

# Commissioning Condensing Boilers

## Perform system and component tests to reduce problems

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**A** boiler is an integral component of a hot-water-heating system that includes system pumps and piping, valves and heat emitters, and control sensors and equipment. System-level tests, along with individual component tests, should be completed as part of thorough commissioning. Generally, the performance of a boiler and hot-water system is acceptable if it meets the design intent and specified operating sequence.

An effective commissioning process begins early in design, is performed by an experienced commissioning agent (CA), and involves the incorporation of commissioning requirements into specifications. Effective commissioning typically includes the development of a basis-of-design document, a statement of design intent, a construction-document peer review, and a design- and construction-phase commissioning plan.

Commissioning has evolved to include the preparation and submission of operation-and-maintenance (O&M) manuals and videos, the training of building-operations staff on system O&M procedures, and the ongoing monitoring of system performance, including an end-of-warranty followup 10 months after a project's acceptance.

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This article will focus on the construction-phase prefunctional and functional tests that are a vital part of verifying component and system performance.

### PREFUNCTIONAL CHECKLISTS

Prefunctional tests and checklists should be completed throughout construction, during normal commissioning site visits, as the installation of various components and systems are completed. These checklists generally include:

- Equipment documentation—the CA's verification that the manufacturer's submissions, installations, startup, manuals/documentation, and O&M manuals are presented.
- Verification of model numbers—the CA's verification that the equipment specified was installed.
- Installation checks. Completed by the CA, mechanical contractor (MC), or controls contractor (CC), these should include the points listed in the sidebar. Associated checklists for pumps and heating terminal units also should apply.
- Operational checks. Completed by the CA, MC, or CC, these include the testing of boiler safeties, efficiency, and vibration and verification that the supply-water set point is within 2 F.
- Sensor calibration. Testing/calibration of sensors dedicated to the boiler/system, including checking sensor location. Generally, criteria for acceptance is 2 F between displayed and measured values.

• Sign-off by all parties that the prefunctional checklist is complete and has been submitted for approval and that the equipment and systems are ready for functional testing, subject to any noted outstanding issues.

Prerequisites to performing functional checkout include:

- All major components (boiler, pumps, and valves) have been started, and startup reports and prefunctional checklists have been submitted and approved.

• All control-system functions (buildingwide and **local packaged**) have been programmed and are operable per contract documents.

• Piping-system flushing has been completed and the required report approved.

• The water-treatment system has been completed and is operational.

• The vibration-control report has been approved.

• The hydronic-system test and balance has been completed and approved.

• All architect/engineer punchlist items have been corrected.

• The functional-test procedures have been reviewed and approved by the installing contractors.

• All safeties and operating ranges have been reviewed.

• The test requirements and sequences of operation have been submitted.

• The schedules and set points have been submitted.

• Sufficient clearance for servicing around equipment has been confirmed.

Each system is unique, so functional checklists are project-specific. Typically, there are component- and system-level tests. Component-level tests target distinct functions of each piece of equipment (including start/stop procedures, time delays, safeties, operational and failure interlocks, and alarms). System-level tests typically focus on evaluating proper integration of each component to satisfy the desired control strategy (including staging, part-load performance, set points, and reset strategies).

### FUNCTIONAL-PERFORMANCE TESTING

Functional-performance testing should occur throughout all seasons so the entire system can be observed under normal operating conditions. This may not be possible because of cost constraints, so system operation and performance must be verified by either

## Boiler-Installation Checklist

The following, adapted from Portland Energy Conservation Inc., is a detailed inventory of elements to consider when installing boiler systems for a smooth commissioning process:

### General installation

- Good general appearance/no apparent damage.
- Test-and-balance report shows hot-water flows within 10 percent of design.
- Boiler and accessory environments clean.
- Boiler installed away from areas subject to flooding.
- Adequate boiler and accessory access for maintenance.
- No visible water leaks.
- Pressure gauges and thermometers installed per design.
- Equipment labels affixed per specification.
- Required seismic restraints in place.
- Flue installed completely and sloped properly.
- Combustion air supply complete.
- Boiler combustion adjusted for altitude.

- Boiler vented independently.
- Low-water cutoff installed at least 6 in. above boiler.
- Boiler air vent installed.
- System filled, and, if required, proper percentage of glycol installed.
- Pressure and temperature plugs installed per design.

### Piping in vicinity of boilers

- Gas piping installed and tested.
- Gas supply air at the proper pressure.
- Hydronic piping, including makeup-water piping, safety reliefs, and purge valves, complete and tested.
- Piping configuration per design and manufacturer's requirements.
- Piping insulation in good condition, where visible.
- Check valves and flow switches installed in proper direction.
- Piping not supported on boiler or valves.
- Hydronic-system flushing complete, and strainers cleaned.
- Isolation and balancing valves installed per design.
- Automatic valves stroke freely and close tightly.

- Pipe fittings and accessories complete and per design.
- Pressure-relief valve installed and piped to drain, with pipe not supported on valve.
- Pressure-relief-valve setting per manufacturer's requirements.
- Piping type and flow direction indicated on piping.
- Water-treatment system installed.
- Expansion tanks, air eliminator, etc., installed per design and operational.
- Air vents and bleeds at high points of systems functional.
- Condensate pumps installed per design and operational.
- Condensate piped to drain and, if required by code, neutralized.

### Electricity and controls

- Electrical connections tight.
- Power disconnects installed and labeled.
- Control-system interlocks functional.
- All control devices, pneumatic tubing, and wiring complete.
- Boiler gateway or interface to control system installed and functional.

creating false loads on the equipment or through the manipulation of system set points. Trend logging is a must, especially in verifying operating and reset schedules.

When performing functional tests, consider:

- Safety and interlock tests, as well as other test procedures and loop tuning, could place a system at risk if sequences do not function as intended. Appropriate precautions, including procedures for quickly aborting a test, should be in place to protect equipment and people.
- Prefunctional checklists should be completed on all components/systems served by boilers. Equipment should be capable of safe, temporary operation.
- All resets, except the one being tested, should be overridden to prevent

unwanted system interaction during testing. Once all resets are restored, stable system operation should be verified. Check for conflicting or mismatched reset schedules that could create system inefficiencies and comfort issues.

- If testing a hot-water-reset strategy when there is minimal or no heating load, minimize test time by first testing the low end of the hot-water-supply reset control. It is easier to add heat to a loop than it is to remove heat when there is little load on a system.
- If a boiler system is tested during off-peak months, ensure the temperature of spaces served by heat emitters and air-distribution systems do not exceed safe limits, which could cause comfort issues, unsafe working conditions, or the

tripping of fire dampers.

- Not all boiler systems can be tested at or near full load during construction. Therefore, commissioning plans should provide for off-season testing, balancing, and optimization of integrated systems under the best conditions.

• The amount of time necessary to complete functional tests on a hot-water system depends on the size and complexity of the installation and specified control sequences. Allow enough time for each test to avoid costly mistakes.

Sample detailed functional checklists are available at [www.peci.org](http://www.peci.org), [www.cacx.org](http://www.cacx.org), and [www.bcxa.org](http://www.bcxa.org).

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