a record of the actual control settings. These reports are in addition to those required by local authorities.

OBSERVANCE OF SAFETY PRECAUTIONS

1.10 Safety should be first in the minds of all personnel performing or observing the heating equipment tests outlined in this section. Adequate safeguards should be taken while tests are being performed to protect personnel and equipment and the following precautions should be observed:

(a) Always wear safety glasses.

(b) Always avoid hot surfaces in and around the boilers or furnaces.

(c) Never stand in front of combustion chamber doors when the burner is lighting off.

(d) Always keep hands away from working parts when burner is operating.

(e) Be alert for carbon monoxide as it is a by-product of incomplete combustion.

(f) Be alert for leaking fuels and other potential fire hazards.

(g) Review the procedures with the test observers and explain the results expected and conditions which can be observed during the tests, eg, loud noise associated with the opening of steam safety valves.

(h) Always brief personnel on the location of all shutdown controls in the event of an emergency.

(i) Always account for test leads or jumper wires used to bypass control devices.

Note: Do not place temporary jumper wires or straps in the rear of any plug-in control device.

2. TEST EQUIPMENT

2.01 In addition to the usual mechanic's tools, the following equipment is required:

- Test leads consisting of approximately 3 feet of insulated 14-gauge stranded wire with insulated alligator clips. Test leads should be brightly colored to provide visual identification.
- Good quality pressure gauge that has been recently calibrated.
- Test thermometer.
- Volt-ohmmeter.
- Battery-operated electrical continuity tester.
- Combustion analysis equipment.
- Stopwatch.
- Manometer for testing gas pressures.
- Draft gauge.

3. HYDROSTATIC TEST

3.01 Upon initial installation, subject all steam and hot water heating boilers to a field hydro-

static test of one and one-half times their maximum allowable working pressure. During the period the pressure is applied, inspect for signs of leaks. It is recommended that this test be conducted on field-erected boilers prior to installation of the insulation. Fill the boiler with water at room temperature, if possible, or fill it in advance and allow water to rise to room temperature. This prevents condensation and makes leak inspection easier.

Note: This test is in addition to any hydrostatic tests performed at the factory by the manufacturer.

3.02 Isolate the boiler from the heating system and remove the safety valve. Remove all controls and appurtenances unable to withstand the test pressure without damage.

4. VISUAL INSPECTION

4.01 Prior to further acceptance testing, inspect the heating plant and heating plant room to assure that work is completed in accordance with the specifications and/or drawings and that the installation is ready for testing. Make sure that:

- All piping is complete, properly supported, and terminated and that valves are tagged for identification.
- All electrical work is complete and properly terminated. Junction box covers should be available for installation immediately after testing.
- Debris is removed from the area.
- Lighting is adequate.
- All controls are properly installed.
- Fuel source is available.
- As-built electrical wiring diagram is available.
- All fuses, circuit breakers, motor starters, and overloads are installed and properly sized.
- Operations and maintenance manuals are prepared and available.
- Combustion air intake is clear from obstructions and correctly sized.

5. TESTS

ELECTRICAL

5.01 ***Remote Disconnect Test:*** This test is conducted with a voltmeter connected to the power terminals of the combustion controller ***with*** the circuit energized. Each remote disconnect, in turn, should be operated to assure that each will interrupt the power source.

5.02 ***Hot Leg Test:*** This test, performed ***with*** electrical power to the combustion controller (control circuit should be off), is to verify that the ***limit controls*** are installed in the hot leg to the combustion controller. Each limit control, in turn, is manually tripped and the voltmeter across the power terminals is observed for circuit interruption.

5.03 ***Continuity Test:*** This test, performed ***without*** electrical power on the control circuit, is for the purpose of verifying the placement of all ***operating controls*** in the circuitry. This test is conducted with a battery-powered continuity tester and test leads that are connected to the appropriate terminals of the primary or combustion controller. All operating controls are placed in the "on" position and each, in turn, is manually tripped to interrupt the control circuit.

5.04 ***Slow Drain Test: DANGER: The terminals of the feed pump controller can be energized from a separate source and cause electrical shock.*** This test is performed to verify the mechanical action of each float or probe-actuated water level controller. The continuity tester and voltmeter connected to the appropriate terminals of the combustion controller indicate the status of each control, in turn, as the water is slowly drained from the boiler. This test can be used to mark the respective water levels on steam boiler water gauges as each control is operated.

COMBUSTION CONTROLS

5.05 ***Primary Combustion Controls:*** These controls provide for the safe start-up of a burner and supervision of the flame throughout the firing cycle. These controls vary depending upon the size of burner, ignition source, and type of fuel used. It is recommended that the manufacturer's manual be reviewed to determine the proper operation and timing sequence of the controller. These devices are

tested by interrupting the pilot fuel and timing the interval for main fuel valve(s) closure. (See Section 760-530-110* for required timing intervals.)

5.06 ***Pilot Turndown Test:*** This test is required to determine if the smallest pilot flame capable of holding in the flame relay is large enough to safely light off the main burner. See manufacturer's literature for specific details on test procedure.

5.07 ***Burner Interlock Controls:*** When required, these controls prove that the conditions for combustion are established and that the burner is ready for starting. In addition, they verify that conditions are satisfactory for continued burner operation. These controls vary depending upon the burner type and configuration. Test each control both electrically and mechanically to assure proper operation. These controls include:

- Draft switches
- Damper controls
- Air flow/proving switches
- Firestats
- Combustion air interlocks
- Mechanical ventilation interlocks.

OPERATING CONTROLS

5.08 The operating controls will have previously been tested electrically using the continuity test (paragraph 5.03) and should be tested under burner operating conditions. In this test, temperature (hot water boiler and warm air furnaces) or pressure (steam boiler) is permitted to rise to the set point of the temperature or pressure control thus stopping the burner. Upon reduction in temperature or pressure, the burner should restart.

5.09 During this burner firing sequence, the low water feeder/pump controller and fuel cutoff control should be operated by means of the blowdown valves. The burner should shut down and restart when the water level returns to normal.

5.10 Other operating controls, such as the burner interlocks, should be operated and the burner and combustion controller shutdown sequence observed.

*Check Divisional Index 760 for availability.

LIMIT CONTROLS

5.11 ***High Limit Temperature/High Limit Pressure Controls:*** Test leads are placed across the operating control terminals and the temperature or pressure increased until the high limit control is tripped. The burner should shut down in a manual reset condition. Remove the test lead and check that upon a reduction in temperature or pressure the control does not reset until manually restored. This test shall be repeated for each high limit control.

5.12 ***Low Water Limit Control:*** During a firing cycle, operate the low water limit control. The burner should shut down in a manual reset condition. Upon restoration of the water level, the control should not reset until manually restored.

5.13 ***Safety Shutoff Fuel Valves: DANGER: While testing fuel valves, the reintroduction of fuel into the firebox can be hazardous.*** During the firing cycle, shut off these valves by individually operating the test switches, if provided, or by disconnecting the hot leg lead. The valve should close, the fire should go out, and the primary combustion control should shut down the burner. Testing the pilot safety shutoff fuel valves must be done during the pilot proving period prior to the main burner being ignited. After testing each valve, restore the test switch to normal or reconnect the hot leg lead. The test switches shall be operated for the interval of time required for the flame relay of the primary combustion controller to operate and shut down the system.

5.14 ***High/Low Gas Pressure Controls:*** During the firing cycle, operate these controls to assure that they shut down the burner in a manual reset condition and that these controls do not reset until manually restored. Testing of the high limit gas pressure control requires an increase in gas line pressure, or the use of dry nitrogen gas, with the control isolated from the gas train.

5.15 Following the testing of the limit controls, cycle the burner through at least one firing sequence.

COMBUSTION EFFICIENCY

5.16 A combustion efficiency test is required on all new fuel-burning heating plants to determine

the efficiency of the combustion process and how well the heat produced by the burner is being absorbed by the boiler or furnace.

5.17 Testing equipment, such as manufactured by the Bacharach Company, is used to perform flue gas analysis and to measure stack temperature, smoke density, and draft.

5.18 The specific operating characteristics of the heating plant to be observed should be described in the specifications for the work.

5.19 Perform combustion efficiency testing and adjustments required on new work prior to the safety or relief valve capacity test for boilers.

> ***Note:*** Details for performing these tests are contained in Section 770-210-305.

SAFETY VALVE TESTING—STEAM BOILERS

5.20 Safety valve tests are required for all new steam boiler plants before being placed in service to assure that the safety valve opens at the required set pressure and relieves the pressure at a rate which limits the rise in pressure when the burner is firing at the maximum fuel rate. The makeup water feed device must have sufficient capacity and delivery pressure to the boiler to equal the full discharge of the safety valve. Section 770-210-302 describes safety valve tests to be performed during the operation and service of steam boiler plants.

Capacity Test

5.21 ***DANGER: Steam discharging from the safety valve during this test can be hazardous.*** A capacity test must be performed on safety valves on all new steam boiler installations or on existing steam boilers when there is any modification that affects the steam generating capacity of the boiler, such as changing the size of the burner, changing the rate of fuel flow to the burner, or changing to a grade or type of fuel not previously fired. Also, make a capacity test after replacing a safety valve and following a hydrostatic test (Part 3). Make all such tests in the presence of a telephone company representative and/or the architect's superintendent or the consulting engineer. The results of the capacity test shall be recorded and made part of the permanent project file and heating plant log. ***Hydrostatic testing is not to be considered as an acceptable test to check set pressure or capacity of a safety valve.*** Hydrostatic testing verifies the physical integrity of the pressure vessel following manufacture or repairs. Follow these procedures to perform a capacity test:

(a) Establish necessary general trial conditions and review preparation for test with personnel involved.

(b) A considerable amount of steam will be discharged from the safety valve during this test. Therefore, it is recommended that arrangements be made to dissipate the steam to the building exterior. Avoid ventilation air intakes serving other areas of the building.

(c) Temporarily install calibrated test gauge to check accuracy of the boiler pressure gauge during all phases of these tests.

(d) Set burner to operate at its maximum capacity. Make sure that combustion is complete with proper overdraft, cutting back on fuel supply if necessary to accomplish this.

(e) Isolate the boiler from the supply and return piping making sure that the water feeder can feed water to the boiler if it is necessary during the test.

(f) Temporarily place test leads across the appropriate terminals of the operating pressure control to permit testing of the high limit pressure control and turn on the burner.

(g) When the high limit pressure control demonstrates its ability to stop the burner, place test leads across its terminals, reset it manually, and allow the burner to operate until the boiler pressure approaches 15 pounds per square inch gauge (psig).

(h) If the valve opens at proper set pressure (±2 psig), keep the burner running until the maximum pressure is reached and then hold it for 2 minutes. Maximum pressure should not exceed 20 psig.

(i) If the valve does not operate between 13 to 17 psig or if pressure begins to exceed 20 psig, immediately shut off the burner and make the boiler inoperative until a new valve is installed and tested.

(j) If test conditions are met satisfactorily, turn off the burner and observe test gauges to see that the valve closes and firmly reseats, without simmering, at an acceptable pressure, usually 2 to 4 psig below the valve set or opening pressure. If the valve fails to close properly, shut off the burner and make boiler inoperative until a new valve is installed and tested.

(k) In the case of steam heating boilers, the boiler should be equipped with a low water cutoff and automatic water feeder which prevents a low water condition during the test.

(l) After confirmation of capacity, remove the test leads from the high limit control and allow it to cycle once to determine that it is functioning properly.

(m) Remove test leads from the operating pressure control and allow it to cycle the burner to assure proper operation.

SAFETY RELIEF VALVE TESTING—HOT WATER BOILERS

5.22 Safety valve relief tests are required for all new hot water boiler plants before being placed in service to assure that the safety relief valve opens at the required set pressure and relieves the pressure at a rate which limits the rise in pressure when the burner is firing at the maximum fuel rate. The makeup water feed device must have sufficient capacity and delivery pressure to the boiler to equal the full discharge of the safety relief valve. Section 770-210-301 describes safety relief valve tests to be performed during the operation and service of hot water boiler plants.

Capacity Test

5.23 ***DANGER: Steam and hot water discharging from the safety relief valve during this test can be hazardous.*** A capacity test must be performed on safety relief valves on all new hot water boiler installations or on existing hot water boilers when there is any modification that affects the water heating capacity of the boiler, such as changing the size of the burner, changing the rate of fuel flow to the burner, or changing to a grade or type of fuel not previously fired. Also, perform a capacity test after replacing a safety relief valve and following a hydrostatic test (Part 3). Make all such tests in the presence of a telephone company representative and/or the architect's superintendent or the consulting engineer. The results of the capacity test shall be recorded and made part of the permanent project file and heating plant log. ***Hydrostatic testing is not considered an acceptable test to check set pressure or capacity of a safety relief valve.*** Hydrostatic testing verifies the physical integrity of the pressure vessel following manufacture or repairs. Follow these procedures to perform a capacity test:

(a) Establish necessary general trial conditions and review preparation for test with personnel involved.

(b) A considerable amount of steam and hot water will be discharged from the safety relief valve during this test. Therefore, it is recommended that arrangements be made to dissipate the steam and hot water to the building exterior. Avoid ventilation air intakes serving other areas of the building.

(c) Temporarily install a calibrated test gauge to check accuracy of the boiler pressure gauge.

(d) Set burner to operate at its maximum capacity. Make sure that combustion is complete with proper overdraft, cutting back on fuel supply if necessary to accomplish this.

(e) Isolate the boiler from the rest of the system (supply and return piping and the expansion tank) making sure that the water feeder at city pressure can feed water to the boiler if it is necessary to do so during the test.

(f) Temporarily place test leads across the appropriate terminals on the operating control to demonstrate the ability of the high temperature cutout to function properly. After this has been done, place test leads across high limit terminals to permit continuous operation of the burner.

(g) Observe that the safety relief valve(s) opens at the proper pressure, ie, ±3 psig of the set pressure for set pressures up to 60 psig and ±5 percent of the set pressure for set pressures above 60 psig.

(h) If the valve(s) does not operate within its set pressure tolerances, immediately shut off the burner and make the boiler inoperative until a new valve is installed and tested.

(i) If valve(s) opens at proper set pressure, keep burner running until maximum pressure is

reached and then hold it for 1 to 2 minutes. Maximum pressure rise should not exceed the limits set forth in Section 760-530-112.*

(j) If test conditions are met satisfactorily, turn off the burner and observe pressure gauge to see that the valve closes and firmly reseats without simmering. The blowdown, or the difference between the opening pressure of a pressure relief valve and the reseating pressure, may be 20 to 50 percent of the set pressure for a safety relief valve. If the valve fails to reseat or close properly, shut off the burner and make the boiler inoperative until a new valve is installed and tested.

(k) After confirmation of capacity, the energy stored in the boiler should be dissipated. This can be done in the following manner:

(1) Shut off automatic water feeders.

(2) Actuate try lever of safety relief valve until boiler pressure approximates normal operating pressure.

(3) Slowly open supply (header) valve.

(4) Slowly open return valve.

(5) Start circulating pump.

(6) Slowly open line to expansion tank.

(7) Open automatic water feeders.

*Check Divisional Index 760 for availability.

(l) Remove the test lead from the high limit control and allow it to cycle once to determine that it is functioning properly.

(m) Remove the test lead from the operating control and allow it to cycle the boiler to assure proper operation.

6. APPURTENANCES

6.01 The operation of other appurtenances that can be installed on the heating plant must be tested mechanically to assure that the device will function as intended. The device must be tested electrically to make certain it is located properly in the control circuitry and does not cause electrical feedback to occur. Such appurtenances can include:

(a) Thermostats and timing devices

(b) Circulating pumps

(c) Electrically operated flow valves

(d) Alarm devices

(e) Water feeder on return collection tank

(f) Fuel valves

- Antisiphon solenoid
- Spring-loaded antisiphon
- Fusible or fusible link valves.