



Member of the FM Global Group

Examination Standard for Low Water Level Limit Controls for Boilers

Class Number 7710

May 2021

Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1. INTRODUCTION

1.1. Purpose

- 1.1.1. This standard states testing and certification requirements for low water level limit controls for boilers.
- 1.1.2. Testing and certification criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2. Scope

- 1.2.1. This standard sets performance requirements for low water level controls used on boilers and feedwater vessels to protect against abnormal (below minimum safe) water level. They are intended to operate electrical contacts to provide an alarm and burner shutdown in the event of loss of primary water level. Low water level conditions may result in boiler destruction by overheating.
- 1.2.2. A high pressure low water level limit control is a device consisting of a sensor, alarm, and trip functions for use at an operating pressure of 250 psi (1725 kPa) or greater. A typical application of this control is its installation on a steam drum to sense drop in water level below the normal operating water level.
- 1.2.3. A low pressure low water level limit control is generally similar to the high pressure control except for lower maximum operating pressure. It may incorporate a time delay(s) which is activated when the water drops to the trip point before shutting off boiler firing.
- 1.2.4. The requirements of this standard shall be used to measure and describe the performance of low water level limit controls in response to exposure from heat, pressure, etc., under controlled laboratory conditions. The results of these controlled exposures shall not be used to describe or appraise actual exposure conditions, since such conditions will vary widely.

1.3. Basis for Requirements

- 1.3.1. The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2. The requirements of this standard reflect tests and practices used to examine characteristics of low water level limit controls for the purpose of obtaining certification. Low water level limit controls having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

1.4. Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

1.4.1. Examination and tests on production samples shall be performed to evaluate

- the suitability of the product
- the performance of the product as specified by the manufacturer and required for certification; and as far as practical,
- the durability and reliability of the product.

1.4.2. An examination of the manufacturing facilities and audit of quality control procedures is made to evaluate the manufacturer's ability to produce the product which was examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5. Basis for Continued Certification

The basis for continual certification may include, but is not limited to, the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agencies product surveillance program.

1.6. Effective Date

The effective date of this certification standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7. System of Units

Units of measurement used in this Standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

1.8. Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies.

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

1.9. Terms and Definitions

For purposes of this standard, the following terms apply:

Boiler: A closed vessel in which water is heated, steam is generated, and/or steam is superheated in any combination, under pressure or vacuum by the direct application of heat.

Boiler vs. steam generator: These terms can be used interchangeably.

DCS: Distributed control system.

LWCO: Low-water cut-off.

MFT: Master fuel trip.

Power boiler: A boiler in which steam is generated at a pressure of more than 15 psi (100kPa).

Power generation boiler: A boiler used exclusively or primarily for producing steam in an electric power generating facility.

2. GENERAL INFORMATION

2.1. Product Information

Low water level limit controls for boilers can be entirely mechanical in construction, or can be entirely electronic or a combination of both. Other designs meeting the criteria of this standard may also be considered for certification.

2.2. Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- A complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- General assembly drawings, complete set of manufacturing drawings, materials list, anticipated marking format, piping and electrical schematics, nameplate format, brochures, sales literature, spec. sheets, installation, operation and maintenance procedures; and
- the number and location of manufacturing facilities.
- All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.3. Requirements for Samples for Examination

2.3.1. Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:

- Sample requirements to be determined by the certification agency

2.3.2. Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.

2.3.3. The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.

2.3.4. It is the manufacturer's responsibility to provide any necessary test fixtures, such as those which may be required to evaluate the level limit controls.

3. GENERAL REQUIREMENTS

3.1. Physical or Structural Features

- 3.1.1. A low water level limit control may be mechanically or electrically operated. If the device is used to control boiler water-feed pump operation, it shall also incorporate a low water level limit function. In addition, equipment providing this supervision shall cause limit switch operation on level sensing element failure. For example, loss of electrical continuity or, in mechanical type equipment, failure of the float mechanism.
- 3.1.2. A float operated low water level limit control shall be provided with either a fixed stop arrangement designed to prevent overtravel of mechanisms and floats; or the mechanisms shall be designed to permit such overtravel safely and without damage.
- 3.1.3. A low water level limit control shall be available as a complete and identifiable assembly. It shall perform to the manufacturer's specifications in all respects.
- 3.1.4. Connections for the low water level limit control shall be ½ in. nominal pipe size or larger.
- 3.1.5. Any open, short circuit, or ground fault in the wiring shall result in initiation of the shut down sequence and cause an appropriate alarm at the boiler control panel.

3.2. Markings

- 3.2.1. A certified low water level limit control shall be permanently marked on the exterior to include the name of the manufacturer, distinctive type or model designation.
- 3.2.2. The device shall be marked to indicate operational electrical ratings and operating temperature range and pressure ratings.
- 3.2.3. Controls that incorporate an external chamber for housing the trip mechanism shall have the trip level marked on the outside surface of the chamber.
- 3.2.4. The control shall bear a date code marking which will signify date of manufacture of the control; it shall be clearly visible on the control exterior or when the terminal housing is removed.
- 3.2.5. If a manufacturer produces the subject low water level limit control at more than one location, each control shall have a distinctive marking to identify it as a product of a particular location
- 3.2.6. The model or type identification shall correspond with the manufacturer's catalog designation and shall uniquely identify the certification agency's mark of conformity.
- 3.2.7. The certification agency's mark of conformity shall be displayed visibly and permanently on the product and/or packaging as appropriate and in accordance with the requirements of the certification agency. The manufacturer shall exercise control of this mark as specified by the certification agency and the certification scheme.
- 3.2.8. All markings shall be legible and durable.

3.3. Manufacturer's Installation and Operation Instructions

3.3.1. The manufacturer shall

- provide detailed instructions and illustrations showing the correct method of installing their control device for proper function,
- provide detailed operating procedures for this control, and
- provide a parts/repair list with required maintenance instructions and instructions for periodic testing of the control.

3.4. Calibration

3.4.1. Each piece of equipment used to verify the test parameters shall be calibrated within an interval determined on the basis of stability, purpose, and usage. A copy of the calibration certificate for each piece of test equipment is required. The certificate shall indicate that the calibration was performed against working standards whose calibration is certified and traceable to an acceptable reference standard and certified by an ISO/IEC 17025 accredited calibration laboratory. The test equipment shall be clearly identified by label or sticker showing the last date of the calibration and the next due date. A copy of the service provider's accreditation certificate as an ISO/IEC 17025 accredited calibration laboratory should be available.

3.4.2. When the inspection equipment and/or environment is not suitable for labels or stickers, other methods such as etching of control numbers on the measuring device are allowed, provided documentation is maintained on the calibration status of thus equipment.

4. PERFORMANCE REQUIREMENTS

4.1. Operating Characteristics

- 4.1.1. The trip point of a low water level limit control shall be nonadjustable, and the trip point restoration shall require manual action to reset if the control is used for low pressure, unsupervised boilers. Manual reset is not required if the control is used in conjunction with a supervised burner management system.
- A HIGH PRESSURE (rated at 250 psi [1725 kPa] and above) low water level limit control, shall operate upon actuation of the tripping mechanism to close the safety shutoff valve controlling fuel to the burner.
 - A LOW PRESSURE low water level limit control may incorporate a maximum 90 second time delay for closing the safety shutoff valve.
- 4.1.2. The low water level limit control shall be operationally tested to show that it performs in accordance with the manufacturer's specifications.

4.2. Temperature

- 4.2.1. A control shall be capable of operation through an ambient temperature range of 35°F (2°C) to 140°F (60°C), or at the limits specified by the manufacturer, whichever is greater.
- 4.2.2. The control shall operate satisfactorily during and after exposure to 35°F (2°C) and 140°F (60°C) ambient temperatures for a minimum of 4 hours at each temperature, or at the limits specified by the manufacturer.

4.3. Pressure

- 4.3.1. Parts exposed to boiler water shall be capable of withstanding 1.5 times the maximum rated working pressure.
- 4.3.2. A test pressure of 1.5 times the maximum rated operating pressure shall be applied to the low water limit control for 10 minutes. No permanent deformation, change in operating characteristics or leakage shall result.

4.4. Electrical Insulation

- 4.4.1. The low water level limit control shall withstand a 1 minute high potential applied between current carrying parts and ground. Bonding resistance between accessible conductive elements of the equipment and ground shall not exceed one ohm.
- 4.4.2. A potential of 1000 volts, 60 Hz plus twice the rated maximum voltage shall be applied for 1 minute between all primary current carrying parts and the enclosure ground. No arcing or breakdown shall occur. Leakage current shall not exceed 0.5 mA.

Note: If input voltage rating is 60 V or less, the applied voltage shall be 500 V.

- 4.4.3. Bonding shall be determined by measuring the resistance between conductive elements and the protective grounding terminal.

4.5. Limit Control Durability

- 4.5.1. In the mechanical type control, collapse, leakage, or failure of the float mechanism shall result in the initiation of the shutdown sequence and cause activation of trouble alarm contact(s). Failure of an electrical type control, using electromechanical type relays, shall result in shutdown and activation of alarms upon contact and/or hold-in coil failure.
- 4.5.2. The low water level limit control shall be subjected to an operational test of at least 5,000 cycles of operation at rated electrical contact load. No failure or change in the performance characteristics shall result from this test. Electromechanical relay contacts shall not fuse in the closed position.

4.6. Accuracy

- 4.6.1. The low water level limit control shall maintain the required degree of accuracy before and after the tests described in Paragraphs 4.4 and 4.5.
- 4.6.2. The low water level limit control trip mechanism shall operate within $\pm 1/4$ in (6 mm) of the specified trip point with decreasing water level for the low limit control and increasing water level for high limit control, if provided.

4.7. Voltage Variation

- 4.7.1. The control shall operate properly over a primary source voltage range of 85 to 110 percent of rated voltage.
- 4.7.2. Source voltage shall be varied from 85 to 110 percent of rated. There shall be no change in operating characteristics, or failure to respond to level limit alarms and trip points.

5. OPERATIONS REQUIREMENTS

5.1. Demonstrated Quality Control Program

5.1.1. A quality assurance program is required to assure that subsequent products produced by the manufacturer shall present the same quality and reliability as the specific products examined. Design quality, conformance to design, and performance are the areas of primary concern.

- Design quality is determined during the examination and tests and may be documented in the certification report.
- Continued conformance to this standard is verified by the certifier's surveillance program.
- Quality of performance is determined by field performance and by periodic re examination and testing.

5.1.2. The manufacturer shall demonstrate a quality assurance program which specifies controls for at least the following areas:

- existence of corporate quality assurance guidelines
- incoming quality assurance, including testing
- in-process quality assurance, including testing
- final inspection and tests
- equipment calibration
- drawing and change control
- packaging and shipping
- handling and disposition of discrepant materials.

5.1.3. Documentation/Manual

There should be an authoritative collection of procedures/policies. It should provide an accurate description of the quality management system while serving as a permanent reference for implementation and maintenance of that system. The system should require that sufficient records are maintained to demonstrate achievement of the required quality and verify operation of the quality system.

5.1.4. Records

To assure adequate traceability of materials and products, the manufacturer shall maintain a record of all quality assurance tests performed, for a minimum period of two years from the date of manufacture.

5.1.5. Drawing and Change Control

- The manufacturer shall establish a system of product configuration control that shall allow no unauthorized changes to the product. Changes to critical documents, identified in the certification report, may be required to be reported to, and authorized by the certification agency prior to implementation for production.
- Records of all revisions to all certified products shall be maintained.

5.2. Surveillance Audit

- 5.2.1. An audit of the manufacturing facility is part of the Approval investigation to verify implementation of the quality assurance program. Its purpose is to determine that the manufacturer's equipment, procedures, and quality program are maintained to ensure a uniform product consistent with that which was tested and certified.
- 5.2.2. Certified products or services shall be produced or provided at, or provided from, location(s) disclosed as part of the certification examination. Manufacture of products bearing a certification mark is not permitted at any other location prior to disclosure to the certification agency.

5.3. Manufacturer's Responsibilities

- 5.3.1. The manufacturer shall notify the certification agency of changes in product construction, components, raw materials, physical characteristics, coatings, component formulation or quality assurance procedures prior to implementation.

5.4. Installation Inspections

Field inspections may be conducted to review an installation. The inspections are conducted to assess ease of application, and conformance to written specifications. When more than one application technique is used, one or all may be inspected at the discretion of the certification agency.

6. BIBLIOGRAPHY

ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories.*

FM 3810, *FM Approvals Standard for Electrical and Electronic Test, Measuring, and Process Control Equipment*