INCH-POUND
MIL-B-24535A(SH)
22 March 1989
SUPERSEDING
MIL-B-24535(SH)
6 April 1976
(See 6.11)

MILITARY SPECIFICATION

BURNER, CARBON MONOXIDE AND HYDROGEN, CATALYTIC TYPE (MARK V)

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the design and construction of a Mark V burner for removing carbon monoxide and hydrogen from submarine atmospheres.

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).

SPECIFICATIONS

FEDERAL

HH-P-31 - Packing and Lagging Material, Fibrous Glass Metallic and Plain Cloth and Tape.
QQ-S-763 - Steel Bars, Wire Shapes, and Forgings, Corrosion Resisting.
PPP-C-320 - Fiberboard; Corrugated and Solid, Sheet Stock (Container Grade), and Cut Shapes.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 4460

MILITARY

MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
MIL-G-1149 - Gasket Materials, Synthetic Rubber, 50 and 65 Durometer Hardness.
MIL-S-1222 - Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-C-2212 - Controllers, Electric Motor, A.C. or D.C. and Associated Switching Devices.
MIL-M-7793 - Meter, Time Totalizing.
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-I-16411 - Insulation Felt, Thermal, Glass Fiber.
MIL-F-16552 - Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type).
MIL-M-17060 - Motors, 60-Hertz, Alternating Current, Integral Horsepower, Shipboard Use.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories and Provisioned Items (Repair Parts): Packaging of.
MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
MIL-L-20213 - Lithium Hydroxide (LiOH), Technical.
MIL-C-21665 - Catalyst, Carbon Monoxide and Hydrocarbon Oxydizing (For Use in an Air Purifying Device Aboard Submarines).
MIL-H-22577 - Heating Elements, Electrical: Cartridge, Strip and Tubular Type.
MIL-H-46855 - Human Engineering Requirements for Military Systems, Equipment and Facilities.

STANDARDS

MILITARY

MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-278 - Welding and Casting Standard.
MIL-STD-681 - Identification Coding and Application of Hookup and Lead Wire.
MIL-STD-740-1 - Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-740-2 - Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment.

MILITARY (Continued)

MIL-STD-769 - Thermal Insulation Requirements for Machinery and Piping.
MIL-STD-1399, Section 300 - Interface Standard for Shipboard Systems Electric Power, Alternating Current. (Metric)
MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Other Government drawing. The following other Government drawing forms a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
NAVSEA 5000-S1112-1385778 - Mounts, Resilient, EES Type.

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following document forms a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
B 333 - Standard Specification for Nickel-Molybdenum Alloy Plate, Sheet and Strip.
B 335 - Standard Specification for Nickel-Molybdenum Alloy Rod.
B 424 - Standard Specification for Ni-Fe-Cr-Mo-Cu Alloy (UNS N08825 and UNS N08821) Plate, Sheet, and Strip.

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

(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 document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.3.

3.2 Description. The burner shall extract carbon monoxide and hydrogen from ambient air in a submarine. Burner efficiency shall be not less than that shown in table I. The air shall flow from the space through an inlet filter, a blower, inlet (first) pass of a heat exchanger, a heater, catalyst bed, outlet (second) pass of the heat exchanger, an aftercooler, an afterfilter and then to the space. An automatic temperature control system shall be incorporated to monitor the air temperature at the catalyst bed and maintain a temperature control sensitivity of 600 ± 10 degrees Fahrenheit (°F). The temperature of the air at the face of the catalyst bed shall not vary from 600 ± 25°F when measured in accordance with 4.7.8.2. Temperature indicators shall be provided to monitor air temperatures in the catalyst bed (650°F) and afterfilter chamber (160°F). The burner's control system shall operate automatically to maintain the 600 ± 10°F catalyst bed temperature. Control of the temperature in the afterfilter chamber shall be maintained by a high temperature shutdown switch. A drain plug shall be provided at the low point of the burner. Lifting pad eyes shall be provided that will support the burner during hoisting operations when fully loaded.

TABLE I. Efficiency for the burning of carbon monoxide and hydrogen.

Gas burned	Inlet concentration	Efficiency (percent burned)
Hydrogen	0.50 percent 1.00 percent 1.50 percent 1.80 percent	85 90 90 90
Carbon monoxide	50 p/m 100 p/m	85 90
Hydrogen and carbon monoxide	1.80 percent 100 p/m	90 90

3.3 Operation. After the burner has been filled, started, and control settings have been established, the burner shall operate over a 24-hour period with an average requirement of 5 minutes maximum per hour for routine operational checks exclusive of maintenance requirements.

3.4 Ambient conditions. The burner shall operate at a ship's ambient temperature range of 40 to 122°F, and a pressure of 30 inches of mercury (Hg) absolute, with variations of plus or minus 6 inches of Hg.

3.5 Capacity. With the filters (air and lithium carbonate) and catalyst installed, the burner shall provide a minimum air flow of 650 cubic feet per minute (ft^3/min) with 3 inches water gauge excess pressure at the entrance to the afterfilter chamber.

3.6 Services. The burner shall operate at rated capacity with the services specified in 3.6.1 and 3.6.2.

3.6.1 Cooling water. Cooling water shall be used for indirect cooling. The burner shall operate with water at 95°F, at a maximum gauge pressure of 100 pounds per square inch (lb/in^2), and with maximum and minimum flow rates of 25 and 5 gallons per minute (gal/min), respectively. The maximum allowable pressure drop between the inlet and outlet water connections shall be 10 lb/in^2.

3.6.2 Power. Power to be supplied shall be 440-volt, 3-phase, 60 hertz (Hz). The burner power requirements shall be not greater than 50 kilowatts (kW) during warmup and 35 kW during operation under normal conditions.

3.7 Arrangement.

3.7.1 Maintenance and operation. The arrangement shall be based on engineering and human engineering design factors to facilitate systematic operation and maintenance (see 6.3 and appendix B). Equipment requiring periodic maintenance shall be easily accessible so that it can be removed and replaced without interference. Access to the burner for maintenance and operation shall be limited to the front and both sides of the burner. Space required for maintenance and operation shall be limited to 30 inches from the leading edges of the bottom mounting bracket and 12 inches on each side of the burner. The rear of the burner shall not be used for accessibility.

3.7.2 Components. Components shall be arranged so that flow is downward through the catalyst bed, second pass of the heat exchanger, aftercooler, and afterfilter. The control panel and instrument panel shall be mounted on the front of the burner. The air intake and discharge shall be located as high as possible.

3.7.3 Adjustable controls. Adjustable controls on the front of the panel shall be accessible to the operator without having to stoop or bend over. To facilitate shipboard installation, the upper and lower mounts shall have not less than 6 inches clearance maintained around each mount.

3.8 Interchangeability. Similar equipment and parts installed in burners furnished on the same contract or order, or manufactured to the same drawings, shall be interchangeable without the necessity of further machining or hand fitting of any kind. Where the contractor has previously furnished similar burners, parts installed in previous burners shall be interchangeable with the parts furnished on the contract or order. This requirement is not intended to restrict improvements in design, operation, and maintenance. Changes will be subject to NAVSEA review. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance and strength.

3.9 Weight, mounting, and overall dimensions.

3.9.1 Center of gravity. The loaded and empty weights, main mount locations and orientation, and the width, depth, and height dimensions shall be as shown on figure 1. The center of gravity of the burner shall be not more than 8 inches and as close as possible to a point in the center of a plane passing through and bounded by the four main mounts. The final location of the center of gravity is subject to NAVSEA review.

3.10 Noise.

3.10.1 Airborne noise. The airborne noise output of the burner shall not exceed the limits specified in table II when measured 3 feet from the equipment.

TABLE II. Airborne noise limits.

Octave band (Hz)	Sound pressure level (dB)	Octave band (Hz)	Sound pressure level (dB)
37.5-75	90	600 - 1200	75
75 -150	85	1200 - 2400	75
150 -300	80	2400 - 4800	75
300 -600	80	4800 - 9600	75

3.10.2 Structureborne noise. The structureborne noise output of the burner shall not exceed the limits shown on figure 2. Accelerometer blocks used to obtain structureborne noise data shall remain on the equipment as delivered to the Government.

3.11 Vibration. The burner shall operate under conditions specified for type I environmental vibration as specified in MIL-STD-167-1 for frequencies up to and including 33 Hz.

3.12 Shock. The burner shall withstand the shock requirements specified in MIL-S-901 for grade A, class II equipment. The burner shall be constructed for installation on Navy type resilient mounts with a snubber arrangement as required, satisfactory to the Command or agency concerned.

3.13 Inclination. The burner shall meet the specified requirements when mounted in an upright condition and when subject to the various conditions of trim, list, pitch, and roll as follows:

	Submerged	Snorkel	Surface
Trim (permanent)	+30 degrees	±7 degrees	±7 degrees
Pitch amplitude	±7-1/2 degrees	±10 degrees	±10 degrees
Period of complete pitch:			
Cycle	120 seconds	6 seconds	6 seconds
List	15 degrees	15 degrees	15 degrees
Roll amplitude	±30 degrees	±30 degrees	±60 degrees below 10 knots 30 degrees above 10 knots
Period of complete roll:			
Cycle	14 seconds	14 seconds	12 seconds

Equipment and machinery shall continue to operate and not be damaged due to trim angles up to 45 degrees for short periods of time (up to 5 minutes), under casualty conditions. Minor oil leaks or similar abnormal conditions will be permitted under this condition.

3.13.1 Conditions. The conditions resulting from the following combinations shall be met:

(a) List and trim.
(b) List and pitch.
(c) Roll and trim (surface only).
(e) Roll and pitch.

Degrees shall be measured from vertical to either side for list and roll, and from the normal horizontal (fore and aft) plane up down for trim and pitch. The period shall be the time for one complete cycle, for example, the time for the ship to pitch or roll starting from one extreme to the other and return. Conditions of permanent list and roll, or trim and pitch, shall not be considered additive.

3.14 Insulation and gaskets. Hot external surfaces shall be insulated and lagged in accordance with MIL-STD-769 and MIL-I-16411 to reduce the insulation surface temperature to less than 150°F. A full face gasket, conforming to HH-P-31 shall be used for the catalyst access plate, heater access plate, and aftercooler access plate. Cloth type asbestos material shall not be used for seals. Neoprene gaskets in accordance with MIL-G-1149, class 1, may be used in all other areas.

3.15 Electrical equipment.

3.15.1 Electrical input power. The burner shall operate with the following nominal voltage and frequency rating and with input electrical power requirements in accordance with MIL-STD-1399, section 300.

Nominal voltage	Frequency	Voltage tolerance	Frequency tolerance
440 volt alternating current (ac), 3-phase	60 Hz	±5 percent	±5 percent

3.15.2 Motor. The electric motor shall conform to design B of MIL-M-17060 and the following:

Dripproof protected

(a) Type: Squirrel-cage induction.
(b) Voltage: 440 volts, 60 Hz, 3-phase.
(c) Enclosure: Dripproof protected 45 degrees.
(d) Horsepower: 5.
(e) Speed: 3600 revolutions per minute (r/min) synchronous.
(f) Bearings: Ball.
(g) Duty: Continuous.
(h) Service: A.
(i) Ambient: 122°F (50 degrees Celsius (°C)).
(j) Insulation: Class B, F, or H.
(k) Temperature: At rated load shall not exceed class B rises for 122°F (50°C) ambient.
(l) The motor shall be for submarine service.
(m) Motor balancing rings are required.

Totally enclosed

(a) Type: Squirrel-cage induction.
(b) Voltage: 440 volts, 60 Hz.
(c) Enclosure: Totally enclosed fan cooled.
(d) Horsepower: 3.
(e) Speed: As required.
(f) Bearings: Ball.
(g) Duty: Continuous.
(h) Service: A.
(i) Ambient: 122°F (50°C).
(j) Insulation: Class B, F, or H.
(k) Temperature: At rated loads shall not exceed class B rises for 122°F (50°C) ambient.
(l) The motor shall be for submarine service.
(m) Motor balancing rings are required.

3.15.3 Control circuit. The burner control shall consist of a 440/110 volt transformer, relays in accordance with MIL-C-2212, thermoswitches for indication of excessive temperatures of catalyst bed and afterfilter chamber, overload protectors, automatic shutdown switches, and panel mounted override switches. Motor starting controllers shall conform to MIL-C-2212 and the following:

(a) Duty: Continuous.
(b) Operation: Magnetic, across-the-line.
(c) Protection: Undervoltages (low voltage protection).
(d) Overload: Thermal overload relay.
(e) 440 volts, 3-phase, 60 Hz.
(f) Noise requirements specified in 3.10.
(g) Horsepower rating: As required.

The heaters shall be automatically controlled by a temperature control system to maintain the temperature of the air entering the catalyst bed at 600 $\pm$ 10°F. A manual switch shall be provided so that heaters can be turned off when the blower is running. Overload protection shall be provided for the heaters. On light (amber) and power available light (white) shall be provided.

3.15.4 Electrical components. Electric components shall conform to the requirements of MIL-E-917 in addition to the requirements specified herein. Enclosures shall be dripproof in accordance with MIL-E-2036. Electrical components shall operate continuously when the compartment ambient temperature is 122°F and the burner is operating under normal conditions. Wiring shall be in accordance with MIL-STD-681. Panel wiring shall have terminal markers at both ends except wires less than 12 inches in length may be marked in the center only. Provision shall be included for grounding of the burner in accordance with MIL-E-917 at a single location.

3.15.5 Control panel. The control panel shall have a dripproof enclosure and shall serve as the enclosure for all electrical components mounted therein. Controllers, relays, transformers, amplifiers, and other similar devices shall be mounted in the control panel. The control panel cover shall be hinged and provided with captive screws. The cover design, when open, shall facilitate

complete access to electrical components mounted within the enclosure. The control panel cover shall be equipped with a means to lock the cover in the open position. Components such as indicator lights, switches, and information and face identification plates, shall be mounted conveniently on the front of the control panel. Fuse receptacles, overload reset pushbutton, and similar devices shall be conveniently accessible from the front or side of the control panel. The cable entrance shall be at the rear of the control panel.

3.15.6 Discrete contact closure. A discrete contact closure shall be provided by an unpowered contact set and shall be used only for the purpose of providing burner operating status to the ship monitoring sub-system. Switch characteristics shall be 50 ohms or less contact resistance in the closed state and 6120 ohms or greater in the open state. Voltages supplied across the contacts of up to 160 volts root mean square (rms), 60 or 400 Hz or up to 60 volts direct current (dc) shall not damage the contacts when currents between 10 and 100 milliamperes (mA) provided by the specified source voltages are passed through the closed contacts. These contacts shall not exhibit closed resistance greater than 50 ohms.

3.16 Service connections. Unless otherwise specified (see 6.2), the cooling water and air connections and their location shall be as shown on figure 1.

3.17 Components.

3.17.1 Mounts. Main mounts shall conform to Drawing 5000-S1112-1385778. The four main mounts shall be type 6E900. The actual loading of these mounts shall be less than the nominal rating; thus, the sustained load shall be less than 900 pounds. The temperature of these mounts at the hottest point shall be less than 150°F. This shall be accomplished without the use of water for cooling the mounts.

3.17.2 Inlet filter. The inlet filter shall be reusable and cleanable. The filter arrangement shall be such that no bypass occurs. The filter shall be quickly and easily demountable for servicing and retained by quick-opening fasteners. The filter shall be of the wire mesh type in accordance with MIL-F-16552. The pressure drop across a clean filter at 650 ft^3/min shall not exceed 0.5 inch water gauge.

3.17.3 Blower. A blower shall operate continuously under the conditions specified herein and at the back pressure afforded by the burner and shall be of a nonoverloading construction. The blower shall be direct-driven and include a hub with balancing provisions. The blower hub and motor balancing ring (see 3.15.2) shall be used to provide a balanced blower motor assembly. The blower discharge shall be connected to the burner inlet duct by means of a flexible connection to reduce noise transmission. The flexible connection shall not be damaged by shock, vibration, or maintenance near the connection. The blower/ motor assembly shall also be isolation mounted from the lower portion of the burner to reduce noise transmission.

3.17.4 Heat exchanger.

3.17.4.1 Description. The heat exchanger shall be a counterflow type with downward flow through the second pass and shall transfer to the inlet air, not less than 75 percent of the increased heat load of the air leaving the catalyst section. The heat exchanger shall be such that any of its surfaces which come in contact with the incoming air shall not come in contact with the air leaving the catalyst section. The heat exchanger flange surfaces and the mating flange surfaces shall be machined surfaces with a roughness less than 63 microinches rms. The heat exchanger shall prevent any leakage between passes in excess of 20 standard ft^3/min at 15 inches water gauge differential. The heat exchanger core and seals shall prevent any leakage passes in excess of 20 standard ft^3/min at 15 inches water gauge differential. The heat exchanger core and seals shall be replaceable. An access for examination shall be provided at the inlet and outlet of the second pass. The second pass of the heat exchanger and aftercooler shall minimize devices in which halogen acid condensate or catalyst dust can collect, provide maximum corrosion allowance, and facilitate washing and removal of catalyst dust.

3.17.4.2 Casing. The heat exchanger shall be a plate type with a minimum plate thickness of 0.013 inch. The heat exchanger casing shall be 300 series corrosion-resisting steel.

3.17.5 Heater. Heating elements shall be hermetically sealed in accordance with type I of MIL-H-22577 except the heater dimensional tolerances shall be plus or minus 5 percent. Terminal construction and materials shall ensure easy removal of terminal connections after continuous operation without damage to the heating element. Terminal connections shall be of a bus bar type arrangement. The watt density of the heater element shall not exceed 25 watts per square inch. Individual heaters shall be replaceable in the heat assembly. The heater shall be sealed and shall be such that it may be removed and replaced through an access plate on the front of the burner. The heater elements shall be nickel-copper alloy.

3.17.6 Catalyst bed. The catalyst bed shall be located in a horizontal position and the flow through it shall be downward. The catalyst bed shall be constructed like a drawer and shall be removable from the front of the burner. The catalyst bed shall have a minimum volume of 1.35 cubic feet. The velocity through the bed when filled with catalyst shall not exceed 150 feet per minute. The bed shall be constructed so that up to 10 percent setting of the catalyst will not permit air to bypass the catalyst. Provision shall be made to add or remove catalyst from the top of the bed. The catalysts shall be retained by two (top and bottom) perforated nonclogging plates that shall withstand the temperatures and temperature cycling encountered without distortion. The plates shall be nickel-iron-chromium-molybdenum-copper alloy in accordance with ASTM B 424. Other portions of the catalyst bed shall be 300 series corrosion-resisting steel. Seals to prevent air from by-passing the catalyst bed shall not utilize a cloth type asbestos material. Thermocouples in the catalyst bed shall be installed so that damage to wiring and junctions will not occur during loading and unloading of catalyst.

3.17.7 Catalyst. The catalyst shall be in accordance with MIL-C-21665 (mesh size 3 to 8 mesh) and shall be provided in the quantity required to perform all tests specified herein (see 6.8). Catalyst will not be required for production units.

3.17.8 Lithium carbonate (Li_2CO_3). The contractor shall supply Li_2CO_3 necessary to perform all tests specified herein (see 6.8). Li_2CO_3 will not be required for production units.

3.17.9 Aftercooler. A water cooler coil shall be provided on the discharge side of the heat exchanger. The capacity of the external cooling coil shall be such that the temperature of air leaving the external cooling coil shall not exceed 120°F when 2 percent hydrogen is being burned in the catalyst. The external cooling coil shall be part of the burner but shall be removable as an individual unit and shall be completely accessible from the front of the burner. The cooling coil shall be so arranged that condensation will not drain back into the burner. This performance shall be based on cooling with a maximum of 25 gal/min of 95°F fresh water. Water passages shall be tested for tightness and strength at 225 lb/in^2. The design temperature of the aftercooler shall be 500°F. The cooling water inlet and outlet shall terminate in a 1-inch nominal pipe size (nps) nickel-copper alloy stub end. The air from the aftercooler shall discharge directly into the afterfilter chamber. The aftercooler shall be a tube and fin type with a minimum water tube wall thickness of 0.028 inch.

3.17.10 Afterfilter. An acid clean-up afterfilter shall be provided downstream of the aftercooler. The afterfilter shall consist of six equally sized trays removable from the front of the burner. Each tray shall contain granular Li_2CO_3 in 2-inch depths. The Li_2CO_3 may be obtained by completely carbonating Navy stock lithium hydroxide (LiOH) conforming to MIL-L-20213. The linear velocity through the afterfilter shall not exceed 53 feet per minute. Structural members shall be 300 series corrosion-resistant steel. Areas exposed to discharge air shall be polytetrafluoroethylene coated. The air from the afterfilter shall discharge through a 114 square inch (maximum) opening. The temperature of the afterfilter airstream shall be monitored as specified in 3.17.13.

3.17.11 Damper. Air flow through the burner shall be controlled by an externally mounted adjustable damper. Material shall be 300 series corrosion-resistant steel.

3.17.12 Air flow measuring system. A pressure gauge and necessary pitot tube arrangement shall be provided for the purpose of determining the air flow through the burner. The accuracy of the air flow measuring system shall be within plus or minus 5 percent. The gauge shall also be used for determining the pressure drop through the inlet filter, the heat exchanger inlet side, the catalyst bed, the heat exchanger outlet, aftercooler, and afterfilter. An instrument mounting bracket shall be provided at the front of the unit containing the pressure gauge and valve manifolding. Panel cut-outs shall be provided as required to facilitate maintenance. Test plugs shall be provided to check the pressure gauge calibration. The pressure gauge shall withstand the maximum pressure developed by the blower. Corrosion-resistant steel (300 series) tubing, fittings and valves shall be used. Each valve shall be operated individually.

3.17.13 Temperature monitoring system. An automatic temperature control system shall be provided to indicate the air at the inlet edge and control the temperature of the catalyst bed. The catalyst bed temperature shall be controlled at the inlet edge. The controller shall have the following characteristics:

Ambient temperature operating range:	32 to 160°F
Set point accuracy:	±0.25 percent full scale
Indicator accuracy:	1 percent full scale
Indicator range:	0 to 800°F

Controller shall automatically control the heaters to maintain the air temperature at 600 ± 10°F. Temperature indicators shall also be provided to monitor temperatures at the outlet edge of the catalyst bed and in the airstream of the afterfilter chamber. Temperature indicators shall be remote reading types located in the control panel on the front of the burner.

3.7.13.1 Protective devices. Independent high temperature control shall be provided to shut down the burner on air overtemperature, that is, 675 ± 10°F at the inlet of the catalyst bed and 175 ± 10°F in the afterfilter chamber. Manually operated electrical overrides of the shutdowns shall be provided. Indicating and shutdown sensors shall be of the thermocouple type. Indicating and shutdown sensors utilized in the catalyst bed and afterfilter chamber shall be located in a common sheath in each case. The sensor locations shall be fixed. The control systems shall indicate an excessive temperature of 650 ± 10°F in the catalyst bed and 160 ± 10°F in the afterfilter chamber. Red lights shall be provided to indicate these overtemperatures. The sensors and controllers associated with the catalyst bed control shall operate continuously at temperatures up to 800°F. The temperature monitoring system shall be repairable without removing any other component.

3.17.14 Bypass system. A manual means of bypassing a portion of the incoming air around the heat exchanger shall be provided to keep the temperature at the catalyst bed from exceeding 675°F when burning hydrogen in any concentration up to 2 percent. The bypass system shall be operable from the front of the burner. The system shall be fabricated with corrosion resisting steel of the 300 series in accordance with QQ-S-763.

3.18 Material. Materials and metals permitted by MIL-E-917 shall be used. Unless otherwise specified herein, structural parts shall be corrosion-resistant metals as specified in MIL-E-917. Aluminum protection by anodic treatment shall be provided in accordance with MIL-A-8625. Material used shall be subject to review by NAVSEA. The heat exchanger and the complete aftercooler shall be nickel-molybdenum-chromium alloy in accordance with ASTM B 333 or ASTM B 335. When any of the material is formed by any method which will reduce its corrosion-resistance, the material shall be treated to restore it to its original corrosion-resistant condition. Welding shall be in accordance with MIL-STD-278. Nuts and bolts shall be corrosion-resisting steel of the 300 series in accordance with MIL-S-1222. Components containing mercury shall not be used. Components shall also be free from mercury contamination due to the manufacturing process,

examination, tests, or the material having come in direct contact with mercury, any of its compounds, or with any mercury containing devices employing only a single boundary of containment. (A single boundary of containment is one which is not backed by a second seal or barrier to prevent contamination in event of rupture of the primary seal or barrier.) Galvanic action shall be kept to a minimum through the selection of proper materials. Use of other than 300 series corrosion-resisting steel shall be subject to NAVSEA review. Where welding of corrosion-resisting steel is required, material resistance to intergranular corrosion (precipitated carbides) shall be used.

3.18.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable 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 specifically specified.

3.19 Routine overhaul. Items requiring routine overhaul or periodic replacement, such as the inlet filter, blower, motor, aftercooler, afterfilter, temperature controls heater assembly, and pressure monitoring components shall be readily accessible and shall be able to pass through a 25-inch diameter hatch and a 20-inch wide door.

3.20 Human engineering. The burner shall incorporate the human engineering design requirements of MIL-H-46855 and MIL-STD-1472.

3.21 Safety design review. Safety shall be an integral part of all reviews held for all the equipment, subsystems, and components. The contractor shall conduct system safety program reviews. Where possible, the system safety reviews shall be conducted as part of the overall program review to assess the status of compliance with the overall safety objectives. This review shall identify any deficiencies of the system with respect to safety and provide guidance for further analysis or design effort which may be required. Qualified contractor system safety personnel shall attend these design reviews. NAVSEA shall be notified prior to each system safety program review, to permit participation by Navy personnel (see 6.3).

3.21.1 Safety analyses. Safety analyses shall be performed to identify hazardous conditions for the purpose of their elimination or control. Analyses shall be made to examine the equipment, subsystems, components and their interrelationship to include logistic support, training, maintenance, and operational environments.

3.22 Reliability and maintainability.

3.22.1 Reliability. The mean-time-between-failure (MTBF), shall be not less than 2000 hours (see 6.3 and appendix A). A failure shall be defined as occurring when the burner ceases to function or its performance degrades below the requirements of this specification.

3.22.2 Maintainability. The mean-time-to-repair (MTTR), shall be not more than 4 man-hours.

3.22.3 Time totalizing meter. The burner shall incorporate a time totalizing meter in accordance with MIL-M-7793.

3.22.4 Performance monitoring. Performance monitoring and related displays shall be provided that will allow continuous sensing of critical performance parameters and indications of performance degradation or approaching failure. The monitoring devices shall be centrally located. The monitor system shall include automated visual and audible alarm indications of burner or component failure and visual identification of a specific failed assembly or module.

3.23 Identification and information plates. Each burner assembly shall be provided with an identification plate, an information plate, and an airflow range plate. Identification and information plates shall conform to types A, B, C, and D of MIL-P-15024 and MIL-P-15024/5.

3.23.1 Anodized aluminum photographic process. Anodized aluminum plates shall have the photosensitive silver compounds embedded within the oxide layer. After photographic processing, the image shall be sealed in the oxide layer by chemical treatment of the layer. Stamping of additional marking information will not be permitted.

3.23.2 Identification plate. Identification plate shall contain the following information:

(a) Item name.
(b) Model and size (when applicable).
(c) National stock number.
(d) Component identification number (CID).
(e) Contract number.
(f) Manufacturer's name and address.

3.23.3 Information plate. Information plate shall contain the following information:

(a) Simplified operating instructions.
(b) Range of air flows and temperatures.
(c) Safety precautions.

3.23.4 Air flow range plate. The air flow range plate shall be tabular (50 ft^3/min increments) or graphic and show the air flow versus the pressure drop for a range of 400 to 750 ft^3/min.

3.24 Workmanship. Welds shall be free of burrs and there shall be no excessive warpage in the final assemblies. Flange faces shall be within plus or minus 1/64 inch coplanarity, clean, smooth, and free of pits, burrs, and other defects. Sharp edges shall be rounded. Bolt holes shall be aligned within plus or minus 1/32 inch. Bolt holes shall be not more than 1/32 inch oversized.

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 (see 6.3). 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 the 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.

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

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. The first unit on each contract or order shall be subjected to the examination specified in 4.5 and the tests specified in 4.7.1 through 4.7.9.5.

4.4 Quality conformance inspection. Quality conformance examination and tests shall be performed on each unit as follows:

(a) Examination (see 4.5).
(b) Airborne noise (see 4.7.1).
(c) Structureborne noise (see 4.7.2).
(d) Catalyst bed temperature (see 4.7.8.2).
(e) Resilient mount temperature (see 4.7.8.4).
(f) Excessive temperature shutdown (see 4.7.8.6).
(g) Burner warmup and cooldown (see 4.7.8.7).
(h) Burner assembly (see 4.7.9.2).
(i) Differential pressure manifold (see 4.7.9.3).
(j) Aftercooler (see 4.7.9.4).
(k) Airflow calibration (see 4.7.8.8).

4.5 Examination. Each burner shall be examined to determine conformance to the requirements of this specification for finish, dimensions, workmanship and all other requirements not involving tests.

4.6 Fault isolation. Where the failure of the lowest replaceable assembly, module, or part is not automatically identified by the monitor system or built-in test procedures, any special test equipment required for fault isolation shall be provided along with support equipment as required for removal and replacement, adjustment, calibration, and alignment. Emphasis shall be placed upon the adaptation and selection of standard items already in Government inventory.

4.7 Tests. Tests shall be conducted in accordance with 4.7.1 through 4.7.9 (see 6.3).

4.7.1 Airborne noise. Before and after the shock and vibration tests, the burner shall be tested for airborne noise as specified in MIL-STD-740-1 (see 6.3).

4.7.2 Structureborne noise. Before the shock and vibration tests, the burner shall be subjected to the structureborne noise tests specified in MIL-STD-740-2. After the shock and vibration tests and correction of defects, the structureborne noise tests shall be repeated and shall meet the criteria shown on figure 2 (see 6.3).

4.7.3 Vibration. The burner shall be vibration tested in accordance with type I requirements of MIL-STD-167-1. The burner shall be installed for the test without the use of mounts (see 6.3).

4.7.4 Shock. The burner shall be subjected to a high impact shock test in accordance with MIL-S-901 for grade A, class II equipment. If the results of the shock test require any major changes in design, the test shall be repeated on a unit on which the design changes have been incorporated. The contractor shall completely disassemble the burner down to the component level after the shock test. Defects shall be corrected prior to final acceptance of the burner (see 6.3).

4.7.5 Safety testing. Safety tests shall be as approved by the contracting activity.

4.7.6 Reliability demonstration test. The contractor shall conduct an endurance test on the first unit as specified in 4.7.6.1 and 4.7.6.2 (see 6.3).

4.7.6.1 Endurance test. If not already accomplished on a previously supplied unit, the contractor shall conduct a 2000-hour endurance test on the first unit. The unit shall experience no failures in accumulating the 2000 hours of test time. Any shutdown of the unit excluding those caused by (a) equipment external to the contract unit, or (b) the 675°F temperature control device, when the unit is burning hydrogen and the temperature is within plus or minus 10°F of the set point, or (c) scheduled shutdowns to accommodate normal working hours, shall be cause to stop the test and reject the test unit. Prior to any retest, the contractor shall determine the cause of failure and correct the deficiency. The corrective action shall be reviewed by NAVSEA. Any additional retesting above the required 2000 hours will be determined by NAVSEA, but in no case shall the retest exceed 700 hours. The tests, or portion thereof, specified in 4.7.8 may be run concurrently with the endurance test. The test shall be conducted using atmosphere air at ambient conditions except if tests as specified in 4.7.8 are conducted concurrently. Performance requirements (see 4.7.8) shall be met throughout the test period.

4.7.6.2 250-hour test. If the 2000-hour test has already been accomplished on a unit previously furnished, the contractor shall conduct a 250-hour test on the first unit. The 250-hour test shall be conducted as specified in 4.7.6.1 except 250-hour test and 500-hour retest times apply.

4.7.7 Maintainability demonstration test. A maintainability demonstration test shall be conducted for which the maximum repair time for any repair action shall not exceed 10 man-hours and the MTTR (man-hours) shall not exceed the specified MTTR (man-hours) of 4.0 man-hours (see 6.3). The maintainability test shall be performed within the area constraints specified in 3.7.1. Test procedure shall be as approved by the contracting activity. As a minimum, maintenance task times shall be demonstrated and recorded for the following burner components:

(a) Catalyst bed.
(b) Blower/motor assembly.
(c) Heater assembly.
(d) Aftercooler.
(e) Afterfilter.
(f) Heat exchanger.
(g) Temperature controllers.

4.7.8 Performance.

4.7.8.1 Burning efficiency. After the shock test, the burner shall be tested to determine its efficiency for removal of carbon monoxide and hydrogen. The burner shall be operated for the time periods and gas combinations specified in table III. The efficiencies described in table I (see 3.2) shall be demonstrated.

TABLE III. Burning efficiency.

Gas burned	Inlet concentration	Duration (hours)
Hydrogen	0.50 percent	1
	1.00 percent	1
	1.50 percent	1
	1.80 percent	1
Carbon monoxide	50 p/m	2
	100 p/m	2
Hydrogen and carbon monoxide	1.80 percent H_2	
	100 p/m CO	4

This test shall be conducted at a room temperature of 70 ± 5°F and 45 to 55 percent relative humidity. During each test phase, the mechanical, thermal, and electrical operating parameters of the burner, as well as inlet and outlet gas concentrations shall be recorded.

4.7.8.2 Catalyst bed temperature. The uniformity of temperature across the face of the catalyst bed shall be demonstrated to be 600 ± 25°F. Not less than 24 equally-spaced thermocouples located at the inlet screen in a single horizontal plane shall be utilized to measure these temperatures. Data shall be recorded each hour for 2 hours.

4.7.8.3 Ambient temperature. The burner shall be operated for 4 hours at normal operating conditions of 600 ± 10°F and 650 ft^3/min at a room temperature of 100°F minimum to demonstrate that its control system functions at elevated ambient temperature.

4.7.8.4 Resilient mount temperature. After the burner has operated for 4 hours at a temperature of 600°F, temperature of resilient mounts shall be measured. The temperature of the rubber portions of the mounts shall not exceed 150°F.

4.7.8.5 Surface and control box temperature. Temperatures shall be recorded on external surfaces of the burner; including the inside of the control box after 4 hours of normal burner operation at 600°F. Temperatures in the control box shall not exceed 150°F. Burner surfaces exposed to operator contact shall not exceed 150°F.

4.7.8.6 Excessive temperature shutdown. Operation of the excessive temperature lights and shutdown functions shall be demonstrated. Warning lights shall turn on at 160 ± 10°F and 650 ± 10°F respectively for the afterfilter and catalyst bed areas. Shutdowns shall occur at 175 ± 10°F and 675 ± 10°F respectively for the afterfilter and catalyst bed areas. The catalyst bed shutdown test shall be performed by admitting hydrogen at increasing inlet concentrations without bypass operation. The afterfilter test shall be performed by securing cooling water flow.

4.7.8.7 Burner warmup and cooldown. Burner warmup time from switch-on to 600°F stabilization shall be measured and recorded. Burner cooldown time from heater switch-off to 150°F shall be measured and recorded.

4.7.8.8 Airflow calibration. The pitot flow meter shall be calibrated at room temperature over a flow range of 400 to 750 ft^3/min in increments of 50 ft^3/min.

4.7.8.9 Weight, center of gravity, and mount deflections. The complete burner assembly weight and center of gravity shall be measured and recorded. Individual weights of the aftercooler, heat exchanger, catalyst drawer, heater assembly, afterfilter drawers, blower and motor shall be measured and recorded. Mount deflections shall be measured by measuring the unloaded mount height and loaded mount heights.

4.7.9 Pressure tests.

4.7.9.1 Heat exchanger. The heat exchanger shall be pressure tested to determine conformance to the requirements specified in 3.17.4.

4.7.9.2 Burner assembly. The completed burner assembly, less blower and inlet filter assembly, shall be pneumatically pressure tested at 28 inches water gauge for 1/2 hour. Residual pressure shall be above 8 inches of water.

4.7.9.3 Differential pressure manifold. Each side of the differential pressure manifold shall be pressurized to 14 inches water gauge with air with all valves in the off position. The unit shall be bubble-tight under water.

4.7.9.4 Aftercooler. The aftercooler shall be hydrostatically pressure tested at 225 lb/in^2. No leakage shall be allowed.

4.7.9.5 Post shock and vibration examination. The catalyst drawer, after-filter drawers, aftercooler, and heater assembly shall be removed from the burner after completion of the shock and vibration tests and examined for damage. Additionally, the heat exchanger, the internal and external features of the burner and component parts shall be examined, in place, for damage. Further disassembly shall be performed, as required, to fully assess any damage incurred. Component redesign shall be effected to correct any significant problems.

4.8 Rejection. Breakage, deformation, or failure to meet the requirements of this specification when examined and tested shall be cause for rejection (see 6.3).

4.9 Inspection of packaging. Sample packs, and the inspection of the preservation, packing, and marking for shipment, stowage, and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.9.)

5.1 General.

(a) Navy shipboard stowage fire-retardant requirements.

(1) Treated lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping containers and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.
Level C - Type I - non-weather resistant.
Category 1 - general use.

(2) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard, cleated fiberboard boxes including interior packaging forms shall meet the flame spread index and the specific optic density requirements of PPP-F-320.

5.2 Preservation, packing, and marking. Carbon monoxide and hydrogen burners and accessories, shall be preserved level A (method IIA), C, or commercial, packed level A, B, C, or commercial and marked in accordance with MIL-E-17555 as specified (see 6.2) and as follows:

(a) Openings into the burner shall be capped, sealed, or plugged to assure effective action of the desiccant.
(b) Desiccant shall be placed in any interior spaces of the burner. The desiccant shall be distributed within the barrier and shall be secured by taping or tying, or otherwise secured to prevent movement, rupture of the desiccant bags, or damage to the barrier.
(c) The method of mounting the burner within the container shall ensure the integrity of the requirements of MIL-STD-740-1 and MIL-STD-740-2.

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 burners covered by this specification are used to remove carbon monoxide and hydrogen from submarine atmospheres.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) 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).
(c) Quantity of burners required.
(d) Whether first article is required (see 3.1).
(e) Location of service connections, if other than as specified (see 3.16).
(f) Fire retardant material requirements (see 5.1).
(g) Level of preservation, packing, and marking requirements (see 5.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Description (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific

acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference paragraph	DID number	DID title	Suggested tailoring
3.7.1 and appendix B	DI-DPRP-80651	Engineering drawings	---
3.18	DI-E-2121	Certificate of compliance	---
3.21	DI-SAFT-30010	System safety program plan	---
3.22.1 and appendix A	DI-MISC-80652	Technical information reports	---
4.1.1	DI-R-4803	Inspection system program plan	---
4.7	UDI-T-23732	Procedures, test	---
4.7.1	DI-HFAC-80272	Equipment airborne sound measurements test report	---
4.7.2	DI-HFAC-80274	Equipment structureborne vibration acceleration measurements test report	---
4.7.3	UDI-T-23762	Report, vibration testing	---
4.7.4	UDI-T-23753	Reports, equipment shock test	---
4.7.6	DI-RELI-80250	Reliability test plan	---
4.7.7	DI-R-2129	Plan, maintainability demonstration	---
4.7.7	DI-R-7113	Report, maintainability demonstration	---
4.8	UDI-T-23724	Report, failure/malfunction	---
5.2	DI-PACK-80120	Preservation and packing data	---
5.2	DI-PACK-80121	Special packaging instructions (SPI)	---

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract (see appendix C).

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the (items) 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 3.1), and the number of items to be tested as specified in 4.3. 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 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.6.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.7 Management control system document. The following management control system document should be included on DD Form 1660:

(a) MIL-P-15137.

6.8 Availability of catalyst and lithium carbonate. The contractor may purchase the catalyst and Li_2CO_3 necessary for test from the Government.

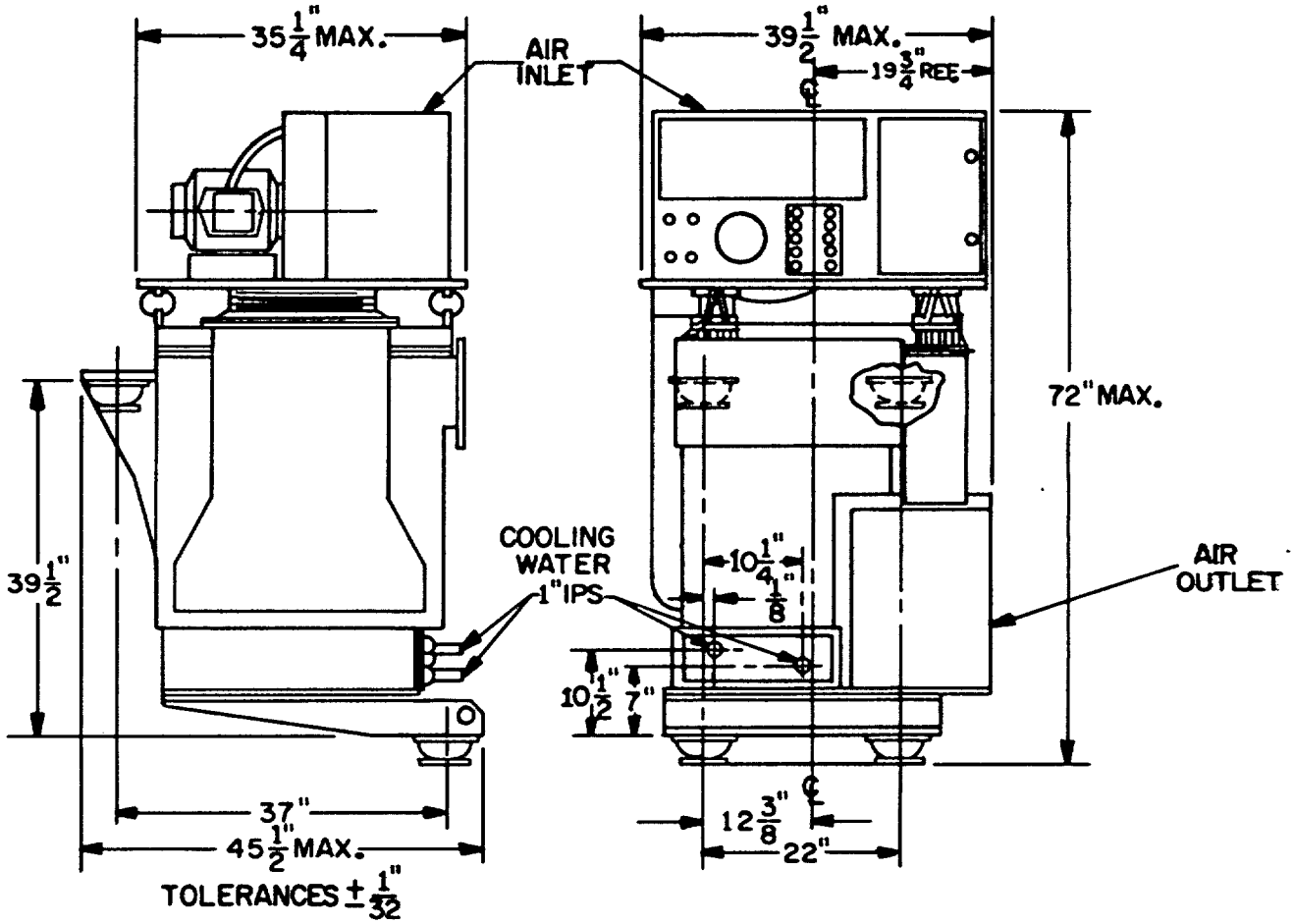
6.9 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.10 Subject term (key word) listing.

Carbon monoxide removal
Catalyst
Hydrogen removal
Lithium carbonate
Submarine atmosphere

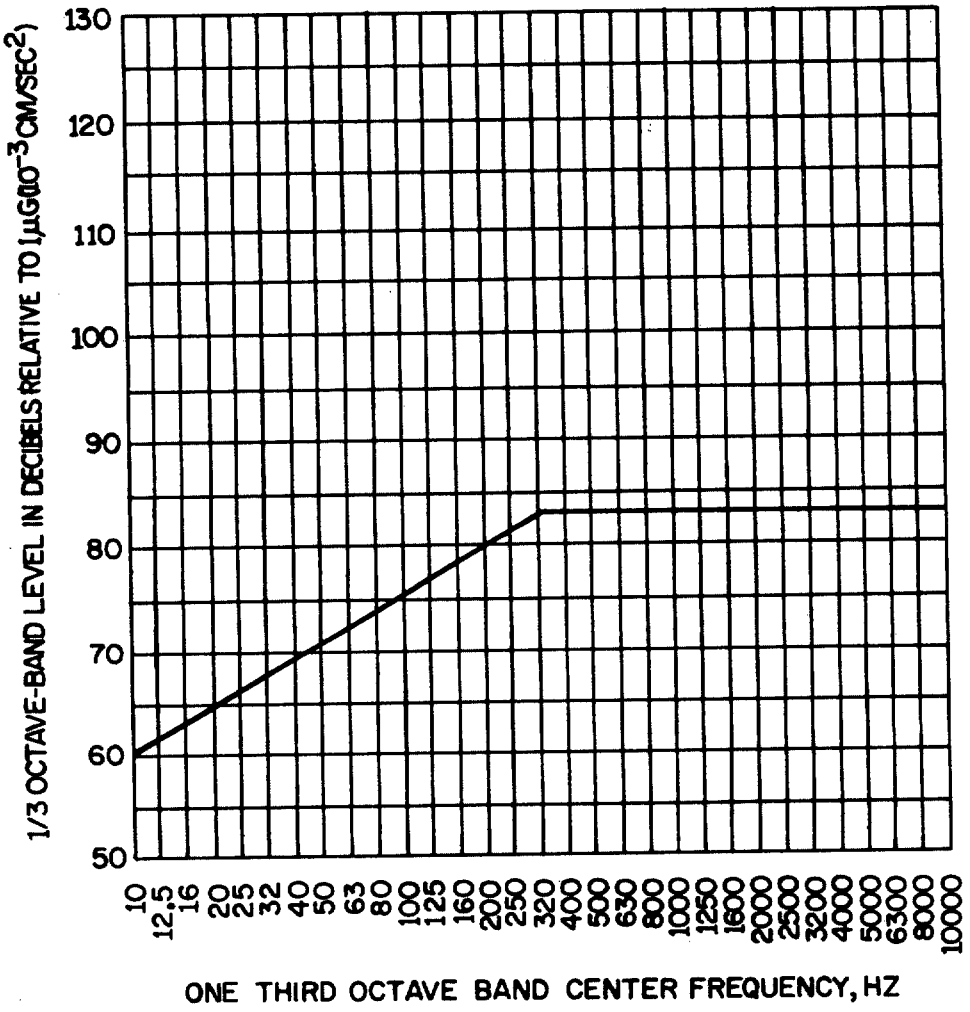
6.11 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 4460-N023)



SH 11027

FIGURE 1. Weight, overall dimensions, and mount location.



SH 11028

FIGURE 2. Structureborne noise acceptance criteria.

APPENDIX A

TECHNICAL REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. The appendix covers the technical content requirements that should be included in reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80652 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Standards and handbook. The following standards and handbook 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.

STANDARDS

MILITARY

MIL-STD-756 - Reliability Modeling and Prediction.
MIL-STD-1629 - Procedures for Performing a Failure Mode, Effects and Criticality Analysis.

HANDBOOK

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.

(Unless otherwise indicated, copies of federal and military standards and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

30. REPORTS

30.1 Reports. When required by the contract or order, reports shall contain the following information:

30.1.1 Reliability prediction. The reliability prediction shall be prepared in accordance with MIL-STD-756 and MIL-HDBK-217. Where no valid failure rate data exists for piece parts or subassemblies, then the prediction shall be based on known operational failure rate data of a similar type equipment modified as necessary for differences in design, application, or other known factors. Prediction methods, failure rate data and their sources shall be fully documented. The predicted reliability shall be compared with the required value and if noncompliance is indicated, a corrective action plan shall be formulated for review and acceptance.

30.1.2 Failure mode and effects analysis. The failure mode and effects analysis (FMEA) shall be prepared in accordance with MIL-STD-1629. The analysis shall be conducted to the functional subassembly level of MIL-STD-1629, except for the temperature monitoring system and the control circuit which the analysis shall be extended to the individually replaceable item level.

30.1.3 Maintenance engineering analysis. The maintenance engineering analysis shall be conducted on all individually replaceable items in the burner.

APPENDIX B

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that should be included on drawings when required by the contract or order. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DRAWINGS

30.1 Drawings. When required by the contract or order, drawings shall contain the following information:

30.1.1 Type II drawings. Type II drawings shall be so complete as to permit:

(a) Evaluation of performance and quality of the equipment against requirements of this specification.
(b) Evaluation of operational and personnel safety.
(c) Acquisition of parts by the supply system.
(d) Installation, operation, maintenance, and repair of the equipment and all components thereof without contractor's assistance.

30.1.1.1 Assembly drawings. Assembly drawings shall include a sectional assembly with complete list of material, with references to applicable subassembly and detail drawings. The list of material shall include every part required in the assembly, including those parts not required to be detailed. This may necessitate some side or partial views in order to show parts not otherwise shown in the main section view. The list of materials shall include an indication of each part to be furnished as an on board repair part (this is not a repair parts list). Assembly drawings shall also include performance data or curves, as applicable.

30.1.2 Type III drawings. Type III outline and diagram drawings shall be furnished as a supplemental drawing to all type II drawings. Certification data for motors and electrical equipment shall be prepared. Characteristics may be shown in separate tables and shall include information necessary to specifically verify or supplement drawings. Typical information required for certification data is speed, design rating conditions, rating or capacity, horsepower, type of drive, design fluid quantities, heat transfer area, design temperatures and flows, test pressures, and power requirements.

30.1.2.1 Dimensional outline drawings. The outline drawings of the assembled equipment shall be complete so that they can be used for installation guidance. Drawings shall show the following:

(a) Attached auxiliaries and foundation and mounting dimensional requirements.
(b) Table of weight of individual components and weight of complete unit.
(c) List of shipbuilder's connections showing size, type, and dimensions including method and sizes of fastenings, dimensions and clearances as required for installation and servicing plus supplementary data as necessary to permit installation without the contractor's assistance.
(d) Radii of gyration of complete net unit about each of the three principal axes.
(e) Vertical center of gravity for each assembly above the lowest extremity of the equipment support.
(f) Latent and sensible heat dissipation.
(g) Special handling procedures, as required.

30.1.2.2 Diagram drawings. The diagram drawings shall include a tabulation diagram, electrical schematic and electrical connection diagrams with certification data. Each diagram shall show by symbolic representation piping, fittings, valves, and wiring, as applicable. Valves, components accessories, controls and associated instruments shall be given a piece number and be identifiable with the certification data. Piece numbers shall be shown in a consecutive order around each diagram where practical.

30.1.3 Information plate drawing. Drawings shall include the information to appear on the information plate and the arrangement of the information (see 3.23.3).

APPENDIX C

MANUAL TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that should be included in manuals when required by the contract or order. This appendix is not a mandatory part of the specification. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. MANUALS

30.1 Manuals. When required by the contract or order, manuals shall contain the following information. As a minimum, the manual shall include on board repair procedures for component replacement for the following subassemblies: blower/motor, temperature control system, and heater assembly. The manual shall also include internal cleaning procedures for the aftercooler and heat exchanger, calibration, grounding and insulation repair procedures, component normal pressure drop ranges and electrical wiring diagrams.

30.2 Troubleshooting procedures. Troubleshooting procedures shall be prepared and documented by level of maintenance: organizational, intermediate, and depot. They shall include a listing of the support and test equipment required to accomplish each set of procedures along with the estimated man-hours for accomplishment.

30.3 Section I and II procedures. Section I on "Adjustments and Alignment" and section II on "Repair" procedures shall be prepared and documented by level of repair: organizational, intermediate, and depot. They shall also include a listing of the support and test equipment required to accomplish each operation, the personnel requirements, and the estimated man-hours for accomplishment.

30.4 Parts list. The parts list shall designate parts as either repairable or throwaway and indicate the recommended level for such action.

30.5 Scheduled maintenance procedures. The detailed "Scheduled Maintenance" procedures for the organizational level of maintenance shall be recorded on maintenance requirement cards and additional information on maintenance index pages. Scheduled maintenance procedures for the intermediate and depot level of maintenance shall be delineated in the manual in corresponding detail, and the same format.

30.6 Efficiencies. Carbon monoxide and hydrogen burn efficiencies as recorded during the first article test specified in 4.7.8.1 shall be included in the manual for the concentrations shown in table I.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-B-24535A(SH)	BURNER, CARBON MONOXIDE AND HYDROGEN, CATALYTIC TYPE (MARK V)

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