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FEDERAL SPECIFICATION

CONTROLLERS, BOILER-FEED WATER, AUTOMATIC

This specification is approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE

1.1 Scope. This specification covers controllers, consisting of some combination of one or more sensing devices, a flow method or device, and the necessary ancillary components to complete the system, that provide for automatic and independent control of the flow of feed water to boilers operating at steam pressures up to 1,500 pounds per square inch gage (psig) (10,341 kilopascals (kPa) gage) inclusive.

1.2 Classification. Boiler-feed water controllers, covered by this specification, are of the following types, classes, and styles, as specified (see 6.2).

Type I - Feed water flow control valve regulation

Class 1 - Single element, direct-operated

Style 1 - Thermo-mechanical or thermo-hydraulic, inclined tube drum level sensing element
Style 2 - Float-type drum level sensing element

Beneficial comments (recommendations, additions, deletions) and any pertinent
*data which may be of use in improving this document should be addressed to: *
*Commanding Officer (Code 156), Naval Construction Battalion Center, *
*1000 23rd Avenue, Port Hueneme, CA 93043-4301, by using the Standardization *
*Document Improvement Proposal (DD Form 1426) appearing at the end of this *
*document or by letter. *

AMSC N/A FSC 4410

Class 2 - Single element, relay-or pilot-operated

Style 1 - Pneumatic differential pressure drum level indicating transmitter, with proportional pneumatic output signal
Style 2 - Thermo-mechanical, inclined tube proportional level sensing element, with variable gain pneumatic output signal
Style 3 - Electronic cell differential pressure drum level indicating transmitter, with transducer proportional pneumatic output signal
Style 4 - Electric, float-actuated drum level sensing element, with electrical output signal

Class 3 - Two element, relay- or pilot-operated

Style 1 - Pneumatic differential pressure inclined tube drum level and flow indicating transmitters, with proportional pneumatic output signals
Style 2 - Electronic cell differential pressure drum level and flow transmitters, with transducer proportional pneumatic output signals
Style 3 - Thermo-mechanical, inclined tube drum level and flow indicating transmitter proportional pneumatic output signals

Class 4 - Three element, relay- or pilot-operated

Style 1 - Pneumatic differential pressure inclined tube drum level and flow indicating transmitters, with proportional pneumatic output signals
Style 2 - Electronic cell differential pressure drum level and flow transmitters, with transducer proportional pneumatic output signals
Style 3 - Thermo-mechanical, inclined tube drum level and flow indicating transmitter proportional pneumatic output signals

Type II - Feed-pump motor start-stop regulation, single-element, direct-operated, with float-type drum level sensing element

Type III - Feed-pump motor start-stop regulation, single-element, relay- or pilot-operated, with electrical probe drum level sensing element

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Federal Standard

FED-STD-123 - Marking For Shipment (Civil Agencies)

Military Specifications

MIL-V-173 - Varnish, Moisture and Fungus Resistant (For Treatment of Communications, Electronic and Associated Equipment)
MIL-B-3180 - Boilers and Related Equipment Packaging of

Military Standard

MIL-STD-129 - Marking For Shipment And Storage (Part 1 of 4 Parts)

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Other publications. The following publications form a part of this document to the extent specified herein. Unless otherwise specified (see 6.2), the issues are those cited in the solicitation.

American National Standards Institute, Inc. (ANSI):

ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5 - Pipe Flanges and Flanged Fittings
ANSI B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500, and 2500
ANSI B36.10M - Welded and Seamless Wrought Steel Pipe

(Application for copies should be addressed to the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

ASTM:

ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B 61 - Steam or Valve Bronze Castings
ASTM B 62 - Composition Bronze or Ounce Metal Castings

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.)

American Society of Mechanical Engineers (ASME):

ASME Boiler and Pressure Vessel Code
Section II, Materials - Part A Ferrous Materials

(Application for copies should be addressed to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.)

Factory Mutual Engineering and Research (FMER):

Approval Guide

(Application for copies should be addressed to the Factory Mutual Engineering and Research Corporation, 1151 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA 02062.)

Fluid Controls Institute, Inc. (FCI):

70-2 - Control Valve Seat Leakage

(Application for copies should be addressed to the Fluid Controls Institute, Inc., 31 South Street, Suite 303, P.O. Box 9036, Morristown, NJ 07963-9036.)

Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):

SP 25 - Standard Marking System for Valves, Fittings, Flanges, and Unions

(Application for copies should be addressed to the Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., 127 Park St., N.E., Vienna, VA 22180.)

National Fire Protection Association (NFPA):

70 - National Electrical Code

(Application for copies should be addressed to the National Fire Protection Association, One Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.)

Underwriters Laboratories Inc. (UL):

UL 353 - Limit Controls
UL Directory - Gas and Oil Equipment Directory

(Application for copies should be addressed to the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Description. Feed water controllers shall include all of the required sensing, actuating, controlling, controlling elements, and components necessary to establish an automatic system to maintain the proper water level in boilers operating under the conditions as specified herein. Unless otherwise specified (see 6.2), the controllers shall accomplish this function independent of the volume and pressure of the forced draft and fuel oil being supplied to the boiler, for expected use in conjunction with, and as part of, a complete boiler automatic combustion control system. The controllers shall be provided complete with all accessory fittings, piping, tubing, mechanical linkages, wiring, or other materials or parts required to connect the operating components in such a manner as to permit the controllers to perform their designed function. The basic requirements for compliance with the classifications established in 1.2 are as follows.

3.1.1 Controlling valve. Controlling valve controllers shall control the feed water input by automatically positioning a feed water control valve. The controller shall be provided with a bypass around the control valve. The controlling valve shall be equipped with a handwheel or knob for manual control and operation, and shall incorporate the manufacturer’s standard position indicator.

3.1.2 Feed-pump motor start-stop. Feed-pump motor start-stop controllers shall control the feed water by making and breaking electrical contacts to start and stop the feed-pump motor.

3.1.3 Single-element. Single-element controllers shall position a controlling valve in response to changes of water level in the boiler steam drum.

3.1.4 Two-element. Two-element controllers shall position a controlling valve in response to changes of water level in the steam drum, as well as changes in the rate of steam flow from the boiler.

3.1.5 Three-element. Three-element controllers shall position a controlling valve in response to changes of water level in the steam drum, changes in the rate of steam flow and changes in the rate of feed water flow to the boiler. Three-element controllers should consist of two independent controllers; one to control water flow and changing drum level, and the other to control rapid changes in steam and water flow.

3.1.6 Direct-operated. Direct-operated controllers shall have self-contained power transmission systems, which will position the controlling valve or control the feed-pump motor using power developed in the actuating element(s).

3.1.7 Relay- or pilot-operated. Relay- or pilot-operated controllers shall have power transmission systems employing a relay or pilot mechanism which utilizes a source of auxiliary hydraulic, pneumatic, or electric power, as specified (see 6.2), to position the controlling valve or control the feed-pump motor. For type I, class 2, 3, or 4 controllers, the auxiliary power shall be in accordance with the style specified in 1.2.

3.1.8 Thermostatic elements. Thermostatic elements for drum water level control shall consist essentially of a thermostat having a concentrically inclined element complete with an inner chamber and an outer chamber. The inner chamber shall be designed for connection above and below the drum water level. The outer chamber shall be designed for connection on type I, class 1 controllers by hydraulic or mechanical linkage directly to the controlling valve, and on type I, class 2, 3, and 4 controllers, through a relay furnished integrally with the thermostat. The heat emitted from the inner chamber in response to changes in the drum water level shall provide a proportional, mechanical, or hydraulic force in the outer chamber.

3.1.9 Float-elements. Direct-operated, float-actuated controllers shall include a float chamber with an integrally furnished control valve connected directly by mechanical linkage to the float. Relay-operated float controls shall include an electric proportioning control having a slide-wire-type potentiometer connected by mechanical linkage to the float. The proportioning control shall send a signal in response to changes in the drum water level to modulate the feed water flow control valve or to make and break the feed-pump motor electrical contacts.

3.1.10 Pressure elements. Pressure elements shall be designed for connection above and below the drum water level and shall transmit an output pneumatic signal directly proportional to the drum level. The signal from the level transmitter shall be received by a level control relay and sent through a manual-automatic station, if specified (see 3.14.2), to the feed water flow control valve.

3.2 Standard commercial product. The controller shall, as a minimum, be in accordance with the requirements of this specification and shall be the manufacturer’s standard commercial product. Additional or better features which are not specifically prohibited by this specification but which are a part of the manufacturer’s standard commercial product, shall be included in the controller being furnished. A standard commercial product is a product which has been sold or is being currently offered for sale on the commercial market through advertisements or manufacturer’s catalogs, or brochures, and represents the latest production model.

3.3 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.2.1.

3.4 Materials. Materials used shall be free from defects which would adversely affect the performance or maintainability of individual components or of the overall assembly. Materials not specified herein shall be of the same quality used for the intended purpose in commercial practice. Unless otherwise specified herein, all equipment, material, and articles incorporated in the work covered by this specification are to be new and fabricated using materials produced from recovered materials to the maximum extent possible without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specified.

3.4.1 Cast-iron. Cast-iron shall have mechanical properties equal to or better than class B of ASTM A 126.

3.4.2 Steel. Carbon steel, alloy steel, and corrosion-resistant steel for control valve bodies and other pressure-containing parts shall be of a type and grade specified in ANSI B16.5 for the applicable pressures and temperatures.

3.4.3 Copper alloys. Brass or bronze castings shall conform to ASTM B 61 or B 62.

3.5 Interchangeability. All units of the same classification furnished with similar options under a specific contract shall be identical to the extent necessary to ensure interchangeability of component parts, assemblies, accessories, and spare parts.

3.6 Design. The controllers shall be designed for installation as integral components on new packaged or field-erected boilers being furnished under separate specifications or as replacement controllers on existing boilers. In either case, the controllers shall be of the classification specified (see 1.2), and shall be designed to satisfy the performance requirements of 3.8 and to function under the following operating conditions, as specified in the contract (see 6.2):

a. Type, make, and model of boiler, if known
b. Steam drum pressure (psig or kPa)
c. Maximum peak rating of boiler in pounds per hour
d. Type of load (steady, moderately fluctuating, rapidly fluctuating)
e. Final steam temperature and superheater pressure drop at maximum flow
f. Maximum and minimum pressure at inlet to feed water controlling valve
g. Feed water temperature

3.7 Safety. The controller shall comply with the applicable requirements of UL 353 or shall be listed in the FM Approval Guide.

3.8 Performance. Unless otherwise specified (see 6.2), type I, class 1, style 2, and class 2, style 4, type II and type III single-element controllers, selected in accordance with 3.6 and 6.1, shall maintain the boiler water level under all conditions, within +1-inch (+25.4 millimeters (mm)) of the boiler manufacturer’s established boiler water level. Type I, class 1, style 1, and class 2, style 1, 2, and 3 single-element controllers shall maintain the boiler water level under all conditions, within +2-inches (+50.8 mm) of the boiler manufacturer’s established boiler steaming water level. Type I, class 3 and class 4, two- and three-element controllers shall maintain the boiler water level under all conditions, within +2-inches (+50.8 mm) of the high water level and within +2-inches (+50.8 mm) of the low water level set points prescribed by the boiler manufacturer.

3.9 End connections. The end connections of valves and fittings to be connected to the feed pipe, boiler components, or boiler fittings shall be as follows:

3.9.1 Size. The nominal sizes for end connections shall be 1/2 (12.7 mm), 3/4 (19.1 mm), 1 (25.4 mm), 1-1/4 (31.8 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), 3 (76.2 mm), 4 (101.6 mm), 5 (127 mm), 6 (152.4 mm), 8 (203.2 mm), 10 (254 mm), and 12 inches (304.8 mm) pipe size and 14- (355.6 mm) and 16-inch (406.4 mm) outside diameter. The nominal sizes provided for both the feed pipe and the boiler connections shall be as recommended by the manufacturer for the proper installation and operation of his product under the conditions specified herein.

3.9.2 Type. The type of end connections provided shall be as specified (see 6.2), in accordance with the following limitations:

3.9.2.1 Size and pressure limits. Connecting ends shall be of the following types:

a. For pressures not exceeding 600 psig (4136.4 kPa), end connections shall be welded end type or flanged end type, except that size 2-inch (50.8 mm) nominal size and under may be threaded end (female)
b. For pressures exceeding 600 psig (4136.4 kPa), end connections shall be welded end type

3.9.3 Flange and bolt dimensions. For flanged valves or fittings, the flange dimensions, dimensions for bolt holes, and the number and size of the bolts shall conform to ANSI B16.5. The face-to-face dimensions shall be the manufacturer’s standard dimensions.

3.10 Controlling valve assembly. The controlling valve assembly shall be of the size recommended by the contractor for the boiler operating conditions specified in accordance with 3.6 and the contract. The valve flange dimensions shall conform to the requirements of ANSI B16.1, B16.5, or B16.24, as applicable, with respect to maximum pressure and temperature ratings based on the materials for pressure-enclosing parts in 3.11.1.

3.10.1 Body. The valve body shall be cast-iron, semi-steel, cast steel, or bronze conforming to the material requirements of 3.4. The valve body shall withstand the hydrostatic test pressure specified in the ANSI standard listed in 3.10 applicable to the material used.

3.10.2 Valve seats, cages, and valves. Valve seats, cages, and valves shall be fabricated of corrosion-resistant steel, nickel-copper alloy, aluminum bronze or silicon-copper alloy, or any combination thereof. Corrosion-resistant steel for components not requiring heat treatment shall conform to any of the 300 series steels having a nominal chromium and nickel content of not less than 18 and 8 percent, respectively. Corrosion-resistant steel for components requiring hardenability treatment shall be an appropriate steel in the 400 series. In lieu thereof, commercial precipitation-hardened corrosion-resistant steel containing 17 percent chromium, 4 percent nickel, and 4 percent copper may be used. Alternate materials having properties equally suitable for the intended application may be used, subject to the approval of the contracting officer. Metal combinations shall display high resistance to seizure, galling, abrasion, and galvanic action. Seats and cages shall be so assembled with the valve body so that they cannot come loose under operating conditions. Leakage between the seat or cage and the valve body shall not exceed maximum seat leakage specified in FCI 70-2, class II. Valves shall be of the double-seated or fully- balanced piston type.

Double-seated valves shall have disks and seats ground to a fit which will ensure minimum leakage at the operating temperature in accordance with FCI 70-2, class II. Piston-type valves shall fit their bore with the minimum clearance compatible with nonbinding sliding. The motion of double-seated and piston-type valves shall be constrained in such a manner that lateral thrust sufficient to cause appreciable increase in sliding resistance shall not develop.

3.10.3 Valve stems. Valve stems may be integral with or separable from the valve disk. Stems shall be fabricated of one of the materials specified in 3.10.2.

3.10.4 Seals. Valve stems and shafts which pass from one pressure zone to another shall be sealed against visible leakage. Packing materials shall not stick to or score stems or shafts. Grease used for sealing and packing materials shall not react chemically with the materials of the stuffing box, stem, or shaft. Unless otherwise specified (see 6.2), the manufacturer's standard seal material shall be used.

3.10.5 Valve actuators. When the valve assembly provided contains a valve actuator, the actuating device shall move the valve to its correct position without hunting, chattering, or sticking. The valve actuator shall be one of the following types, depending on the style or control medium specified in 3.1.7:

a. A hydraulic motor of the diaphragm, bellows, or piston type
b. A pneumatic motor of the diaphragm, bellows, or piston type
c. An electric motorized valve assembly, or
d. An electric switching device

3.10.5.1 Diaphragms. Diaphragm plates and other parts against which the diaphragm flexes shall be smooth and well-rounded. The design shall be such that the diaphragm will not be subject to injurious twisting, wrinkling, or cutting, and will be such as to ensure ease of replacement by field maintenance personnel.

3.10.5.2 Metal bellows. Metal bellows shall be of nickel-copper alloy, phosphor-bronze, or corrosion-resistant steel.

3.10.5.3 Piston and cylinder. The piston shall be of the double-cup, piston ring, or plain cylinder type, or a flat disk on which a rim of synthetic rubber is bonded. The piston shall be mounted and held rigidly in place on a shouldered rod. Cups shall be of molded leather, synthetic rubber, or other material suitable for the intended use. Piston rings shall be carefully fitted so that clearances will have the smallest value compatible with nonbinding sliding. Cylinders shall be of bronze, cast-iron, or steel.

3.11 Level-sensing element. Unless otherwise specified (see 6.2), the level-sensing element shall consist of a hollow float-type assembly, a thermo-mechanical expansion device, an electrical (conductive) probe assembly, a pneumatic inclined tube, or electronic cell differential pressure-indicating transmitter, or a thermo-hydraulic pressure generator that utilizes the expansive force of steam or a volatile liquid in accordance with the type, class, and style in 1.2. The element shall be mounted on or to the boiler in

a location as determined by the manufacturer to ensure proper operation of the controllers and provide for ease of maintenance, or any necessary adjustments by operating personnel, with minimized required downtime against boiler service use.

3.11.1 Pressure-enclosing parts. Pressure-enclosing parts such as float chambers and pressure generators, shall be made of materials conforming to the ASME Boiler and Pressure Vessel Code, Section II, Materials - Part A Ferrous Materials. The materials and parts shall be selected as follows:

a. Steel parts shall be required for pressures exceeding 250 psig (1724 kPa)
b. Materials for which the allowable stress values (as listed in, or determined by the method used in the ASME Boiler and Pressure Vessel Code, Section II, Materials - Part A Ferrous Materials) decrease 25 percent or more, between 100 degrees Fahrenheit (37.7 degrees Celsius) and the maximum operating temperature specified herein, shall not be used
c. In no case shall a material or part be used for pressures or temperatures in excess of those permitted by the applicable material or part specification or standard

3.11.1.1 Wall thickness. The wall thickness of float cages and other cast parts shall not be less than that required by the applicable ANSI standard as specified in 3.10. The wall thickness of tubular components for use with pressure exceeding 250 psig (1724 kPa) shall not be less than that required by schedule 80 of ANSI B36.10M.

3.11.1.2 Hydrostatic test pressures. All pressure-enclosing parts shall withstand hydrostatic tests at test pressures of not less than twice the boiler design pressure. When the hydrostatic test pressure required by the applicable ANSI standard or by component specifications exceeds twice the designed operating pressure of the boiler, the higher test pressure shall be used. Complete assemblies of pressure enclosed systems shall withstand hydrostatic test pressures of at least 150 percent of boiler design pressure at boiler design temperature.

3.11.2 Floats. Copper floats may be used in float type controllers for use on boilers where the maximum steam drum pressure does not exceed 250 psig (1724 kPa). Corrosion-resistant steel or nickel-copper floats shall be provided for steam from pressures exceeding 250 psig (1724 kPa). All floats shall be capable of withstanding an external pressure of twice the maximum steam drum pressure.

3.11.3 Rods and stems. Float rods shall be of corrosion-resistant metal. Stems shall be of corrosion-resistant steel. Rotating stems for float-actuated controllers shall be supported by antifriction bearings capable of supporting both radial and thrust loads.

3.11.4 Stem-seals. Stem-seals shall conform to 3.10.4. When specified (see 6.2), stuffing boxes shall be provided with radiating bonnets.

3.11.5 Electrodes, electrode-holders, and insulating plugs. Electrodes shall be brass rod or corrosion-resistant steel rod, as specified (see 6.2). Electrodes shall be suitably insulated and equipped so that short-circuiting

cannot occur by direct contact of electrodes with each other or through an intermediate metal, such as boiler metal or electrode-holders or due to excessive corrosion and scale buildup across the electrode insulator to the boiler shell. Insulation on plugs shall be of mica or other insulation suitable for use with steam at the specified operating temperature and pressure. Insulating plugs shall be protected from mechanical injury and dust by a suitable enclosure, provided with a removable access plate to allow inspection of the insulating plugs and electrical connections thereto.

3.11.6 Electric switches. When used in level-sensing elements, electric switches shall be of a design which will permit adjustment of the cut-in and cut-out points, and their action shall be suitable for the particular application. The electrical capacity characteristics of the switches shall be suitable for the available power supply specified (see 6.2). The voltage shall not exceed 120 volts (V). Type I, class 2, style 4 level-sensing elements and types II and III feed-pump motor starters shall conform to UL 353. The listing or approval for listing under limit controls, group H of the UL Gas and Oil Equipment Directory, will be acceptable as evidence of compliance with UL 353.

3.12 Steam-flow sensing elements. Type I, class 3 and 4 steam-flow sensing elements shall be operated by the differences in pressure between two points in the flow from the boiler. The output movement or pressure from the element shall act on a relay- or pilot-mechanism used for controlling the application of auxiliary power in such a way that the specified performance shall be met. Wearing parts shall be designed for long-life, low-friction operation and shall be of corrosion-resistant materials. Springs shall be of phosphor bronze, carbon steel, or corrosion-resistant steel. Carbon steel springs shall be rendered corrosion-resistant. The ends of helical springs shall be closed and ground. Fluid passages shall be smooth and free of any tendency to become clogged.

3.13 Water-flow sensing elements. Type I, class 4 water-flow sensing elements shall modify the positioning of the feed water controlling valve to compensate for changes in water-supply flow. The effect of the water-flow element shall be applied to the pilot-mechanism used for controlling the application of auxiliary power in such a way that the specified performance shall be met. Wearing parts, springs, and fluid passages shall be as specified in 3.12.

3.14 Relay- or pilot-mechanism. The relay- or pilot-mechanism, when specified (see 1.2, 3.1.7, and 6.2), shall coordinate the effects of the level-sensing element, the steam-flow sensing element, and the water-flow sensing element of three-element controllers or the effects of the water-level sensing element and the steam-flow sensing element of two-element controllers into a single effect, or shall use the effect of the water-level sensing element alone for single-element controllers. The single effect, so obtained, shall control the application of auxiliary pneumatic, hydraulic, or electric power, as specified herein, in such a way that the performance specified shall be met. The relay- or pilot-mechanism shall operate to meet the performance requirements of 3.8 and shall not cause hunting, cycling, or fluttering of the controlling valve. Operating parts shall be suitably enclosed for protection from mechanical injury and contamination caused by ingestion of undesirable foreign

materials, and shall be designed for long-life and reliable performance under the anticipated environmental operating conditions.

3.14.1 Lock-in devices. When specified (see 6.2), relay- or pilot-operated controllers used in conjunction with a controlling valve type shall be equipped with a lock-in device which will automatically lock the valve in the then-existing position in case of auxiliary power failure. The lock-in device shall be equipped with an automatic or manual release, as specified (see 6.2), which will unlock the valve when power is restored.

3.14.2 Manual-automatic selector panel. When specified (see 6.2), relay- or pilot-operated controllers used in conjunction with a controlling valve shall be provided with a manual-automatic selector panel. A device for transferring the controller instantly from automatic to manual control and vice-versa, a control mechanism for adjusting the control pressure, and at least two flush-mounted gages to show pressures of the operating medium shall be mounted on the panel. The position of the transfer device shall be clearly indicated by suitable markings on the panel. The direction in which the control mechanism should be operated to raise or lower the water level shall be clearly indicated. The transfer device and operating mechanism shall be free of sharp projections easily caught by clothing, and shall be adequately designed or guarded such as to require a definitive action on the part of the operator and to minimize the dangers of inadvertent or accidental activation. When specified (see 6.2), the panel shall be supplied with an integral, battery-operated auxiliary lighting circuit, to enable the operator to adequately see all controls and gages in the event of a power outage resulting in a loss of normal operating space lighting and which shall automatically activate under such conditions.

3.15 Connecting tubing, linkages, and wiring. Unless otherwise specified (see 6.1 and 6.2), as to specific installation distances, the tubing, linkages, wiring, or other connecting elements used to connect the operating components shall be of suitable length for the boiler type and make.

3.15.1 Instrument and control piping. The materials used for instrument and control piping shall be in accordance with 3.11.1. Hydrostatic requirements shall be in accordance with 3.11.1.2, except that the operating pressure for the particular system shall be used, in lieu of the boiler design pressure, as the basis for requirements.

3.15.2 Mechanical linkages. Mechanical linkages shall operate easily and without lost motion, buckling, or other distortion. Bearing surfaces of joints shall be designed for low-friction operation.

3.15.3 Electrical wiring. Electrical wiring shall be in accordance with UL 353. The size of the conductors used shall be in accordance with NFPA 70 for the current characteristics specified. The types of conductors used shall be chosen in accordance with the temperature rises permitted by UL 353 and the expected heat of the insulation. Circuits shall not exceed either a two-wire nominal 120 V system with equipment ground conductor or a two-wire nominal 120 V system obtained by using an insulation transformer with one side grounded.

3.16 Operating liquids. Operating liquids, such as hydraulic oil or mercury, shall not react chemically with the materials with which they come into

contact in normal operation and shall have physical and chemical stability over the range of temperature and pressure conditions normally encountered in service.

3.17 Electrical components. Electrical components, when used, shall be in accordance with UL 353.

3.18 Fungus resistance. When specified (see 6.2), electrical components and circuit elements, including terminal and circuit connections, shall be coated with varnish conforming to MIL-V-173, except that:

a. Components and elements inherently inert to fungi or in hermetically sealed enclosures need not be coated
b. Current-carrying contact surfaces, such as relay contact points, shall not be coated

3.19 Lubrication. Means for lubricating shall be provided in accordance with the manufacturer's standard practice. Parts requiring lubrication shall be so located as to make the lubricating points easily visible and accessible. All parts requiring lubrication shall be properly lubricated before delivery.

3.20 Marking. The controlling valve body shall be marked in accordance with MSS SP 25. The controller shall be marked in accordance with UL 353 or FM requirements.

3.21 Workmanship.

3.21.1 Steel fabrication. The steel used in fabrication shall be free from kinks, sharp bends, and other conditions which would be deleterious to the finished product. Manufacturing processes shall not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes shall be done neatly and accurately. All bends shall be made by controlled means to ensure uniformity of size and shape.

3.21.2 Bolted connections. Boltholes shall be accurately punched or drilled and shall have the burrs removed. Washers or lockwashers shall be provided in accordance with good commercial practice, and all bolts, nuts, and screws shall be tight.

3.21.3 Riveted connections. Rivet holes shall be accurately punched or drilled and shall have the burrs removed. Rivets shall be driven with pressure tools and shall completely fill the holes. Rivet heads, when not countersunk or flattened, shall be of approved shape and of uniform size for the same diameter of rivet. Rivet heads shall be full, neatly made, concentric with the rivet holes, and in full contact with the surface of the member.

3.21.4 Welding. Welding procedures shall be in accordance with a nationally recognized welding code. The surface of parts to be welded shall be free from rust, scale, paint, grease, or other foreign matter. Welds shall be of sufficient size and shape to develop the full strength of the parts connected by the welds. Welds shall transmit stress without permanent deformation or failure when the parts connected by the weld are subjected to proof and service loadings.

3.21.5 Castings. All castings shall be sound and free from patching, misplaced coring, warping, or any other defect which reduces the casting's ability to perform its intended function.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Material inspection. The contractor is responsible for ensuring that supplies and materials are inspected for compliance with all the requirements specified herein and in applicable referenced documents.

4.1.3 Component and material inspection. Components and materials shall be inspected in accordance with all the requirements specified herein and in applicable referenced documents.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2.1)
b. Quality conformance inspection (see 4.2.2)

4.2.1 First article inspection. The first article inspection shall be performed on one complete controller when a first article is required (see 3.3 and 6.2). This inspection shall include the examination of 4.3 and the tests of 4.4. The first article may be either a first production item or a standard production item from the supplier's current inventory provided the item meets the requirements of the specification and is representative of the design, construction, and manufacturing technique applicable to the remaining items to be furnished under the contract.

4.2.2 Quality conformance inspection. The quality conformance inspection shall include the examination of 4.3, the tests of 4.4.2, and the packaging inspection of 4.5.

4.3 Examination. Each controller shall be examined for compliance with the requirements specified in section 3 of this specification. Any redesign or modification of the contractor's standard product to comply with specified requirements, or any necessary redesign or modification following failure to meet specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations and dimensional measurements. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

4.4 Tests.

4.4.1 Performance tests. The first article, when furnished, shall be completely assembled on a test boiler or other test set-up which can be used to properly simulate the specified boiler operating conditions and feed water pressure. The sample controller shall then be tested for proper operation in strict compliance with the provisions of 3.8 for the operating conditions specified. Failure to hold the specified water levels under the load and operating conditions specified, and other evidence of noncompliance or unsuitability shall be cause for rejection.

4.4.2 Hydrostatic tests. The first article, when furnished, and controlling valves, pressure-enclosing components, hydraulic and pneumatic control piping, fittings, and valves shall be subjected to hydrostatic tests in accordance with 3.10.1, 3.11.1.2, and 3.15.1, as applicable. Floats shall be subjected to an external pressure test in accordance with 3.11.2. The hydrostatic tests may be conducted on individual components or on assemblies. The test pressure shall be maintained for a sufficient length of time to permit a thorough inspection of all parts, joints, and connections. Any evidence of leakage or deformation shall be cause for rejection.

4.4.3 Component operating tests. The first article, when furnished, and all operating components such as controlling valves, actuating elements, pilot valves, switches, and other electrical components, shall be shop tested either as individual components or as systems, as necessary and practicable, to determine their operating ability and condition. Average or normal operating pressures shall be used and the ease and speed of operating shall be checked. Sluggishness of operating and failure to operate shall be cause for rejection.

4.5 Packaging for delivery inspection. The inspection of the preservation, packaging, packing, and marking shall be in accordance with the requirements of section 4 of MIL-B-3180. The inspection shall consist of the quality conformance inspection; and, when specified (see 6.2), a preproduction pack shall be furnished, within the timeframe required, for examination and tests.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing. Preservation, packaging, and packing shall be in accordance with the requirements of MIL-B-3180 with the level of preservation, packaging and the level of packing as specified (see 6.2).

5.2 Marking.

5.2.1 Military agencies. Shipments to military agencies shall be marked in accordance with MIL-STD-129.

5.2.2 Civil agencies. Shipments to civil agencies shall be marked in accordance with FED-STD-123.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The controllers specified herein are intended for use on stationary boilers in power plant or heating installations. The boiler type, model, and make should be specified if known, so that the manufacturer can provide connection elements of the exact length required. Exact desired installation distances and locations should not be specified (see 3.15), unless connection to existing boiler fittings is considered mandatory. Such location requirements may limit bidding because optimum manufacturer's instructions may or may not permit connection to existing fittings when changing from one type or manufacture of controller to another. The type and class of controller should be selected in accordance with the following:

a. Generally, type I level sensing elements should not be specified when the boiler pressure exceeds 250 psig (1724 kPa) for relay- or pilot-operated, single- or two-element installations, or when the controlling valve is larger than 3-inches (76.2 mm) pipe size, or when the pressure differential at the controlling valve (feed water pressure less boiler pressure) normally exceeds the following:

Nominal pipe size, inches (millimeters)	1/2 (12.7)	3/4 (19)	1 (25.4)	1-1/4 (31.8)	1-1/2 (38.1)	2 (50.8)	3 (76.2)
Normal pressure differential, psi (differential, kPa)	50 (345)	50 (345)	40 (276)	30 (207)	20 (138)	15 (103)	10 (69)

b. Types II and III level sensing elements should not be specified when the boiler pressure exceeds 250 psig (1724 kPa), unless this complies with the manufacturer's specifications.

c. Direct-operated controllers should not be used when any of the following conditions exist:

(1) Water supply pressure exceeds 900 psig (6205 kPa)
(2) Water supply pressure exceeds 600 psig (4136 kPa) and controller valve size is greater than 2-1/2 inches (63.5 mm)
(3) The pressure drop across the controller-valve normally exceeds 100 psi (689 kPa) and the controller valve size is larger than 4-inches (101.6 mm) pipe size

(4) The controller-valve size is larger than 5-inches (127 mm) pipe size
(5) The pressure differential at the controller valve normally exceeds 150 psig (1034 kPa)

d. Single-element controllers should not be specified when either of the following conditions exist:

(1) The weight of water in the boiler drum is less than 30 percent of the total weight of water in the boiler
(2) The boiler normally operates with frequent rapid load-swings greater than 10 percent per minute of normal rating

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification
b. Type, class, and style required (see 1.2)
c. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2)
d. When intended use is to be as part of a complete boiler automatic combustion control system (see 3.1)
e. Whether relay- or pilot-operated controllers shall be hydraulic, pneumatic, or electric (see 3.1.7 and 3.14)
f. When a first article inspection is required (see 3.3, 4.2.1, and 6.5)
g. Type, make, and model of boiler on which controller will be installed (if known) and operating conditions (see 3.6)
h. Limits for boiler water level control, if different (see 3.8)
i. Type of connection ends required (see 3.9.2)
j. Type of material for seal, if different (see 3.10.4)
k. Type of level-sensing element, if different (see 3.11)
l. When radiating bonnets are required on stuffing boxes for level measuring devices (see 3.11.4)
m. Whether brass rod or corrosion-resistant steel is required for electrodes on type III controllers (see 3.11.5)
n. Electrical supply characteristics available for electric level sensing elements (see 3.11.6)
o. When lock-in device is required for relay- or pilot-operated controllers and whether the release shall be automatic or manual (see 3.14.1)
p. When manual-automatic selector panel is required for relay- or pilot-operated controllers and whether the panel shall incorporate auxiliary lighting circuitry (see 3.14.2)
q. When installation distances for tubing, wiring, linkages, and other connecting elements are established (see 3.15)
r. When treatment for fungus is required (see 3.18)
s. When a preproduction pack is required and the time frame required for submission (see 4.6)
t. Level of preservation and level of packing required (see 5.1)

6.3 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423),

incorporated into the contract. When the provisions of DOD FAR Supplement, Part 27, Sub-Part 227.405-70 are invoked and the DD Form 1423 is not used, the data should be delivered by the contractor in accordance with the contract or purchase order requirements.

6.4 Part or Identifying Numbers (PINs). The specification number, class, type, and size are combined to form PINs for automatic boiler feed water controllers covered by this document (see 1.2). PINs for the controllers are established as follows:

```
PIN designation ----------- M  -   2864  -  X  -  XX
                            *       *       *     *
Inch-Pound Doc.-------------*       *       *     *
Specification Number----------------*       *     *
Type letter (see 6.4.1)---------------------*     *
Class and style number (see 6.4.2)----------------*
```

6.4.1 Type letter. The type of the controller is identified by a single-digit letter (see table I).

TABLE I. Code letter to type.

Type I	A
Type II	B
Type III	C

6.4.2 Class and style number. The class and style of the controller is identified by a two-digit number (see table II).

TABLE II. Code number to class and style.

	Style 1	Style 2	Style 3	Style 4
Class 1	01	02	-	-
Class 2	03	04	05	06
Class 3	07	08	09	-
Class 4	10	11	12	-

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard

production item from the contractor's current inventory (see 3.2), and the number of items to be tested as specified in 4.2.1. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.6 Subject term (key word) listing.

Feed pump motor regulation
Feed water flow control
Liquid level

6.7 Supersession data. This specification replaces military specification MIL-R-18115D dated 28 October 1988.

6.8 Classification cross reference. Classifications used in this specification (see 1.2) are identical to those found in the superseded military specification MIL-R-18115D.

MILITARY INTERESTS:

Military Coordinating Activity

Navy - YD1

Custodians

Army - CE
Air Force - 99

Review Activities

Army - ME
Navy - SH, CG
Air Force - 84
DLA - CS

CIVIL AGENCY COORDINATING ACTIVITIES:

GSA - FSS

PREPARING ACTIVITY:

Navy - YD1

(Project 4410-0089)