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MILITARY SPECIFICATION

BOILERS, STEAM AND HOT WATER, HIGH AND LOW PRESSURE: FIRETUBE, PACKAGED TYPE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers modified scotch type, horizontal firetube, shop-assembled boiler-burner units equipped with all appurtenances and controls necessary to form complete, self-contained, automatically sequenced, packaged, steam and hot water generators.

1.2 Classification.

1.2.1 Boiler types and classes. Boilers shall be of the following types and classes, as specified (see 6.2.1).

Type I - Low pressure steam generator (15 pounds per square inch gage (psig) maximum operating pressure)).
Type II - High pressure steam generators (100, 125, 150, 200, and 250 psig design pressures, as specified).
Type III - Low pressure hot water generators (30, 60, 75, 100, and 160 psig design pressures, as specified; temperatures to 250° Fahrenheit (F).

Class 1 - Standard duty for permanent individual buildings, central heating, process heating, and power plants.
Class 2 - Special duty for semi-permanent installations in tactical areas of operation.

1.2.2 Boiler groups. For the purpose of defining requirements, boilers covered by this specification are classified under the following groups based on the output in British thermal units per hour (Btu/h) (6.2.1). The maximum boiler capacity of 3.8i shall be as specified (6.2.1).

Group 1 - 400,000 to 2,500,000 Btu/h.
Group 2 - 2,500,001 to 5,000,000 Btu/h.
Group 3 - 5,000,001 to 8,000,000 Btu/h.
Group 4 - 8,000,001 to 14,000,000 Btu/h.
Group 5 - 14,000,001 Btu/h and over.

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, Port Hueneme, CA 93043, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4410-4520

1.2.3 Burner types and control systems. Burners furnished on the boilers shall be of the following types and control systems as specified (see 3.13, 6.1.2 and 6.2).

Type LO - Light-oil fired (grade 2, 4, or J-5 as specified).
Type HO - Heavy-oil fired (grade 5 (light), grade 5 (heavy), grade 6, or Navy special, as specified).
Type G - Gas-fired (natural, manufactured, mixed, or liquefied petroleum gas, as specified).
Type GLO - Combination gas-fired and light-oil fired (type of gas and grade of oil as specified).
Type GHO - Combination gas-fired and heavy-oil fired (type of gas and grade of oil as specified).

Programming control system AR - Automatic, recycling.
Programming control system AN - Automatic, nonrecycling.

Combustion control system (see 6.1.1e):
On-off (group 1 only)
High-low-off
Modulating-simple positioning
Parallel positioning with air/fuel ratio control

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified (6.2.1), the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

VV-F-800 - Fuel Oil, Diesel.

MILITARY

MIL-V-173 - Varnish, Moisture- and Fungus-Resistant, (for Treatment of Communications, Electronic and Associated Equipment).
MIL-F-859 - Fuel Oil, Burner.
MIL-B-3180 - Boilers and Related Equipment, Packaging of.
MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-T-13867 - Treatment, Moisture and Fungus Resistant for Fire Control Electrical and Electronic Instruments and Equipment.
MIL-P-17749 - Pumping Units, Condensate, Heating; And Pumping Units, Vacuum, Heating.

MIL-R-18115 - Regulators, Boiler-Feed-Water, Automatic.
MIL-V-18406 - Valves: Blowoff, Boiler.
MIL-B-18796 - Burners, Single; Oil, Gas, and Gas-Oil Combination, (400,000 Btu's Per Hour and Over Input Capacity).
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating, Solvent Containing.

STANDARDS

MILITARY

MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics Measurements of.

(Copy of specifications, standards, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer).

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the Current DODISS and the supplement thereto, if applicable.

AMERICAN BOILER MANUFACTURERS ASSOCIATION (ABMA)

Packaged Firetube Boiler Ratings.
Standard Test Procedures for Packaged Firetube Boilers.
Lexicon Steam Generating Equipment.
Measurement of Sound From Boiler Units, Bottom Supported Shop or Field Erected.

(Application for copies should be addressed to the American Boiler Manufacturers Association, 950 North Glebe Road, Suite 160, Arlington, VA 22203.)

AMERICAN SOCEITY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code.
Section I - Power Boilers.
Section IV - Heating Boilers.
Section VIII - Pressure Vessels.
ASME Performance Test Code.
PTC 4.1 - Steam Generating Units.

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C64 - Refractories for Incinerators and Boilers, Specification for.
D396 - Fuel Oils.
D2156 - Smoke Density in Flue Gases from Burning Distillate Fuels, Test for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ICS-1 - General Standards for Industrial Controls and Systems.
ICS-2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
ICS-6 - Enclosures for Industrial Control Systems.
MG-1 - Standards for Motors and Generators.

(Application for copies should be addressed to the National Electrical Manufacturers Association, 2101 L Street N.W., Washington, DC 20037.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

No. 70 - National Electrical Code.

(Application for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.)

UNDERWRITERS' LABORATORIES, INC. (UL)

UL 353 - Limit Controls.
UL 726 - Standard for Oil-Fired Boilers.
UL 795 - Commerical-Industrial Gas-Heating Equipment.
Gas and Oil Equipment List for Gas, Gas-Oil and Oil Burners.

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

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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 shall take precedence.

3. REQUIREMENTS

3.1 Description. The steam generators and hot water generators shall be horizontal firetube, multi-pass, modified scotch-type of the dry or wet back type, packaged units mounted on a skid-type structural steel base. Each

generator shall be equipped with a complete burner and fuel system, a forced or induced draft fan, an automatic electronic control system complete with combustion and flame safeguard controls, firing sequence programmer, safety interlocks, limit controls, and central control panel, and such trim and appurtenances as are peculiar to steam units and water units as specified herein. All units shall be factory-wired and assembled except for such readily installed appurtenances as safety valves, water columns, pressure gages, and oil heater piping. These items may be removed prior to shipment to prevent damage, reduce cubage, or meet shipping dimension restrictions. In other respects, the units shall be complete and ready for operation when connected to water, fuel, and electrical supplies. Nomenclature of ABMA Lexicon, Steam Equipment shall apply (see 6.5).

3.2 First article. When specified (6.2.1), the contractor shall furnish a generator for first article inspection and approval (see 4.2.1 and 6.4).

3.3 Standard commercial product. The generators 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 generators 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.

3.4 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 are allowed under this specification unless otherwise specified.

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 insure interchangeability of component parts, assemblies, accessories, and spare parts.

3.6 Safety standards. Steam generators and hot water generators, and any supplementary control devices, safety interlocks, or limit controls required under this specification, shall meet the requirements of the following standards:

a.	Oil-fired units	- UL 726
b.	Gas-fired units	- UL 795
c.	Combination gas and oil-fired units	- UL 726 and UL 795
d.	All units	- ASME Boiler and Pressure Vessel Code

3.7 Standards compliance. Prior to approval of the first article, if one is specified, or prior to approval of the first shipment by the contractor, if a first article is not specified, the contractor shall submit to the contracting officer, or his authorized representative, satisfactory evidence that the generators be proposed to furnish under this specification meet the applicable requirements of 3.6. Acceptable evidence of meeting the applicable requirements of 3.6 shall be the UL certification symbol or label, or a listing in the UL Gas and Oil Equipment list and an ASME stamp symbol of the applicable section of the ASME Boiler or Pressure Vessel Code, or a certified test report from a recognized independent testing laboratory indicating that the generator has been tested and conforms to the applicable requirements of 3.6. Such evidence shall be acceptable to the contracting officer (see 6.3).

3.8 Design. The high pressure steam generators shall be designed in accordance with the requirements of Section I of the ASME Boiler and Pressure Vessel Code applicable to firetube boilers. Low pressure steam generators and hot water generators shall be designed in accordance with Section IV of the ASME code. The generators shall be also designed with any additional requirements specified herein. Boilers shall be of the horizontal fire-tube design for the following conditions as specified (6.2.1).

a. Generator design pressure psig (see 1.2.1 and 3.8.1).
b. Operating pressure psig at the shell or hot water outlet, as applicable.
c. Steam temperature °F.
d. Hot water temperature if other than 200 °F.
e. Feedwater temperature °F.
f. Temperature differental for hot water generators between generator discharge and system return °F.
g. Maximum and minimum anticipated ambient air temperatures °F.
h. Generator site elevation (feet).
i. Maximum continous output in Btu/h.

3.8.1 Design pressure. The design pressures specified herein shall be the maximum allowable working pressure for the boilers as determined by employing the stress values, design rules, and dimensions specified in the applicable section of the ASME Boiler and Pressure Vessel Code. The design pressure for low pressure steam generators shall be 30 psig. The design pressures for high pressure steam generators and low pressure hot water generators shall be as specified in 1.2.1.

3.8.2 Design for thermal shock. Hot water generators shall be designed to withstand water temperature differentials associated with single zone and multi-zone hot water heating systems without danger of damage from stresses induced by thermal shock. The system shall include an interlock which prevents combustion controls (except on-off) from moving from low fire to high fire on light-off until the boiler water reaches a preset temperature. Any of the following methods of controlling thermal shock shall be employed unless

the contract documents limit the methods to one or two of the specified methods (6.2.1).

a. Natural internal circulation: Hot water generators designed for natural internal circulation shall be equipped with supply and return connections sized and located in accordance with the manufacturer's standard practice to provide sufficient natural thermal circulation for minimizing the effects of thermal shock. The design of these units shall have proven satisfactory for the intended purpose by extended use in forced circulation, hot water heating systems having thermal gradients at least as severe as those anticipated under the specified operating conditions.

b. Controlled internal circulation: Hot water generators designed for controlled internal circulation shall be equipped with supply and return connections located on the top centerline of the boiler. The return connection shall be so located and equipped that the return water on entering the shell will be mixed for tempering purposes with the hottest water in the boiler. The inlet nozzle or outlet nozzle, or both, shall be so designed or equipped, that a positive flow of tempered water will then be induced in an essentially horizontal direction along the top of the shell away from the rear tube sheet thus developing a controlled circulatory pattern to assist normal thermal circulation.

c. External control: External control shall consist of an automatic valve assembly mounted on the return connection which shall cause return water to be by-passed from the inlet piping on the boiler to the system supply piping whenever the temperature of the return water falls below a preset temperature. The by-pass system shall automatically reestablish flow through the boiler return inlet when the boiler has recovered sufficiently to restore the predetermined temperature differential.

3.9 Performance. Unless otherwise specified (see 6.1.2 and 6.2.1) performance requirements including furnace heat release ratio, shall be based on the following fuel characteristics:

a. Fuel oil (percent by weight, as fired)

Ultimate analysis:

H_2	10.33
C	87.87
O_2	0.25
N_2	0.14
S	1.16
Ash	0.25

Higher heating value - - - - 18,400 Btu/lb

b. Natural gas (percent by volume as fired).

Ultimate analysis:

Methane- - - - - - - -	90.0
Ethane - - - - - - - -	5.0
Nitrogen - - - - - - -	5.0
Ash - - - - - - - - -	Nil
Moisture - - - - - - -	0.01

Higher heating value - - -	1,075 Btu/ft^3
Higher heating value - - -	21,824 Btu/lb

The gas supply pressure at the site upstream from the service pressure regulator shall be as specified in the contract (6.2.1). When generators are acquired for stock and the conditions at the site are not known in advance, a gas pressure at the inlet to the gas piping of 2 psig shall be assumed for design purposes.

3.9.1 Boiler output conditions. The operating pressure for steam generators shall be as specified in 3.8 and shall be the pressure at which the boiler operating controls shall be set by the manufacturer prior to shipment. Unless otherwise specified (6.2.1), the operating temperature for type III hot water generators at which the temperature-sensing operating controls shall be set by the manufacturer prior to shipment shall be 200° F. For steam generators the moisture content of saturated steam, produced from boiler water having a total dissolved solids concentration of 3500 parts per million and a total alkalinity not in excess of 440 parts per million, shall not exceed one percent during a change within any 3-minute period from 50 percent to 100 percent of rated capacity as well as during continuous operation at full rated capacity.

3.9.2 Capacity. The maximum continuous thermal output of steam generators and hot water generators, expressed in Btu/h at the outlet connection, shall be as specified in 3.8i and shall be based on the conditions as defined in 3.8, 3.9, 3.9.1, and as may be amplified or modified under provisions of the contract documents. If the acquisition documentation should specify capacity for steam generators in terms of boiler horsepower (hp), the thermal output shall be computed on the basis of 33,475, Btu/h per boiler hp or 970 Btu/h per pound of steam at an operating pressure of 14.7 pounds per square inch absolute with a feedwater temperature of 212°F (from and at 212°F). In either case, the specified capacity shall be attained within the limits for heat release and heat transfer specified in 3.9.4 and table I (see 6.3).

3.9.3 Efficiency.

3.9.3.1 Combustion efficiency. In accordance with the ABMA Standard Test Procedures for Packaged Firetube Boilers, the combustion efficiency, as determined by flue gas analysis, for carbon dioxide, carbon monoxide, and oxygen shall be as specified in table II and shall be not less than the average of the three rated loads of table II. When fired with fuels specified herein, the generator shall not exceed the smoke density readings listed in table II when measured in accordance with ASTM D2156 (Shell-Bacharach) of the values except for short periods not to exceed 3 minutes. When specified (6.2.1),

the generators shall be designed to burn the fuels fired herein, so that the particulate, nitrogen oxide, and sulfur dioxide emissions as specified (see 6.1.1.i and 6.2.1) shall not exceed the limits when determined in accordance with 4.4.4. Both stable firing and combustion efficiency shall be maintained over the entire firing range required by table II.

3.9.3.2 Fuel-to-steam efficiency. In accordance with the ABMA Standard Test Procedure for Packaged Firetube Boilers or ASME PTC 4.1 using the input/output method, the fuel-to-steam efficiency for Type I and II generators shall be a minimum of 80 percent when fired at maximum rated output established in accordance with the provisions of 3.9, 3.9.1, and 3.9.2.

3.9.3.3 Fuel-to-hot water efficiency. In accordance with the ABMA Standard Test Procedure for Packaged Firetube Boilers or ASME PTC 4.1, the fuel-to-hot water efficiency for type III generators shall be a minimum of 80 percent when fired at maximum rated output established in accordance with the provisions of 3.9, 3.9.1, 3.9.2.

3.9.4 Thermal input and output. When the units are operating at the maximum rated output established in accordance with the provision of 3.9, 3.9.1, and 3.9.2, the thermal input to the furnace shall be such that none of the rates specified in table I will be exceeded.

3.9.4.1 Surface heat input rate. When the generator is operating at maximum output, the heat input rates Btu/h/ft^2 to the furnace shall not exceed the values specified in table I. The effective radiant heating surface shall be calculated in accordance with 6.5.

3.9.4.2 Volume heat input rate. The volume heat input rate in Btu/h/ft^3 shall not exceed the values specified in table I. The furnace volume shall be calculated in accordance with 6.5.

3.9.4.3 Heat transfer rate. The heat transfer rate shall be determined on the basis of the furnace input Btu/h times the fuel-to-steam or fuel-to-hot water efficiency divided by the total generator heating surface (ft^2) (see 6.5) and shall not exceed the values in table I.

3.9.5 Pressure and temperature regulation. The control systems shall maintain the steam pressure or water temperature, as applicable, at the outlet connection within the following tolerance limits expressed as a percent of the set point values of the operating control:

a.	On-off	- ± 6 percent
b.	High-low-off	- ± 5 percent
c.	Modulating	- ± 3 percent
d.	Parallel positioning	- ± 3 percent
e.	Parallel metering	- ± 3 percent

The specified tolerances shall apply to any load which, within a 1-minute period, swings from a steady state condition to an increase (or decrease) in load equal to a maximum of 10 percent of the full rated capacity of the unit.

Regulation tolerances shall apply to any steady-state condition within the specified burner turndown ratio.

3.9.6 Exit temperature at stack. When an economizer is specified herein the exit temperature at the stack shall not exceed 125°F above the dew point temperature of the steam or above the exit temperature of the hot water.

3.9.7 Noise. When specified (6.2.1), an assessment of the potential hazard of noise exposure on-site of the installation shall be performed by the contractor in accordance with ABMA, the Measurement of Sound from Boiler Units, Bottom Supported, Shop or Field Erected, requirements. Equipment which produce sound pressure levels of 85 dBA or greater shall be labeled with hazardous noise warning decal 8 inches by 10-1/2 inches. Upon determination of the hazardous noise level 85 dBA or greater, the contractor shall notify the contracting officer or his authorized representative. The Contracting Officer shall furnish four decals, NSN 0105-00-212-6020 for each generator. The contractor shall afix one decal on each side of the generator.

3.10 Construction. The steam generators and hot water generators shall be constructed in accordance with the applicable section of the ASME Boiler and Pressure Code for the design pressure specified in 3.8.

3.10.1 Shell. The boiler shell shall be a horizontal, cylindrical, steel pressure vessel of sufficient size to meet the performance requirements of this specification. The boiler shell shall be equipped with all necessary connections including outlet nozzles, return connections, and connections for pressure relief valves, water level controls, and other required trim (see 3.11). Manholes and handholes shall be provided in accordance with the ASME Boiler and Pressure Vessel Code.

3.10.2 Furnace. The furnace shall be a fusion-welded, plain or corrugated, cylindrical steel chamber welded to the tube sheets. Heat distribution shall be uniform under all firing conditions with no flame impingement (see 6.5) on any refractory-covered or water-backed surface. The furnace shall be located within the shell so that it is completely surrounded by water at all times and shall not interfere with the natural circulation of water within the shell. The furnace shall be positioned at a sufficient distance from the shell so that the shell will not be subjected to unequal thermal stresses during start up or any other condition of firing.

3.10.3 Firetubes. Firetubes shall be of steel and shall be of the seamless or resistance-welded type. The tubes shall be fitted into accurately sized holes in the tube sheets and tightly rolled in place. The alinement shall be such as to prevent noticeable deformation or undue stress when the boiler is put in service. The tube and tube sheet assembly shall be water- and gas-tight. The tubes shall be so arranged as not to interfere with the natural circulation of water in the shell or to prevent the cleaning and flushing of all water-sides. All tubes shall be readily removable from one end of the boiler, either the front or the rear. Spinners, turbulators and other such devices shall not be permitted in the firetubes.

3.10.4 Refractories. Refractories shall, in accordance with ASTM C-64, withstand the temperature existing under maximum load conditions. The refractories shall be formed or cast in sections of such size as to be easily replaceable through existing openings. The refractory sections shall be designed and secured in position in such a manner as to withstand the vibration and shocks occurring during shipment, and withstand the burner combustion pulsations. Refractories used for the burner combustion ring and rear or target baffle shall have a pyrometric cone equivalent of not less than 33. Refractory shall be provided for all doors and end covers exposed to temperatures of 600°F. and over.

3.10.5 Doors, covers, and ports. Flue doors and cleanout openings shall be furnished to provide full access to all fireside surfaces for inspection, cleaning, and repair. Doors weighing over 50 pounds shall be hinged or davited. When specified (6.2.1), a spring-loaded relief door or other approved explosion relief device shall be furnished to relieve excessive pressures in the combustion spaces. The explosion relief door or device shall be located at the end of the first gas pass or second gas pass in accordance with the contractors design criteria. The door shall provide an opening area of not less than 60 square inches, and shall have sufficient insulation on the fireside to prevent the heat from damaging the operating mechanism or otherwise impairing the operation of the door or device. Heat resisting observation ports shall be furnished to provide full observation of combustion conditions. All doors, end covers, and observation ports shall be gastight under all conditions of firing. End covers shall be readily removable without impairment to the refractory and without requiring the use of additional refractory binders, cements, or sealing materials. The rear end cover and doors of dry-back boilers shall be adequately reinforced to limit deflection due to thermal stresses and burner combustion pulsations to a value which will prevent progressive cracking and loosening of the refractory.

3.10.6 Insulation. All exterior surfaces of the unit, except the doors, end covers, handholes, manholes, and vents shall be covered where practical with at least 2 inches of fibrous glass, mineral wool, thermal block, or equivalent insulation having a heat transfer coefficient at a mean temperature of 300°F not exceeding 0.45 Btu's per hour per square foot per inch thickness per degree Fahrenheit temperature difference. The use of asbestos or asbestos-containing insulation shall not be allowed. The insulation shall be so formed and secured in place as to prevent sagging or displacement during shipment and operation.

3.10.7 Outer casing. The insulation shall be covered with a sheet steel jacket not less than 0.0289 inch thick (U.S. revised standard gage No. 22). The average surface temperature of the casing shall not exceed 130°F in an ambient temperature of 70°F and a surface wind velocity of 2 feet per second while the boiler is operating at full capacity.

3.10.8 Base. The boiler shall be mounted on steel saddles or equivalent steel supports fastened securely to a structural steel base designed and constructed to make a complete self-contained unit that will require only a flat surface, capable of supporting the weight of the generating unit and water, for a foundation.

3.10.9 Lifting attachments. Suitable lifting attachments and tiedown devices shall be furnished in accordance with the manufacturer's standard practice except as specified herein. The attachments and tiedown devices shall have eyes not less than 3 inches in inside diameters, and plates to withstand any handling conditions encountered. The tiedown devices shall be located at each corner of the boiler. Adequate tiedown devices may also be used for lifting purposes. Each attachment or tiedown device shall be of sufficient capacity to carry the total weight.

3.11 Trim. Each steam generator and hot water generator shall be fully equipped with the trim required under the applicable section of the ASME Boiler and Pressure Vessel Code plus the additional appurtenances specified herein. When disassembly is required for shipping clearance and prevention of damage during shipment such trim and appurtenances may be field installed. The generator steam and hot water trim, valves, connecting piping, and fittings shall be suitable for the design pressure and temperature as specified herein. The trim and appurtenaces shall include but not necessarily be limited to the following:

a. A pressure gage with a minimum diameter of 6 inches having a graduated range that will result in the normal pressure indication being within middle range of the scale. Pressure gages for high pressure steam units shall include a syphon, gage cock, and test connection, and shall be mounted on generator shell.
b. An ASME rated safety valve(s) for steam units as required by ASME Boiler and Pressure Vessel Code.
c. An ASME rated safety-relief valve for hot water units as required by ASME Boiler and Pressure Vessel Code.
d. Low pressure and high pressure steam generators shall be equipped with a water column complete with sight glass, try cock, gage cocks, and blowdown valves. The try cock and valves located more than 6 feet above floor level shall be equipped with levers, chain lengths, and handles for floor level operation. Drain line piping for water column and gage glass shall terminate not more than 2 feet above operating floor with a manual valve.
e. For steam generators two water cut-out switches of the float or electrode actuated type. One switch shall be primary having automatic reset on low water and sounding an alarm on high water. The secondary switch shall have a manual reset and shall activate a red indicating light and sound a alarm on low water. The switches may be integral with or separate from the feedwater regulator (see 3.11.1).
f. For hot water generators, one low water level cut-out switch shall be provided. The switch may be integral with or separate from the feedwater regulator, (see 3.11.1.3) and require a manual reset, activate a red indicating light, and sound an alarm.
g. Excessive steam pressure limit switch or hot water temperature limit switch, each to be supplemental to and separate from the operating control. The limit switch may recycle on control sequence AR shall cause a nonrecycling safety shutdown on control sequence AN and require a manual reset and activate a red indicating light when connected to the burner limit circuit of MIL-B-18796.

h. Low water flow interlock for high temperature water generators rated above 15 psig or 200°F whichever is greater. Low water flow shall require a manual reset and shall activate a red indicating light, and sound an alarm.
i. Both low pressure steam units and hot water units shall be equipped with a generator drain valve sized in accordance with the ASME Code.
j. High pressure steam units shall be equipped with one slow-opening and one quick-opening blowoff valve or a unit-tandem blowoff valve. Blowoff valves shall meet the requirements of MIL-V-18406.
k. High and low pressure steam units 150 hp and greater shall be equipped for continuous blowdown with internal piping and stainless steel disc and seats. The valve shall incorporate means to enable valve opening to be set as desired.
l. Low water level fuel cutout bypass momentary push button station. The push button station is to be located adjacent to the water column and auxiliary low water cutout drain line piping with manual valves. The push button station shall provide for uninterrupted generator operation for all fuels during either water column or low water level fuel cutout chamber blowdown.
m. A feedwater thermometer and well with a scale equivalent to 1.5 times the saturation temperature of the steam, or outlet temperature of the hot water generator.
n. An outlet thermometer for hot water generator with a scale equivalent to 1.5 times the outlet water temperature.
o. Air vent valve with screwed connection and stainless steel disk and seats to vent entrapped air from the generator.
p. Main steam "non return" valve of the angle "Y" pattern, stop check type with flanged connections. Valve shall be sized on the basis of the maximum steam generating capacity, taking into consideration flow characteristics and pressure drop at the varying flow conditions of the operating range when testing the generator and shall not be less than the generator steam outlet.
q. A chemical feed connection with connected integral distributing pipe shall be provided.
r. A steam main with a calorimeter connection.
s. When specified (6.2.1), provide connection for remote sensing of steam pressure, steam flow, air flow, water and/or fuel temperatures.
t. When specified (6.2.1), recorder shall be furnished to indicate and record conditions such as steam flow, air flow, steam pressure, steam, and water temperature as specified (6.2.1). Unless otherwise specified (6.2.1), the recorders shall be mounted on the control panel.

3.11.1 Feedwater regulator. Regulators shall be mounted on, or cross-connected to, the water column. The feedwater piping for high pressure steam units shall include a stop-check valve or a separate check valve and gate valve. The regulators may include as an integral part the low water cutout. The feedwater regulators shall conform to UL353.

3.11.1.1 Primary. Each steam generator shall be equipped with a primary feedwater regulator of the type III (electrode-actuated) or type II (float actuated type) in accordance with MIL-R-18115.

3.11.1.2 Secondary. Each steam generator shall be equipped with a secondary feedwater regulator of the type II (float-actuated type) or type III (electrode-actuated guarded ring type) conforming to MIL-R-18115.

3.11.1.3 Hot water generator. Each hot water generator shall be equipped with one feedwater regulator of the type II (float-actuated type) conforming to MIL-R-18115.

3.11.2 Injector. When specified (6.2.1), high pressure steam generators having an operating pressure of 50 psig or more shall be equipped with a steam-operated feedwater injector in addition to other feedwater system components specified herein. The injector shall be complete with all necessary steam and water valves and shall be connected to the boiler within view of the water column.

3.11.3 Hot water coils. When specified (6.2.1), boilers shall be equipped with internal hot water coils to serve as instantaneous heaters for service water. The coils shall be seamless drawn copper not less than 3/4 inch in outside diameter. The coils shall terminate in threaded inlet and outlet connections on the exterior of the boiler, and shall be designed for the specified temperature rise and maximum draw rate (6.2.1). Unless otherwise specified (6.2.1), the pressure drop through the coil at the maximum temperature and draw rate shall not exceed 5 psig.

3.12. Control systems. Generator control systems shall conform to MIL-B-18796 and shall at least meet the applicable requirements of UL-726 and UL-795. Generators shall be furnished with the following control systems:

a. Programming control system to provide the required control sequence specified in 1.2.3 in accordance with MIL-B-18796. The programming control system shall include electronic flame-failure control, repetitive self-checking circuit, safety interlocks, and limit switches. The programming control system shall govern the prefiring, light-off, and shutdown cycle.
b. Combustion control system specified in 1.2.3 conforming to MIL-B-18796 shall automatically regulate the firing cycle in accordance with the load demand.

Unless otherwise specified (6.2.1), the combustion control system shall be electrically, pneumatically, or hydraulically operated. On type GLO and type GHO combination burners, all controls shall be interlocked with manual fuel changeover switch to prevent firing more than one fuel at a time.

3.13 Burners and fuel systems. Generators shall be furnished with factory installed burners, ignition systems, flame safeguards, and associated fuel systems in accordance with the requirements and options of MIL-B-18796. The burners and fuel systems shall be designed for the fuel systems specified in 1.2.3. The fuel supply temperature shall be as specified (6.2.1).

3.13.1 Oil burners. Oil burners shall be of the types required by MIL-B-18796.

3.13.2 Gas-fired units. Gas-fired units shall have power burners of the partial premix or of the postmix type conforming to MIL-B-18796.

3.13.3 Combination gas- and oil-fired units. A combination burner shall consist of an oil burner and a gas burner each conforming to the requirements of MIL-B-18796 for separate oil and gas burners. The two burners shall be constructed as an integral combination unit requiring the firing of each fuel separately.

3.13.4 Fuel oil pump and strainers. Unless otherwise specified (6.2.1), boilers shall be furnished with a fuel oil pump and strainers conforming to the requirements of MIL-B-18796.

3.13.5 Fuel oil heaters. Unless otherwise specified (6.2.1), boilers with type HO and type GHO burners shall be furnished with fuel oil heaters conforming to the requirements of MIL-B-18796.

3.14 Draft fans. The draft fans shall conform to the requirements of MIL-B-18796. The draft fan shall be for a pressurized or balanced draft system, as specified (6.2.1).

3.15 Control panel. The controls, including operating switches, indicating lights, gages, alarms, motor starters, fuses, and circuit elements of control systems, shall be mounted on a single control panel or cabinet insofar as practicable in order to centralize the control functions conforming to MIL-B-18796. Burner and generator controls shall be located in the control panel mounted at the side of the generator (right or left side when facing generator), for wall mounting, or for remote mounting in a free-standing panel as specified (6.2.1). When a free-standing control panel is to be furnished construction details covering cabinet and wiring for remote starting location, mounted controls, and instruments shall be as specified (see 6.2.1 and 6.3).

3.15.1 Annunciator for the generators. When specified (6.2.1), for Group 4 and Group 5 units an annunciator shall be provided for the generators in accordance with MIL-B-18796. Unless otherwise specified (6.2.1), the annunciator may either be a separate item, or an integral part of the control panel or burner control system.

3.15.2 Smoke density indicator and transmitter. When specified (see 6.1.1(h) and 6.2.1), an electronic opacity monitoring device with strip chart recorder and transmitter for stack mounting shall be provided to detect, indicate, alarm, and record visible emissions from the stack in accordance with MIL-B-18796.

3.16 Economizer. When specified (6.2.1), a separately packaged economizer shall be furnished. The economizer shall be complete with prefabricated interconnecting breeching for attachment to the generator flue outlet and to the feed piping between the economizer and the boiler drum and shall require minimum field assembly. The economizer shall be equipped with feedwater heaters and appropriate controls required to preclude condensation of the flue gases. Valving shall be provided to allow bypass of the feedwater around the economizer. The economizer shall be designed and constructed in accordance

with ASME Boiler and Pressure Vessel Code, Section I. Materials used in construction shall withstand the temperatures and pressures prevailing under maximum load conditions. Soot blower(s) shall be provided on economizers furnished with type HO and type GHO generators as specified in 3.16.1. On economizers furnished for type LO, type G, and type GLO generators, soot blower bearings and wall-boxes shall be provided to permit future installation of soot blowers.

3.16.1 Soot blowers. Soot blowers furnished with economizers shall be steam operated, valve-in-head type and shall be furnished complete with wall sleeves, clamps, hangers, supports, operating chains and other appurtenances required for a complete installation. The blower elements shall be so arranged that all parts of the heating surfaces shall be cleaned of any soot deposits when rotated by manual or automatic means. Elements shall be of such length, diameter, and total nozzle area that for the operating pressure involved there will be no significant difference in the cleaning effect between the nozzle nearest the inlet and those farthest from the inlet of the element. Soot blower piping shall include a valve chain operated from the floor, in addition to an auxiliary steam-stop valve, and drain connection. Soot blowers shall be fitted with scavenging air ports and shall be connected by tubing to the draft fan in a manner to provide sufficient air for continuous scavenging of the blowers while the boiler is firing during periods when soot blowers are not operated for cleaning purposes.

3.17 Stack. When specified (6.2.1), stack sections, stack supports, umbrella collar and cap, and flue transition piece (if required in 3.18), shall be provided. Unless otherwise specified (6.2.1), the stack shall be 20 feet in height when assembled on the boiler and measured from the ground line. Stack sections shall be sheet steel having a thickness of not less than 0.0972 inch. A 0.3125-inch diameter hole shall be provided in the stack not greater than 6 inches from the furnace flue outlet for sampling of the exit gases.

3.18 Transition piece. When specified (6.2.1), a transition piece or junction piece shall be furnished to permit adapting from the boiler outlet to stacks or breeching. Transition pieces shall be designed for vertical or horizontal discharge as specified (6.2.1). The transition piece for vertical discharge shall be capable of carrying the full weight of the stack.

3.19 Condensate return system. When specified (6.2.1), a condensate return system shall be furnished with each steam unit. The system shall conform to type I of MIL-P-17749 and shall be sized to deliver not less than twice the total feedwater required at maximum rated output of the unit. The capacity of the condensate receiver shall be not less than one-fifth the volume of water converted to steam per hour.

3.20 Electrical wiring and equipment.

3.20.1 Electric motors. Electric motors for the driven auxiliaries shall be constructed and rated in accordance with the applicable provisions of NEMA MG-1. Motors shall be general purpose, continuous duty, ball-bearing, induction motors. The motors shall be designed for operation on a power supply

having the specified characteristics (6.2.1). Unless otherwise specified (6.2.1), motors shall be furnished with dripproof enclosures and sealed or encapsulated windings.

3.20.2 Motor starters. Unless otherwise specified (6.2.1), motors less than 15 hp shall be provided with magnetic across-the-line starters with overload and undervoltage protection and manual-off-automatic control stations. Motors over 15 hp shall have reduced voltage starting with overload and undervoltage protection and manual-off-automatic control stations. Magnetic starters shall conform to the applicable requirements of NEMA ICS-1, ICS-2, and ICS-6, and shall have NEMA type 12 enclosures.

3.20.3 Wiring and safety devices. All electrical wiring and circuit safety devices shall conform to NFPA No. 70. All control circuits shall be two wire, one side grounded, not to exceed nominal 120 volts, and be protected with suitable fuses, or circuit breakers. All safety interlocks and limit switches shall be wired in the hot side of the burner limit control circuit and not in any external circuits such as pilot or fuel valve circuits.

3.21 Fungus resistance. When specified (6.2.1), electrical components and circuit elements, including terminal and circuit connections, shall be treated for moisture and fungus resistance in accordance with MIL-T-13867 as specified herein. Electrical components with a temperature rise of 40° Centigrade (°C) or less shall be coated in accordance with type II of MIL-T-13867 with fungus resistant varnish conforming to MIL-V-173. Components with a temperature rise exceeding 40°C shall be coated in accordance with type III or IV of MIL-T-13867 with varnish conforming to MIL-I-24092 with grade and class of varnish dependent on the component, class of insulation above 40°C and the recommendations of the manufacturer of the equipment.

3.22 Electromagnetic interference suppression. When specified (6.2.1), the unit shall conform to the electromagnetic interference suppression requirements and test limits for class 3 group III equipment as specified in MIL-STD-461.

3.23 Cleaning, treatment, and painting. Surfaces normally painted in good commercial practice shall be cleaned, treated, and painted as specified herein. The color of the finish coat shall be as specified (6.2.1). Surfaces to be painted shall be cleaned and dried to insure that they are free from contaminants such as oil, grease, welding slag and spatter, loose mill scale, water, dirt, corrosion product, or any other contaminating substances. As soon as practicable after cleaning, and before any corrosion product or other contamination can result, the surfaces shall be prepared or treated to insure the adhesion of the coating system. The painting shall consist of at least one coat of primer and one finish coat. The primer shall be applied to a clean, dry surface as soon as practicable after cleaning and treating. Painting shall be with manufacturer's current materials according to manufacturer's current processes and the total dry film thickness shall be not less than 1.5 mils over the entire surface. The paint shall be free from runs, sags, orange peel, or other defects.

3.24 Technical manuals. The contractor shall provide technical manual(s) conforming to the Data Item Description(s) (DID) listed on the Contract Data Requirements List (CDRL) (DD Form 1423) (see 6.3).

3.25 Instructions. Each unit shall be furnished with operating instructions prepared in a permanent, legible form suitable for posting on or near the unit (see 6.3). The operating instructions shall include information relating to the normal start up and shut down of the unit and shall otherwise comply with the recommendations for operating instructions as given in UL 726 or UL 795, or both, as applicable. The following warning sign shall be prominently located on all hot water generators in 1/4 inch-letters:

WARNING
RAPID REPLACEMENT OF YOUR HOT WATER WITH RETURN WATER AT TEMPERATURE BELOW THE BOILER MANUFACTURER'S RECOMMENDATIONS CAN CAUSE SERIOUS DAMAGE TO YOUR BOILER. DO NOT ALLOW THIS TO HAPPEN. DO NOT FIRE YOUR BURNER UNTIL AFTER WATER FLOW HAS BEEN ESTABLISHED IN ALL ZONES AND THROUGH BOILER.

3.26 Identification marking. Identification shall be permanently and legibly marked directly on the generator or on a corrosion-resisting metal plate securely attached to the generator at the source of manufacturer. Identification shall include the manufacturer's model and serial number, name and trademark to be readily identifiable to the manufacturer.

3.26.1 Military marking. When specified (6.2.1) an identification plate will be furnished by the contracting officer for each generator. The contractor shall stamp all necessary data in the blank spaces of the plate provided for that purpose. The plate shall be securely affixed to each generator in a conspicuous place. The applicable nomenclature contained in the contract item description shall be placed in the top blank.

3.27 Workmanship and fabrication. Workmanship and fabrication shall be in accordance with the ASME Boiler and Pressure Code and shall be of such quality as to produce boilers that meet the standards prevalent among manufacturers who normally produce equipment of the type specified herein.

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 as specified herein. Except as otherwise specified in the contract or 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 assure supplies and services conform to prescribed requirements.

4.1.1 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).
c. On-site testing (see 4.2.3).

4.2.1 First article inspection. The first article inspection shall be performed on one unit when a first article is required (see 3.2 and 6.4). This inspection shall include the examination of 4.3 and the tests of 4.4, and when specified, the preproduction pack inspection of 4.5 (6.2.1). 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. Quality conformance inspection shall include the examination of 4.3, the tests of 4.4.1 and 4.4.5, and the packaging inspection of 4.5.

4.2.3 On-site testing. Testing shall be performed on the generator(s) at the site after installation and shall be witnessed by a certified boiler inspector acceptable to the contracting officer. This testing shall be in addition to quality conformance inspection performed at the factory and shall be supplemental to first article inspection, if such inspection is specified. On-site operational testing shall consist of tests of 4.4.2, and when specified (6.2.1), tests of 4.4.4 and all tests deemed necessary by the acquisition activity to verify compliance with the requirements of this specification. On-site testing shall be performed either by the boiler manufacturer or by the installing contractor, as specified (6.2.1). The manufacturer shall have the privilege of representation at tests performed by others. When the manufacturer is responsible for on-site tests, the detailed requirements and schedule for the test program shall be as specified in the contract (6.2.1). In all cases, deficiencies revealed by on-site testing shall be corrected at the boiler manufacturer's expense and any required retesting shall also be at the manufacturer's expense.

4.3 Examination. Each generator 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.

4.3.1 Design verification. When specified (see 6.2.1 and 6.3), the manufac- turer shall furnish drawings and computations necessary to verify compliance with the heat release criteria of table I.

4.3.2 Standards compliance. The contractor shall make available to the contracting officer or his authorized representative evidence of compliance with the applicable standards cited in 3.6. The Government reserves the right to examine and test all units to determine the validity of the certification.

4.4 Tests. Tests shall consist of the following:

a. Hydrostatic tests (see 4.4.1).
b. On-site operational tests (see 4.4.2).
c. Fuel-to-steam and fuel-to-hot water efficiency tests (see 4.4.3).
d. Particulate and nitrogen emissions tests (see 4.4.4).
e. Auxiliary equipment tests (see 4.4.5).
f. Electromagnetic interference suppression tests when required (see 4.4.6).

The hydrostatic (see 4.4.1) and on-site operational (see 4.4.2) tests shall be performed on each boiler supplied under a contract, including the first article, if furnished. Capacity and efficiency tests and auxiliary equipment tests, shall be performed only on the first article. The electromagnetic suppression tests shall be performed on one unit when electromagnetic suppression control is specified.

4.4.1 Hydrostatic tests.

4.4.1.1 Watersides. Watersides shall be hydrostatically tested in accordance with the requirements of the ASME Boiler and Pressure Vessel Code. The appropriate certification specified in 3.7 shall be accepted as evidence of compliance (see 6.3).

4.4.1.2 Fuel systems. The preassembled fuel system furnished integrally with the boiler shall be checked for leakage during the fire testing of the boiler. The soap bubble or the halogen sniff test method shall be used to verify integrity of the gas system.

4.4.2 On-site operational tests. Each generator shall be fire-tested to demonstrate control and operational conformance and combustion efficiency to the requirements of 3.9.3.1 and 3.12 and to the requirements of this specification under varying load conditions ranging from the specified capacity to the minimum burner turndown ratio without on-off cycling. All burners shall be tested for the ability to start a cold generator in accordance with the manufacturer's instructions. Boilers that exhibit (1) excessive or unexplained loss of ignition, (2) nuisance shutdown due to faulty burner or control operation, (3) improper flame, (4) excessive carbon deposits, or (5) necessity for frequent or difficult adjustments shall be rejected. Operational tests shall be as specified in 4.4.2.1 through 4.4.2.5.

4.4.2.1 Burner tests. On-site tests shall be conducted on the burners as specified in section 4 of MIL-B-18796.

4.4.2.2 Load demand. Generators shall be tested for the ability to provide steam in accordance with the steam demand, (see 3.9.5).

4.4.2.3 Boiler limit and cut-out switches and fuel safety interlocks. Safety shutdowns shall be caused by simulating interlock actuating conditions for each boiler limit and cut-out switches and fuel safety interlocks. Safety shutdowns shall occur in the specified manner.

4.4.2.4 Safety valves. The high-pressure limit switch shall be locked out or otherwise made inoperative and the boiler safety valves shall be lifted by steam. The relieving capacity, popping pressure, blowdown, and reseating pressure shall be determined by observation and measurement to be in accordance with the ASME Boiler and Pressure Vessel Code. This test shall be made in the presence of the contracting officer or his authorized representative. The ASME standard symbol will be accepted only as indicating compliance with the design and material requirements of the code.

4.4.2.5 Blowdown valves and try cocks. All blowdown valves and try cocks shall be tested for proper operation.

4.4.3 Fuel-to-steam and fuel-to-hot water efficiency tests. The fuel-to-steam and fuel-to-hot water efficiency, and steam quality at the specified capacity of the generator shall be determined in accordance with the ABMA Standard Test Procedure for Packaged Firetube Boilers or ASME PTC 4.1. The efficiency shall be determined by the Input/Output Method. Performance shall be as specified in 3.9.3.2 and 3.9.3.3. Test runs shall be made at the maximum rated capacity.

4.4.4 Tests for particulate and nitrogen emissions. When specified (see 6.1i and 6.2.1), tests for emissions of particulates, nitrogen, and sulfur dioxide shall be conducted in accordance with MIL-B-18796.

4.4.5 Auxiliary equipment tests. Draft fans, fuel oil heaters, fuel pumps, dampers, actuators, valves, and electric motors shall be operationally tested to determine compliance with the referenced specifications or standards. Standard approval symbols or certificates of compliance (see 6.3) from certifying organizations may be accepted at the discretion of the contracting officer or his authorized representative. The operation of fans, fuel oil heaters, fuel pumps, and electric motors shall be closely observed during the on-site operational tests (see 4.4.2) for possible defects or nonconformance. The action of dampers, actuators, and valves shall be smooth and without backlash.

4.4.6 Electromagnetic interference suppression tests. To determine conformance to 3.22, the first article shall be subjected to the tests in accordance with MIL-STD-462. When suppressed to conform to 3.22, the manufacturer upon approval of the contracting officer may furnish a certification (see 6.3) in lieu of the test that the generator meets the requirements, together with a list of the suppression devices installed. The list shall be sufficiently detailed to allow visual determination that the devices are installed.

4.5 Packaging inspection. The inspection of the preservation, 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 (6.2.1), a preproduction pack shall be furnished for examination and test within the time frame required (6.2.1).

5. PACKAGING

5.1 Preservation, packing, and marking. Preservation, packing, and marking shall be in accordance with MIL-B-3180 with the level of preservation and level of packing as specified (6.2.1).

6. NOTES

6.1 Intended use. The boilers covered by this specification are intended for generation of steam to be used in processing operations, space heating, or power generating systems. Hot water generators are for space heating and may also be used for service water.

6.1.1 Selection factors. The following should be considered in the selection of a boiler and the exercise of options herein:

a. The boiler type (oil, gas, or combination) should be determined in accordance with the availability or economics of the fuel supply and any Department of Defense requirements for capability of firing multiple fuels.
b. Class 2, special duty boilers are intended primarily for semi-permanent installations where the intended life expectancy of the equipment will be 5 years or less.
c. The boiler or high temperature water generator should be sized to permit efficient burner operation under low load conditions during the summer.
d. Repetitive self-checking circuits have been included as standard because generators operating in occupied buildings or in hazardous locations require such safety controls.
e. Normally, oil-fired generators above 2,500,000 Btu/h output should be capable of burning fuel oil grades No. 2, No. 4, No. 5, and No. 6.
f. Gas-electric igniters are required for UL, FM and Industrial Risk Insurers. Oil igniters should be specified only when gas is not available on group 2 with 20 gallons or less per hour light-off.
g. Standard design pressures for steam generators covered by this specification range from 30 psig to 250 psig and for hot water generators to 160 psig.
h. A smoke density indicator should be specified on all generators over 5,000,000 Btu/h input capacity.
i. If the generator is subject to environmental regulation, each agency should consult with its environmental support office since regulation limits of particulate and emissions vary from city, state, and Federal governments.
j. Economizers can increase fuel to steam efficiencies from 1 to 1-1/2 percent for 150 psig generators and 2-1/2 to 3 percent for 250 psig generators.

6.1.2 Other fuels. The performance requirements specified herein may be based on other fuels providing the quantity on site is sufficient for tests specified in section 4 and a guaranteed ultimate analysis, higher heat content, and oil viscosity are made available at time of testing the generators. Corrections between the values of the analyses in section 3 of this specification

and the guaranteed analyses and heating value should be made in accordance with section 7 of ASME PTC-4.1. Referenced below are some of the most common used fuels with their average viscosity and higher heat content:

Fuel	Average viscosity	Average higher heat content
Light Oil		
Grade 2 and 4 ASTM D396 J-P5 MIL-T-5624 Diesel VV-F-800	125 SUS	140,000 Btu/gal
Heavy oil		
Grade 5 ASTM D396	300-750 SUS	150,000 Btu/gal
Navy Special MIL-F-859 Grade 6 ASTM D396	1000 SUS	150,000 Btu/gal
	Specific gravity	
Natural gas	0.65	1075 Btu/ft^3
Manufactured gases	0.38	535 Btu/ft^3
Mixed gas	0.50	800 Btu/ft^3
Liquefied petroleum gas	1.55	2500 Btu/ft^3

6.2 Ordering data.

6.2.1 Acquisition documents should specify the following:

a. Title, date, and number of this specification.
b. Type, class, group, and actual capacity of boiler required in Btu/h, design pressure for types II and III; burner type, grade of fuel oil or type of gas to be burned, type of programming control system, type of combustion control system (see 1.2 and 3.9.2).
c. If specifications and standards are different (see 2.1.1).
d. When first article is required (see 3.2).
e. The following design conditions are required (see 3.8).
   (1) Generator design pressure (psig) for type II and type III generators (see 1.2.1).
   (2) Generator operating pressure (psig).
   (3) Steam temperature (°F).
   (4) Feedwater temperature (°F).
   (5) Temperature differential for hot water generator between generator discharge and system return (°F).
   (6) Maximum and minimum anticipated ambient air temperature (°F).
   (7) Generator site elevation (feet).
   (8) Maximum continuous output in Btu/h.
f. When control of thermal shock shall be limited to one or two of the specific methods (see 3.8.2).
g. When performance criteria shall be based on other than as specified. Supply the required fuel characteristics (ultimate analysis, and higher heating value) of intended oil or gas fuel (see 3.9).

h. Available gas supply pressure at site upstream of the service pressure regulator (see 3.9).
i. When operating temperature for hot water generators shall be other than 200°F (see 3.9.1).
j. When the generator shall conform to particulate, nitrogen oxide, and sulfur dioxide emissions requirements, and emission limits, (see 3.9.3.1 and 6.1.1(i)).
k. When an assessment of the potential hazard of noise exposure is required (see 3.9.7).
l. When an explosion relief door or device is required (see 3.10.5).
m. Required connections for remote sensing of steam pressure, steam flow, air flow, water temperatures, and fuel(s) (see 3.11(s)).
n. When physical properties are to be recorded, if recorders are to be furnished, and if recorders are to be mounted on other than the control panel (see 3.11(t)).
o. When a steam-operated feedwater injector is required on high pressure steam generators (see 3.11.2).
p. When hot water coils for service water are required; temperature rise and draw rate (gal/min), pressure drop, if different (see 3.11.3).
q. Medium of operation for combustion control if different (see 3.12).
r. The required fuel supply temperature (see 3.13).
s. When fuel pump is differenet (see 3.13.4).
t. When fuel oil heaters are different (see 3.13.5).
u. Type of draft system required (see 3.14).
v. Required location of control panel type of mounting and details of the free standing control panel including location, construction, mounted controls, instruments, and wiring for remote starting (see 3.15).
w. When an annunciator is required and if different (see 3.15.1).
x. When smoke density indicator is required (see 3.15.2 and 6.1(h)).
y. When an economizer is required (see 3.16).
z. When a stack is required and length if other than 20 feet (see 3.17).
aa. When transition piece is required and whether for vertical or horizontal discharge (see 3.18).
bb. When condensate return system is required (see 3.19).
cc. Required electrical characteristics of the motors and if motor enclosures are different (see 3.20.1).
dd. If motor starters different (see 3.20.2).
ee. When fungus resistance is required (see 3.21).
ff. When electromagnetic interference suppression is required (see 3.22).
gg. Required color of finish coat (see 3.23).
hh. When military marking is required (see 3.26.1).
ii. When on-site testing is required; when generator shall be tested for emissions of particulates and oxides of sulfur and nitrogen; method of testing; who is to perform tests; whether on-site testing will the performed by the generator manufacturer or by the installing contractor; outline of tests if generator manufacturer will perform tests (see 4.2.3 and 4.4.4).
jj. When design verification is required (see 4.3.1).

kk. When a preproduction pack is required and time frame required for submission (see 4.2.1 and 4.5).
11. Level of preservation and level of packing required (see 5.1).

6.3 Data requirements. When this specification is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved DD Form 1664, Data Item Description (DID), and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of paragraph 7-104.9(n) of the Defense Acquisition Regulations are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs:

Paragraph No.	Data requirements title	Applicable DID No.	Option
3.7, 4.4.1.1 4.4.5	Certification of compliance	DI-E-2121	None
3.7	Reports, tests	DI-T-2072	None
3.9.2	Design	DI-R-24040A	None
3.15	Installation drawings	DI-E-7031	None
3.24, 3.25	Publication, commercial	DI-M-24010A	None

(DIDs related to this specification, and identified in section 6 will be approved and listed as such in DoD 5000.19L, Vol. II, Acquisition Management Systems and Data Requirements Control List. Copies of DIDs required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.4 First article. When a first article inspection is required, the item will be tested and should be a first production item or it may be a standard production item from the contractor's current inventory as specified in 4.2.1. The first article should consist of one unit. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examination, test, and approval of the first article.

6.5 Definitions. The following definitions are applicable for use by the contractor and acquisition agency in the interpretation and implementation of the requirements of this specification. Other terms used in this specification should be interpreted in accordance with the definitions of UL 726, UL 795, and the ABMA Lexicon.

6.5.1 Burner control system. A burner control system is the system by which a furnace is purged and the burner is automatically started, ignited, monitored, and stopped. Automatic, recycling burners restart without manual actuation when a preset pressure or temperature is reached. Automatic, nonrecycling burners shall require manual actuation of a staring switch and fuel shutoff valve to re-establish the firing cycle.

6.5.2 Burner turndown. The burner turndown shall be the minimum continuous safe firing rate which can be effected automatically by the combustion control system during the normal firing cycle wihtout interruption or change of burner components. The burner turndown shall be epxressed as a percentage of the maximum continuous firing rate.

6.5.3 Effective radiant heating surface. The effective radiant heating surface shall be the heat exchange surface within the furnace limits which is directly exposed to the radiant heat of the flame on one side and the water being heated on the other. This surface shall be expressed in square feet and shall be equal to the product of the interior mean circumference of the furnace tube and the furnace length plus the area of the water cooled surface in the first gas reversal chamber as defined in the furnace volume below, exclusive of any refractory covered areas and any tube sheet area. On corrugated furnace tubes, the diameter shall be measured from the line tangent to the crest of the corrugations on one side to the troughs on the opposite side.

6.5.4 Furnace volume. Furnace volume shall be expressed in cubic feet and shall be the product of the interior cross-sectional area and length of the furnace tube plus the volume of the first gas reversal chamber providing the gas reversal chamber rearwall and the gas reversal chamber sidewalls are cooled by boiler water subjected to natural circulation as part of the boiler units water/steam circulation system. For corrugated furnace tubes, the diameter as specified in furnace effective radiant heating surface shall be used to compute the mean circumference.

6.5.5 Flame inpingement. Flame impingement means physical contact of the burner flame on the surface (fireside) carrying the products of combustion of the furnace or any tube and tube sheet of the boiler so that the flame path is diverted at these surfaces.

6.5.6 Nonrecycling safety-shutdown. Stopping burner operation by shutting off all fuel and ignition energy to the furnace by means of a safety interlock or safety controls and requiring a manual reset.

6.5.7 Recycling shutdown. Stopping of a burner operation by a normal shutdown when certain interlocks and limit switches have sensed a limit or off-limit condition and then allows the burner to automatically recycle when the condition corrects itself.

6.5.8 Trail-for-ignition period (main burner establishing period). That interval of time during light-off during which a safety control circuit permits the main burner fuel safety shutoff valves to be opened before the flame detection system is required to supervise the main burner flame.

6.5.9 Total generator heating surface. The total generator heating surface shall be expressed in square feet and shall consist of those surfaces which are exposed to the products of combustion on one side and water on the other. The total generator heating surface shall be measured on the side receiving the heat and shall include the radiant heating surface defined herein plus the firetubes and the portions of such other convection surfaces which are below the normal water line.

6.6 Cross-reference. The following cross-reference of classification applies.

MIL-B-17452C	MIL-B-17452D
Type I	Type I
Type II	Type II
Type III	Type III
Class 1	Class 1
Class 2	Class 2
Group 1	Group 1
Group 2	Group 2
Group 3	Group 3
Group 4	Group 4
Group 5	Group 5
Type LO	Type LO
Type HO	Type HO
Type G	Type G
Type GLO	Type GLO
Type GHO	Type GHO
Programming Control AR	Programming Control AR
Programming Contral AN	Programming Control AN
Combustion Control Systems	Combustion Control Systems
On-Off	On-Off
High-Low-Off	High-Low-Off
Modulating-positioning	Modulating-simple positioning
Not designated	Parallel positioning with air/fuel ratio control

6.7 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodian:

Army - ME
Navy - YD
Air Force - 99

Review activity:

Air Force - 84

User activities:

Army - CE
Navy - MC

Preparing activity:

Navy - YD

Project No. 4410-0053

TABLE I. Furnace heat input and heat transfer criteria in thousands of Btu/h.

Boiler size group	Volume input rate per cu. ft. of furnace volume		Surface input rate per sq. ft. of ERHS		Heat transfer rate per sq. ft of heating surface based on thermal output	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
	Dry and Wet back	All	Dry and Wet back	All	All	All
1	275	400	75	150	6.7	11
2	225	400	80	150	6.7	11
3	215	400	100	150	6.7	11
4	200	400	115	150	6.7	11
5	200	400	130	150	6.7	11

TABLE II. Requirements for combustion.

FUEL	Natural Gas 1075 Btu/ SCF Percent			Light Oils No. 2, JP-5 Diesel Percent			Medium Oils No. 4, NSFO Percent			Heavy Oils No. 5 and 6 Percent		
Percent of Rated load	40	70	100	40	70	100	40	70	100	40	70	100
Products of Combustion												
Carbon dioxide (minimum)	8.5	9.0	10.0	10.5	11.5	12.5	11.0	12.0	13.0	12.0	12.6	13.6
Oxygen (maximum)	6.0	5.0	4.0	6.0	5.0	4.0	6.0	5.0	4.0	6.0	5.0	4.0
Carbon monoxide (maximum)	*	*	*	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Excess air (maximum)	40	25	20	40	30	20	40	30	20	40	30	20
Equivalent Bacharach Smoke Scale (maximum)	0	0	0	2	2	2	3	3	3	3	3	3
Average Combustion Efficiency	80			81			81			81		

*Units rated below 30,000,000 Btu/h input capacity shall meet UL 795 requirements for carbon monoxide. Units rated above 30,000,000 Btu/h input capacity shall meet 0.05 percent maximum.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-B-17452D	BOILERS, STEAM AND HOT WATER, HIGH AND LOW PRESSURE: FIRETUBE,

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.