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7 December 1981
SUPERSEDING
MIL-P-24082B(SH)
22 October 1976
(See 6.7)

MILITARY SPECIFICATION

PLANT, CARBON DIOXIDE REMOVAL, LIQUID ABSORBENT TYPE (MARK IIIB) (FOR SUBMARINES)

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 This specification covers a Mark IIIB carbon dioxide (CO_2) removal plant, and test kit for the plant, capable of removing CO_2 from a submarine atmosphere and discharging this CO_2 overboard against variable submergence pressures. The CO_2 removal shall be accomplished by continuous absorption and desorption of the CO_2 in an aqueous solution of chelated monoethanolamine (MEA) (see 6.4).

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearings, Ball, Annular, General Purpose.
PPP-B-636 - Boxes, Shipping, Fiberboard.

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 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4460

MILITARY

MIL-C-17 - Cables, Radio Frequency, Flexible and Semirigid, General Specification for.
MIL-C-104 - Crates, Wood; Lumber and Plywood Sheathed, Nailed and Bolted.
MIL-P-116 - Preservation-Packaging, Methods of.
MIL-B-117 - Bags, Sleeves and Tubing - Interior Packaging.
MIL-B-121 - Barrier Material, Greaseproofed, Waterproofed, Flexible.
MIL-S-901 - Shock Tests, H.I. (High-Impact), Shipboard Machinery Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-P-1144 - Pipe, Corrosion-Resistant, Stainless Steel, Seamless or Welded.
MIL-F-1183 - Fittings, Tube, Cast Bronze, Silver-Brazing.
MIL-S-1222 - Studs, Bolts, Hex Cap Screws, and Nuts.
MIL-C-2212 - Controllers, Electric Motor, A.C. or D.C. and Associated Switching Devices, Naval Shipboard.
MIL-M-7793 - Meter, Time Totalizing.
MIL-T-8606 - Tubing, Steel, Corrosion-Resistant (18-8 Stabilized and Extra Low Carbon).
MIL-B-11722 - Bromophenol Blue Solution, Indicator, 3.0 to 4.6 PH Range.
MIL-V-13811 - Varnish, Waterproofing, Electrical, Ignition.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-S-15291 - Switches, Rotary, Snap Action.
MIL-E-16400 - Electronic, Interior Communication and Navigation Equipment, Naval Ship and Shore: General Specification for.
MIL-T-16420 - Tube 70-30 and 90-10 Copper-Nickel Alloy Seamless and Welded.
MIL-W-16878 - Wire, Electrical, Insulated, High Temperature.
MIL-M-17060 - Motors, 60 Hertz, Alternating Current, Integral Horsepower (Shipboard Use).
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts: Packaging and Packing of.
MIL-C-17605 - Charcoal, Activated, Unimpregnated.
MIL-P-17639 - Pumps, Centrifugal, Miscellaneous Service, for Use on Naval Ships.
MIL-L-17672 - Lubricating Oil, Hydraulic and Light Turbine, Noncorrosive.
MIL-B-17931 - Bearings, Ball, Annular, for Quiet Operation.
MIL-F-18866 - Fittings, Flared Tube, 37-Degree, Steel.
MIL-I-18997 - Indicator, Pressure, Panel Mounted or Case Supported, General Specification for.
MIL-F-19207 - Fuseholders, Extractor Post Type, Blown Fuse Indicating and Nonindicating, General Specification for.
MIL-V-19772 - Valves, Temperature Regulating, Automatic.
MIL-F-20042 - Flanges Pipe, Bronze (Silver Brazing).

MILITARY (Continued)

MIL-H-22577 - Heating Elements, Electrical: Cartridge Strip and Tubular Type.
MIL-M-23573 - Monoethanolamine Chelating Agent Solution.
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating, Solvent Containing.
MIL-T-24107 - Tube, Copper (Seamless).
MIL-M-24365 - Maintenance Engineering Analysis: Establishment of, and Procedures and Formats for Associated Documentation; General Specification for.
MIL-P-25732 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 275°F.
MIL-I-45208 - Inspection System Requirements.
MIL-H-46855 - Human Engineering Requirements for Military Systems, Equipment and Facilities.

STANDARDS

MILITARY

MIL-STD-167-1 - Mechanical Vibration of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
MIL-STD-419 - Cleaning and Protecting Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment.
MIL-STD-470 - Maintainability Program Requirements (For Systems and Equipments).
MIL-STD-471 - Maintainability Demonstration.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-785 - Reliability Program for Systems and Equipment Development and Production.
MIL-STD-882 - System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for.
DOD-STD-1399, Section 300 - Interface Standard for Shipboard Systems - Electric Power, Alternating Current.
MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
MIL-STD-1627 - Bending of Pipe or Tube for Ship Piping Systems.
MIL-STD-1629 - Procedures for Performing a Failure Mode and Effect Analysis for Shipboard Equipment.
MS16142 - Boss, Gasket Seal Straight Thread Tube Fittings, Standard Dimensions for.

DRAWINGS

MILITARY

NAVSHIPS 803-1385778 - Mounts, Resilient, EES Type.
NAVSHIPS 810-1385850 - Piping Instrument, Pressure, for All Service.
NAVSHIPS 810-1385884 - Unions, Fittings and Adapters, Butt and Socket Welding, 600 PSI WOG and OXY (IPS).
NAVSHIPS 810-1385888 - Unions, Butt and Socket, Welding for O.D. Tubing 6000 P.S.I., WOG.
NAVSHIPS 810-4384536 - Valves, Bronze 1/4" - 2" Union End Globe, Angle, and Stop Check.
NAVSHIPS S5901-1385801 - Piping Chilled Water, Air Conditioning, Diagrammatic Arrangement of.
NAVSHIPS SS501-818415 - Lagging and Insulation Schedules.
NAVSHIPS SS501-1517738 - Submarines CO_2 Removal System Test Pressures.
NAVSHIPS SS501-1524708 - Purifier.
NAVSHIPS SS501-1524716 - Test Kit.
NAVSHIPS 9000-S6202-73907 - Light, Indicator (Switchboard), 2 Lamp, SPF, Types B-27A through B-27G.
NAVSHIPS 9000-S6202-73919 - Light, Indicator, Single Dial - WT, Integral Transformer, Base Mtd; 117V, Sym. 2815.1, 450V., Sym. 2815.2, Panel Mtd, 117V., Sym. 2815.3, 450V., Sym. 2815.4.
NAVSHIPS 9000-S6504-73904 - Bell-Wt., 115 Volts -60 Cycles, Type IC/B1S4, Sym. 2622.

PUBLICATIONS

MILITARY

NAVSEA 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.
NAVSEA 0900-LP-084-6010 - Handbook of Standardization Format for the Preparation of Reliability Demonstration Test Procedures.
NAVSEA 0960-LP-000-5010 - Guide for Design of Shock Resistant Naval Equipment.

NAVAL RESEARCH LABORATORY

Report 7396 - Shipboard Shock and Navy Devices for Its Simulation.

(Copies of specifications, standards, drawings, and publications required by contractors 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. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
B16.5 - Steel Pipe Flanges and Flanged Fittings.
B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
A 213 - Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes, Spec. for.

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

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

3. REQUIREMENTS

3.1 Materials.

3.1.1 Materials that are in contact with each other in a marine environment shall be galvanically compatible. Reactive materials such as magnesium, or brittle materials such as gray cast iron, shall not be used. MEA solution shall not be permitted to come in contact with copper or copper alloys, carbon steel, natural rubber, or other materials subject to corrosive attack.

3.1.1.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall 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.

3.1.2 Pipe shall be corrosion-resisting conforming to MIL-P-1144, grade 304L or 316L except that grade 304 and 316 may be used for nonwelded fittings. When the latter materials are fabricated in any manner which reduces their corrosion resistance, they shall be heat-treated to restore their original condition. Passivating treatment, paint, or other surface coatings shall be used to protect materials subject to corrosion.

3.1.3 Surfaces to be painted shall be completely free of rust, mill scale, weld scale, weld flux, oil, grease, deteriorated paint, and other surface contaminants. Metal surfaces requiring paint for corrosion

resistance shall receive pretreatment and paint as soon as practical after cleaning. Pretreatment shall consist of one complete coverage coat of a pretreatment coating. Paint shall consist of two complete coverage coats of light gray enamel. Insulation shall be painted with two complete coverage coats of fire-retardant paint. Second coats shall not be applied until the preceding coat has become dry and hard. Before the application of any paint coating, all bare spots on the preceding coating shall be "touched-up". The preparation, pretreatment, and paint requirements as specified in the component specifications specified herein shall preclude the above similar requirements.

3.1.4 Fabrication and inspection of welded joints and repair of castings shall be in accordance with MIL-STD-278. Silver brazing shall not be performed on corrosion-resisting steel. Fabrication and inspection of silver brazed joints shall be in accordance with NAVSEA 0900-LP-001-7000.

3.1.5 Materials which are capable of producing dangerous gases or other harmful effects under conditions (including fire) encountered in Naval shipboard service shall not be used with the exception of MEA.

3.1.5.1 Materials containing asbestos shall not be used in fabrication and assembly unless concurrence is obtained from the Naval Sea Systems Command (NAVSEA).

3.1.6 Materials shall contain no metallic mercury or mercury compounds (see 3.9) and shall be free from mercury contamination. During the manufacturing process, tests, or inspections, the material offered shall not have come in direct contact with mercury or any of its compounds nor 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.)

3.2 General design.

3.2.1 Plant and test kit shall conform to the requirements specified herein and shall be manufactured in accordance with the final drawings furnished by the contractor for each applicable contract. Plant shall include all necessary materials and equipment arranged as a packaged unit mounted on a common base.

3.2.2 Plant shall consist of absorption, reactivation, cooling, purification, control, indicating and alarm systems and shall be delivered with 8 bags of resin and one test kit. Air shall be drawn from the ship's atmosphere into the top of an absorber to remove CO_2. The air shall then leave the absorber and pass through an air cooler, moisture separator, and air purifier and exit to the ship's atmosphere. The air purifier shall remove ammonia and MEA vapors. MEA shall be pumped from the bottom of the absorber in such a manner that a large portion of MEA is recycled to the top of the absorber and a small portion goes to a pressurized boiler-stripper where the CO_2 is released. By means of the pressure leaving the

boiler-stripper, MEA shall be forced into the absorber. The CO_2 leaving the boiler-stripper shall be cooled, voided of liquid moisture, and compressed to submergence pressure. A means shall also be provided to pump waste (spent) MEA solution to the ship's sanitary tank and to fill the absorber and boiler with MEA and water.

3.2.3 Ambient conditions. Plant shall operate at a ship's ambient temperature range of 40 to 122°F, and a pressure of 30 inches of mercury (in. Hg) absolute, with variations of plus or minus 6 in. Hg. Plant shall not be damaged when subjected to ship compartment absolute pressures of between 10 and 30 pounds per square inch (lb/in^2).

3.2.4 Services. Plant shall operate at rated capacity with the services specified in 3.2.4.1 through 3.2.4.5.

3.2.4.1 Process air shall be drawn into the plant by a centrifugal blower, through a connection even with the top of the plant. During test, the conditions of the inlet process air shall be 80°F temperature, 70 percent relative humidity, and 30 in. Hg absolute pressure.

3.2.4.2 Chilled water shall be used for indirect cooling. Chilled water temperature shall be no less than 49°F and at a maximum gage pressure of 150 lb/in^2. The maximum allowable quantity of chilled water shall be 12 gallons per minute (gal/min). The maximum allowable heat transferred to the chilled water shall be 60,000 Btu/hr based on the normal inlet process air conditions of 3.2.4.1. The maximum allowable pressure drop between the plant inlet and outlet chilled water shall be 26 lb/in^2.

3.2.4.3 Fresh water (not chilled water) at a maximum gage pressure of 40 lb/in^2 shall be used for mixing with MEA in the plant.

3.2.4.4 Plant shall operate with 440-volt, 3-phase, 60 hertz (Hz). Plant shall not require more than 20 kilowatts (kW) for normal operating loads nor more than 28 kW for in-rush loads.

3.2.4.5 Chelated MEA in accordance with MIL-M-23573 shall be used as the CO_2 absorbing media. The plant shall operate with MEA available at a maximum gage pressure of 20 lb/in^2. MEA in the plant shall be a 4.0 to 5.0 normal aqueous solution.

3.2.5 Capacity. Plant shall continuously remove CO_2 at minimum rates of 11.0 pounds per hour at 0.5 volume percent concentration in the inlet air, and 17.0 pounds per hour at 1.0 volume percent concentration in the inlet air. These capacities are based on the amount of CO_2 discharged from the compressor, process air conditions of 3.2.4.1, and the tests of 4.3.3. Plant shall also be capable of trouble free operation at an inlet CO_2 concentration of 1.5 volume percent.

3.2.6 Weight, mounting, and overall dimensions. Wet and dry weights, main mount locations and orientation and the width, depth, height, and drainway (see 3.3.2.1) dimensions shall be in accordance with figure 1. The center of gravity of the plant shall be as close as possible to, but under no circumstances more than 6 inches from, a point in the center of a plane passing through and bounded by the four main resilient mounts. The final location is subject to review by NAVSEA.

3.2.6.1 Items requiring routine overhaul, such as pumps, motors, and heat exchangers shall be designed to pass through a 25-inch diameter hatch and a 20-inch wide door.

3.2.7 Service connections. Unless otherwise specified (see 6.2.1), the service connections and their location shall be in accordance with table I.

TABLE I. Service connections.

Service connection	Location and orientation 1/	Size	Type
CO_2 discharge	1 foot - 6-5/8 inches to socket depth and right of ℄ plant 1 foot - 9-1/2 inches to rear of ℄ plant 2 feet - 3-3/4 inches elevation Opening: Facing right	1/4 inch nps	Unions as specified in 3.3.11.6(b), except that unions conforming to Dwg 810-1385888 shall not be used for service connections and the tail piece shall be welded to the CO_2 plant piping piping
MEA supply	3-1/8 inches to right of ℄ plant 1 foot - 10-1/4 inches to socket depth and front of ℄ plant 6-5/8 inches elevation Opening: Facing front	1/2 inch nps	

See footnote at end of table.

TABLE I. Service connections. - Continued

Service connection	Location and orientation[1/]	Size	Type
MEA waste discharge	----------	1/2 inch nps	Unions as specified in 3.3.11.6(b), except that unions conforming to Dwg 810-1385888 shall not be used for service connections and the tail piece shall be welded to the CO_2 plant piping (Continued)
Chilled water supply	1 foot - 10 inches to left of ℄ plant 4-1/2 inches to front of ℄ plant 2 feet - 9-1/2 inches elevation to socket depth Opening: Facing down	1 inch nps	
Chilled water return	1 foot - 8 inches to left of ℄ plant 1 foot - 9 inches to socket depth and rear of ℄ plant 1 foot - 11 inches elevation Opening: Facing rear	1 inch nps	
Fresh water supply	7-1/4 inches to left of ℄ plant 12-1/2 inches to socket depth and front of ℄ plant 5 feet - 7 inches elevation Opening: Facing rear	1/2 inch nps	
MEA drainway drains (2)	2 foot - 3/4 inches to both sides of ℄ plant 1 foot - 6 inches to front of ℄ plant Opening: Facing down	1/2 inch nps	

See footnote at end of table.

TABLE I. Service conditions. - Continued

Service connection	Location and orientation 1/	Size	Type
Electric	Through underside of control panel	----------	As specified herein
Air inlet	5 feet - 9 inches, elevation 9 inches to rear of ℄ plant 12 inches to right of ℄ plant	6 inches diameter maximum	Air silencer, if necessary
Air discharge	5 feet - 9 inches, elevation to face of opening Opening: Facing up Approximate in center of top plate of purifier	6 inches wide 10 inches long	Rectangular opening

1/ Tolerance for location of fittings is ±1/16 inch.

NOTES:
(a) Elevations are from lower edge of base.
(b) Right and left directions are the observers right and left while looking at the front of the plant.
(c) Openings shall be parallel to principle plane.
(d) Dimensions which position the path of flow are to the centerline of the fitting.

3.2.8 Noise and vibration. Plant shall not be damaged by internally excited vibrations, or by environmental vibrations specified in MIL-STD-167-1, for frequencies up to and including 33 Hz. Each plant shall not exceed the airborne noise limits specified in table II and the structureborne noise limits shown on figure 2 when tested in accordance with 4.3.5 and 4.3.5.1.

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

3.2.9 Pitch and roll. Plant shall perform its principal functions of removing CO_2, remain structurally sound, and shall avoid loss of MEA solution, lubricating oil, and cooling water under the following conditions:

(a) When inclined 30 degrees from the vertical in both the front-to-back and back-to-front directions.
(b) When inclined 30 degrees from the vertical in both the left-to-right and right-to-left directions.

3.2.10 Shock. Plant shall withstand shock requirements conforming to grade A, class II, type A of MIL-S-901.

3.2.10.1 Except as specified herein, bolts, nuts, studs, pins, screws, and other fasteners shall be made of corrosion-resisting steel of the 300 series in accordance with MIL-S-1222. The bolt requirements specified herein shall also apply to studs and screws. Bolts shall be installed with a locking device to prevent loosening and backing off as a result of vibration and shock (see 3.2.8 and 3.2.10). Nicking of threads or welding of nuts is prohibited except as specified herein. Mounting bolts for equipment in excess of 10 pounds and bolts for flanges shall be fastened with nylon insert type, self-locking nuts. Nuts shall be easily accessible for removal. Where bolts pass through metal in a manner that makes the bolt head inaccessible, tack welding or other means shall be provided to retain the bolt in position when the nut is removed. Such bolts shall be hardened to minimize stripping of threads and their material shall be selected to minimize galling. MIL-S-1222 shall be used as a design guide for bolts. The allowable shear stress for bolts shall be 0.6 times the allowable yield strength of the material. Bolts designed to be stressed in shear shall be installed in holes with a maximum diameter of the nominal bolt diameter plus 1/32 inch maximum for bolts 3/4 inch and smaller, and plus 1/16 inch maximum for bolts larger than 3/4 inch.

3.2.10.2 For additional information and assistance in designing for shock resistance, see NAVSEA 0960-LP-000-5010 and NRL Report 7396.

3.2.11 Interchangeability. Similar equipment and parts installed in plants 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. Where the contractor has previously furnished

CO_2 removal plants, similar equipment and parts installed in previous plants shall be interchangeable with the equipment and parts in the plants on the contract or order. This requirement is not intended to restrict progress in design, operation, and maintenance improvement for the plant. Changes may be made subject to review by NAVSEA.

3.2.12 Operation. After the plant has been filled, started, and control settings have been established, the plant shall be capable of operating over a 24-hour period with an average operator attention (excluding maintenance) requirement of 5 minutes maximum per hour. Shipboard operation requires that the operator check the various indicating devices at hourly intervals and test the effluent air for trace MEA at 4 hour intervals, test the MEA normality at 24 hour intervals, and make the necessary adjustment.

3.2.13 System safety program. The contractor shall develop and maintain an effective system safety program that is planned and integrated into all phases of design, production, and testing of the equipment. The system safety program shall provide a disciplined approach to identify hazards and prescribe corrective actions in a timely cost effective manner in accordance with the system safety precedence established in MIL-STD-882. The system safety program tasks shall be specified in a formal plan (system safety program plan). The plan shall include requirements to be imposed on each subcontractor to assure compatibility with the system safety program for the equipment. MIL-STD-882 shall be used as guidance for preparing the system safety program plan (SSPP).

3.2.13.1 Safety testing. Tests shall be proposed in the SSPP to validate the safety of the equipment.

3.2.13.2 Integration of associated disciplines. The contractor shall indicate in the SSPP how safety will interface with other disciplines in order to prevent duplication of effort.

3.2.13.3 Safety design review. Safety shall be an integral part of all design reviews held for all the equipment, subsystems, and components. The contractor shall conduct system safety program reviews. Where possible, the system safety program 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. Minutes of these system safety program reviews shall be prepared.

3.2.13.4 Safety analyses. Safety analyses shall be performed to identify hazardous conditions for the purposes 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.

3.2.14 Arrangement. The arrangement shall be based on engineering and human engineering design factors to facilitate systematic operation and maintenance. Equipment shall be arranged to facilitate access for purposes of maintenance and operation. Equipment requiring periodic maintenance shall be easily accessible and capable of being removed and replaced without interference. Access to the plant for maintenance and operation shall be limited to the front and both sides of the plant. The space required for maintenance and operation shall be limited to 24 inches in front and 18 inches on each side of the plant. The rear of the plant shall not be used for accessibility.

3.2.14.1 Plant shall be designed to facilitate the addition of make-up water and MEA while the plant is operating. The control panel shall be mounted on the front of the plant on the rise side with the front of the control panel flush with the front of the plant. Adjustable controls on the front of the panel shall be accessible to the operator without having to stoop or bend over. Other equipment requiring positioning or observation during normal plant operation and filling shall be located near the front of the plant in the general vicinity of the middle third of the plant and shall be accessible to the operator without having to stoop, bend over, or in any way have to reach behind other components. The boiler and absorber level gages shall be located within 6 inches of the front of the plant, may be at any convenient elevation and shall not be obscured for observation from the front of the plant. The blower and compressor oil level indicators shall be located to facilitate oil level observations from either side or the front of the plant. Compressor oil fill and drain connections shall be at the front of the plant.

3.2.14.2 To facilitate shipboard installation, the space around the upper and lower mounts (see 3.3.1) shall be void of any material with the exception of the mounts and mount support brackets.

(a) For the lower mounts, the space is that below a horizontal plane passing through the lower edge of the mounts.
(b) For the upper mounts, space is that which is around the mounts and bounded by the following planes:
    (1) Vertical planes coincident with the rear and each side of the plant.
    (2) A vertical plane parallel to the rear of the plant and 4 inches in front of the centerline of the mount.
    (3) Vertical planes parallel to the side of the plant and 4 inches from the centerline of the mounts in directions toward the absorber.
    (4) A horizontal plane 6 inches above the mount flanges.
    (5) A plane on an angle of 50 degrees with the horizontal sloping downward toward the rear of the plant, and intersecting the vertical centerline of the mounts at a point 10 inches below the mount plates.

3.2.15 Moisture. Droplets or "slugs" of MEA and water shall not enter the purifier resin (see 3.3.8 and 3.3.9) and CO_2 compressor.

Discharge air from the plant shall contain no visible droplets of liquid.

3.2.16 Connections. Connections and joints for all mechanical and electrical equipment shall be as specified in 3.3.11.

3.3 Mechanical equipment design.

3.3.1 Mounts. Mounts shall conform to Dwg 803-1385778. The four main mounts (see 3.2.6) shall be type 6E2000. Mounts for double mounting (see 3.3.6) shall be suitable for the intended loading.

3.3.2 Absorber, base, and boiler-stripper. Materials for the absorber, base, and boiler-stripper shall be corrosion-resisting steel. Pipe which is an integral part of absorber or boiler-stripper shall be seamless. Completed absorber, base, and boiler-stripper shall be acid cleaned internally and externally in accordance with the requirements for corrosion-resistant steel pipe as specified in MIL-STD-419. The absorber and boiler-stripper shall be packed column designs. Packing shall be woven wire mesh type made of corrosion-resisting steel. Other packing material or types may be used subject to review by NAVSEA. Packing shall be cleaned to remove dirt and oil prior to filling the absorber. Boiler-stripper shall be installed at an elevation which facilitates complete gravity drain of waste MEA to the absorber.

3.3.2.1 Absorber and base. Absorber and base shall be a welded integral unit constructed so as to aid in attenuating noise and vibration. The top of the base shall consist of a plate which shall prevent parts, tools, and MEA leakage from falling below the plant. A structural angle or similar device shall be welded around the perimeter of the base to form an MEA leakage drainway not more than 2 inches deep by 2 inches wide. Drainway shall be sloped to drain connections provided on the sides of the plant near each of the front corners of the plant. Removable screens shall be installed over each drain to protect the ship's drain system from foreign matter. A portable hose (see 3.3.11.6(d)) and fresh water shall be used to flush the drainway. Plates or bars shall be welded across the front and rear of the plant and on top of the base to prevent MEA leakage. Absorber shall allow air and MEA to enter near the top to provide cocurrent flow. The lower portion of the absorber shall act as an MEA sump. The bottom of the absorber shall be dished head, or similar construction, to form a curved radius at the lower edge. The bottom of the absorber may extend below the top of the base. A horizontal drain line and valve, facing the front shall be provided at the lowest extremity of the absorber and shall be capable of completely draining the absorber by gravity. A liquid level gage with shut-off valves shall be provided to indicate the sump MEA level and to facilitate measurement of liquid added to the absorber. The liquid gage shall be furnished with a replaceable plastic tube which shall be shockproof and transparent, shut-off valves, and corrosion-resisting material tube guards and graduated scale (see 3.3.10.6). The top of the absorber shall be flanged and bolted to the main body of the absorber. The exhaust air duct from the absorber shall be sized so that the effluent air velocity does not exceed 10 feet per second (ft/s). The packing volume shall be not less than 11 cubic feet.

3.3.2.2 Boiler-stripper. Boiler-stripper shall be a welded integral unit. Boiler section shall be provided with an automatic liquid level control device and a reflex type gage (see 3.3.10.6). Float control valve shall be designed to prevent forcible discharge of hot MEA to the

surroundings. Level control device shall control the amount of MEA leaving the boiler section. This flow shall be regulated over a flow range that will be suitable for adequate heat transfer in the heat exchanger and MEA cooler (see 3.3.7). A heater (see 3.5.2) shall be installed in the boiler section in a manner to facilitate easy access, removal and replacement. Boiler section shall also be provided with the liquid level detecting devices (see 3.5.3). The top of the boiler-stripper shall be flanged to accommodate a removable CO_2 cooler (see 3.3.7). Boiler-stripper shall operate under a gage pressure not to exceed 40 lb/in^2 to prevent excessive thermal degradation of the MEA. Back pressure regulating valve shall be tightly closed when not under gas pressure.

3.3.2.3 MEA filter. Plant shall include a packed bed of activated carbon, located at a suitable point in a cold MEA stream. Flow through the carbon bed shall be upward and shall be 1/4 to 1 gal/min. Air purification carbon in accordance with MIL-C-17605 shall serve to remove foam-and-color-causing contaminants from the MEA solution. The bed shall contain a volume of 1/2 cubic feet (minimum) of carbon, and shall be provided with filters, drain and vent valves, flow controls, etc. as necessary to permit convenient and simple replacement of used carbon and to prevent dust from contaminating the MEA solution.

3.3.3 MEA pump. An MEA pump shall be used to recycle MEA, to pump rich MEA (see 6.4) to the top of the stripper, and pump waste MEA to the ship's sanitary tank and shall be in accordance with class C-1 of MIL-P-17639, except as specified herein. Thermometer gages, and shock tests are not required specifically for the pump. The pump shall be provided with mechanical shaft seals. Replacement of the seal mating ring shall not require replacement of the impeller. Motors and controllers shall be as specified in 3.5. Materials in contact with MEA, or with MEA leakage from the pump seals with the exception of nonmetallic materials, shall be corrosion-resisting steel. Pump shall have a discharge gage pressure compatible with the boiler-stripper design, and not less than 40 lb/in^2 to facilitate pumping waste MEA to the ship's sanitary tank.

3.3.4 Air blower and CO_2 compressor.

3.3.4.1 General requirements. Both the air blower and CO_2 compressor shall meet the requirements for the conditions imposed in plant service. They shall be reliable, and parts shall be resistant to corrosion and shall be accessible for repair (see 4.3.7).

3.3.4.1.1 Bearings shall be anti-friction type in accordance with either MIL-B-17931 or FF-B-171, provided the contractor meets the noise and vibration requirements of this speicfication (see 3.2.8).

3.3.4.1.2 Both the air blower and CO_2 compressor shall be furnished with self-contained lubrication systems. Lubricants for these components shall be automatic transmission fluid, type A, and MIL-L-17672 lubricating oil, respectively. Lubrication replenishment devices shall be easily accessible from the front or either side of the plant. Drain facilities shall be provided as applicable and shall preclude lubricant leakage outside the confines of the air blower and CO_2 compressor.

3.3.4.1.3 Oil level indicators shall be provided and shall be connected to the oil sump in a manner so as not to be affected by pressure variations between the oil sump and the atmosphere. This type of indicator connection applies whether or not the sump is vented to atmosphere. Oil indicators shall be marked "F-" and "L-" to indicate full and low, respectively. If the indicators are the type that when oil is visible, the level is satisfactory, only "F-" to indicate full shall be marked on the indicator.

3.3.4.1.4 Air blower and CO_2 compressor shall be driven by V-belts or directly driven by motors. Couplings shall be avoided. Where V-belt drives are used, the number of pulleys shall be kept to a minimum. Pulleys shall be single groove and made of corrosion-resisting steel. Pulleys shall be alined to a tolerance of plus or minus 1/32 of an inch. V-belts shall be high strength and shall be rated to transmit power at least 1.25 times the required horsepower for the driven auxiliary. A means to adjust V-belt tension and pulley alinement shall be provided.

3.3.4.2 Air blower. Air blower shall be furnished and shall be designed to operate continuously under the conditions specified herein and at the back pressure afforded by the plant design and the conditions of 3.2.4.1. Blower housing or inlet and discharge lines shall be provided with a means to facilitate measurement of the blower inlet and discharge pressures. The rotational speed of the blower impeller shall be a maximum of 14,500 revolutions per minute (r/min).

3.3.4.3 CO_2 compressor. CO_2 compressor design shall be a two-stage or three-stage, air cooled reciprocating compressor. A noise diffuser shall not be used on the discharge side of the compressor.

3.3.4.3.1 CO_2 compressor shall be designed to operate continuously when used to raise the pressure of CO_2 to gage pressures which will vary from 25 lb/in^2 to the pressure specified in notes of Dwg SS501-1517738. Compressor shall also continue to operate with suction pressures and capacities afforded by the plant design. Multi-stage compressors shall be furnished with interstage coolers (as required) and relief valve(s) (see 3.3.11.2). Vent valves (see 3.3.11.2) shall be installed in the compressor suction and discharge piping to facilitate starting the compressor in the unloaded condition. Oil filters or screens shall be accessible through a cover or similar means in the crank case.

3.3.5 Guards. Guards shall be provided to prevent accidental contact with moving parts. Guards for "V" belt drives shall consist of an expanded metal steel mesh with an enclosing steel band. Access openings or doors, as required for plant operation and examination, shall be furnished on all guards.

3.3.6 Machinery beds and foundations. MEA pump, air blower, CO_2 compressor and drivers shall be bolted to machinery beds which shall be mounted to the base frame or a foundation with mounts (see 3.3.1). Machinery beds shall be sufficiently rigid and shall be installed in a horizontal plane and may be made of types 304 or 316 corrosion-resisting steel. Snubbers shall be provided to minimize movement of the machinery beds in a horizontal plane. Snubbers shall not affect the shock and noise attenuating characteristics of the mounts. Each machinery bed shall be electrically grounded. Adequate foundations and supports to support equipment shall be welded or bolted to the absorber, base, or boiler-stripper. Vibration isolated pads may be used in lieu of snubbers and mounts.

3.3.7 Coolers and heat exchangers.

3.3.7.1 An air cooler, CO_2 cooler, and MEA heat exchanger and if needed, an MEA cooler shall be installed in the plant. Coolers and heat exchangers shall be the indirect type. The chilled water side of the coolers shall conform to the following:

(a) 150 lb/in^2 operating gage pressure.

(b) 225 lb/in^2 design gage pressure.

(c) 338 lb/in^2 test gage pressure.

3.3.7.2 Air cooler shall be furnished with a means to facilitate drainage of condensate to the absorber. The temperature of the air leaving the cooler shall be of a maximum of 74°F. The air cooler shall be furnished with fins on the air side only (without fins on the water side) in order to reduce mineral deposits. Cooler surfaces shall be nickel, corrosion-resisting steel, or both.

3.3.7.3 Coolers and heat exchangers shall be constructed of corrosion-resisting steel and shall be satisfactory for the heat transfer requirements encountered in plant service. CO_2 cooler shall be furnished with a condensate drain connection. The temperature of the fluid leaving the CO_2 cooler shall be a maximum of 70°F. The MEA heat exchanger shall minimize the heat input requirement for the boiler-stripper. These coolers and heat exchangers may be made of type 304 or type 316 corrosion-resistant steel, provided the corrosion resisting properties are not impaired. Type 304L or 316L shall be used for welded parts.

3.3.8 Separators. Moisture and MEA mechanical separators shall be installed in the air and CO_2 lines. Separators shall be constructed of materials suitable for the intended use, shall be furnished with condensate drain connections, and may be combined as integral parts of applicable coolers or purifier or both. The condensate drain lines shall be equipped with sight gages or other suitable means to ensure adequate drainage. Moisture removal methods requiring reactivation or replaceable cartridges are not acceptable. If demisters or similar devices are used, retainers and supports to prevent deflection dislocation, and disconfiguration of the demisters or devices shall be provided, and they shall be so designed that the superficial gas velocity through them shall be a maximum of 8 ft/s. CO_2 moisture separator shall contain demisting section at least 4 inches deep and shall be large enough to hold at least 1 gallon of carry-over liquid from the CO_2 cooler without flooding the CO_2 compressor.

3.3.9 Purifier. A purifier shall be installed to remove MEA vapor from the effluent air. Purifier shall incorporate a minimum of four resin filled bags. The resin and resin filled bags shall conform to piece numbers 24 and 25 of Dwg SS501-1524708, except that the weight of the nylon cloth shall be 1-1/2 ounces per square yard. A means shall be provided to prevent shifting of the resin in the bag. The resin filled bags shall be arranged within the purifier to a minimum depth of 2-1/2 inches. The linear velocity of process air through the resin bag assembly shall be a maximum of 150 feet per minute (ft/min) and shall be in a downward direction. The resin filled bags shall be housed in an enclosure with retainers and supports to prevent deflection, dislocation, and disconfiguration of the resin filled bags. A means with positive holding devices shall be provided to facilitate removal and replacement of the resin filled bags. Purifier shall be constructed of corrosion-resisting steel, and may be combined as an integral part of the air cooler or applicable separator or both. Eight resin filled bags shall be furnished with each plant.

3.3.10 Plates. Identification and information plates shall be required and shall conform to types A, B, and C of MIL-P-15024 and MIL-P-15024/5 except plastic is not acceptable. Serial numbers may be punched and do not require an enamel fill. All etched, engraved and stamped letters, numerals and other characters shall be filled with black enamel, except for warning and caution plates which shall be filled with red enamel. Plates shall be mounted on or near its associated equipment and shall be as specified herein. Plates shall be readable from the front or sides of the plant.

3.3.10.1 Identification plate. Plant shall have an identification plate located on the front of the plant. Plate shall be a minimum of 3 inches by 5 inches and shall contain the following data:

(a) Title of equipment.
(b) U.S. Navy serial numbers (to be furnished by NAVSEA (see 6.5).
(c) Manufacturer's name, model, and serial numbers.
(d) Contract or order number.
(e) Section for Government representative stamp.

3.3.10.2 Instruction plate. Plants shall contain an instruction plate(s) or paper instruction sheet(s) laminated in plastic. Where multiple sheets are used, they may be installed in book form provided a metal hinge and fastening device are firmly affixed to the plant and all sheets are readily visible. Plate(s) or sheet(s) shall contain the following data:

(a) CO_2 plant flow diagram with valve and special valve identifying numbers, and the descriptive names of other equipment shown on the diagram, and shall be sufficiently complete to illustrate all of the flow processes.
(b) List of valves and special valves with descriptive names and identifying numbers (see 3.8.1). This information may be included on the flow diargram.
(c) Prestart instructions.
(d) Start-up instructions.
(e) Shut-down instructions.
(f) Cautions and warnings (red enamel filler for plates; red print for paper sheets).

3.3.10.3 Plates for the pressure gages, MEA pump and motors shall conform to the applicable equipment specifications.

3.3.10.4 Plates for the blower, compressor, coolers, heat exchangers, special valves and flowmeters shall show the following information:

(a) Manufacturer's name.
(b) Manufacturer's identification numbers, such as model number, part number, and size.
(c) Manufacturer's serial number.
(d) Design characteristics, such as capacity, pressures, except where classified, heat transfer characteristics speeds, calibration data, horsepower, test pressure, etc.
(e) Contract number.
(f) National stock number when known (consult contractor or NAVSEA).

Additional plates for special valves shall contain data conforming to 3.3.10.5. Additional plates for flowmeters and pressure gages shall show the normal flow and pressure ranges.

3.3.10.5 Plates for valves (including special valves) shall contain the following data:

(a) Valve identifying number (see 3.8.1).
(b) Brief description of function of the valve and valve position, as applicable.

3.3.10.6 Liquid level scale plate for the absorber shall be graduated in gallons. Liquid level scale plate for the boiler-stripper shall indicate the alarming level of the liquid level detection devices (see 3.3.2.2) and the level of the highest portion of the heaters and shall be so marked.

3.3.10.7 Plates for the control panel shall be in accordance with 3.5.4 and 3.5.5.4.

3.3.10.8 Warning plates. Warning plates shall be installed at critical locations, such as the heater terminal box cover, to warn against danger or hazards. Warning plates shall contain the following information:

"Warning - 440 volts".

3.3.11 Piping. Piping includes pipe, tube, valves, special valves, flanges, fittings and special fittings. Flanges or unions shall be provided to facilitate removal of equipment that may require repair or replacement. Piping shall be kept to a minimum but shall be sufficient to provide for proper flow of chilled water, fresh water, MEA, CO_2, air, and condensate. The requirements specified herein for pipe shall also apply to "tube" and "lines". Service connections except those for air and power shall be flanges, unions, or union-ended valves.

3.3.11.1 Pipe. A means to prevent spillage shall be provided to fill the absorber, and to flush the MEA drainway (see 3.3.2.1) with fresh water. Flushing line and a portion of the filling line shall be seamless copper tube conforming to MIL-T-24107 with a minimum wall thickness of 0.065 inch. Fresh water from the ship shall be directed through the copper fill line to a funnel (see 3.3.11.6(g)). Flushing line shall be a branch off the copper fill line (see 3.3.11.6(d)). Copper fill line and the funnel shall be arranged to provide an atmospheric break and to enable the operator to see that the water is flowing. The balance of the water fill line from the funnel to the absorber shall be corrosion-resisting steel. Piping subjected to submergence pressure or greater shall be made of 316L corrosion-resisting steel and designed for pressures specified in note 3 of Dwg SS501-1517738. Pipe bends shall meet the requirements of MIL-STD-1627.

3.3.11.1.1 Chilled water lines shall be of 70-30 copper-nickel alloy, type I, class 200 of MIL-T-16420. Chilled water connections to coolers shall be socket-welded.

3.3.11.1.2 All other pipe shall be seamless corrosion-resisting steel in accordance with MIL-P-1144, MIL-T-8606, or ASTM A 213. Welded joints in the CO_2 compressor discharge line shall be socket welds. A means shall be provided to fill the absorber with MEA with a minimum amount of spillage. MEA piping shall be so arranged that the boiler-stripper may be filled by pumping (with MEA pump) from the absorber, and waste MEA from the boiler-stripper can be drained by gravity to the absorber sump. MEA pump shall be used to pump waste MEA from the absorber. Relief valves shall vent to ship's atmosphere in a manner to prevent harm to personnel. Condensate return lines from the CO_2 cooler, air cooler, and separators to the absorber or boiler-stripper as applicable, shall be provided to minimize the loss of MEA and water. Lean and rich MEA sampling lines shall be provided and shall drain into the funnel. Sampling lines and funnel shall be so arranged that a test tube (see 3.6) may be used to collect the sample.

3.3.11.2 Valves. Valves with soft seats conforming to Dwg 810-4384536 shall be installed as throttle valves in the copper portion of the fresh water filling and flushing lines. All other valves, except special valves, shall be made of corrosion-resisting steel. Means shall be incorporated to prevent galling and seizing, utilizing material (except steel) other than that specified herein. Where socket weld ends are used, the valve shall be conditioned as necessary to prevent corrosion after welding. Valves shall be designed and installed so that all internal valve parts may be adjusted as required, and removed without removing the valve body from the plant. Valve packing and soft seats shall be polytetrafluoroethylene, synthetic rubber or similar materials.

3.3.11.2.1 Shut-off valves shall be provided for fresh water filling (between funnel and absorber), MEA pump suction lean MEA discharge from boiler to absorber, MEA waste discharage, compressor discharge (in-line), compressor suction vent and as otherwise required. The MEA pump suction valve shall be flanged.

3.3.11.2.2 Throttle valves shall be provided for rich MEA flow control to the boiler-stripper, rich MEA sampling, compressor discharge vent, MEA supply to absorber and as otherwise required.

3.3.11.2.3 Spring loaded soft-seat check valves shall be provided to prevent backflow of rich MEA from the boiler-stripper, and to prevent backflow of CO_2 discharge from compressor and as otherwise required.

3.3.11.2.4 Automatic, spring loaded, soft seat relief valves shall be provided to protect the boiler-stripper and CO_2 cooler, compressor and as otherwise required. The compressor discharge relief valve setting shall be as specified in note 2(b) of Dwg SS501-1517738.

3.3.11.3 Special valves. Special valves shall be as specified herein and as otherwise required. Special valves shall be designed and installed so that all internal valve parts may be adjusted or removed without removing valve body from the plant.

3.3.11.3.1 Constant flow regulating fittings shall be installed as required, to regulate the chilled water flow and shall conform to the applicable requirements of Dwg S5901-1385801.

3.3.11.3.2 Temperature regulating valves, if required in the chilled water system, shall be in accordance with MIL-V-19772. Materials shall conform to the requirements for series 100 or 250, except that materials in contact with MEA shall be corrosion-resisting steel.

3.3.11.3.3 A back pressure regulating valve shall be installed to maintain a pressure on the boiler-stripper and CO_2 cooler. Valve shall be a diaphragm type and shall modulate the flow of CO_2. Materials in contact with CO_2 shall be corrosion-resisting steel, polytetrafluoroethylene or synthetic rubber. Valve shall be designed to minimize cycling (intermittent or varying flow).

3.3.11.4 Flanges. Flanges for the chilled water systems shall be bronze and shall conform to class 150, plain of MIL-F-20042. Flanges for other systems shall conform to ANSI B16.5 with socket weld connections, as applicable, except that the material shall be corrosion-resisting steel.

3.3.11.5 Fittings. Fittings include items such as tees, ells, pipe couplings and reducers. Fittings for the chilled water system and copper portions of the fresh water system shall conform to MIL-F-1183 and shall have silver braze socket connections. Fittings for other systems shall be corrosion-resisting steel, shall have socket weld connections, and shall conform to ANSI B16.11 or the equivalent tube fitting standard.

3.3.11.6 Special fittings. Special fittings include the following and shall be as specified:

(a) Wye type strainers shall be installed in the rich and lean MEA lines and in the CO_2 discharge line between the CO_2 cooler and back pressure regulator. Strainers 2 inches and larger shall be flanged. Strainers less than 2 inches shall be socket welded. Strainers shall be arranged for screen removal without disconnection of piping. Screen cartridges shall retain foreign matter on the inside of the screen and shall be arranged for adequate clearance between the outside of the screen and inside of the shell. Screen cartridges shall be removable for cleaning but shall be positively located. Materials shall be corrosion-resisting steel.

(b) Unions in the chilled water and copper portion of the fresh water systems shall be silver braze socket unions conforming to MIL-F-1183. Unions for other systems shall be socket weld with an "O" ring seal conforming to Dwg 810-1385884 or 810-1385888 and shall be constructed of corrosion-resisting steel. Where unions are used as adapters between tube and pipe, they shall conform to Dwg 810-1385884 as specified above except the socket for the tail piece shall be bored in accordance with Dwg 810-1385888.

(c) "O" rings and similar items shall be in accordance with MIL-P-25732.

(d) Hose shall be installed for sound, shock, and vibration isolation. The length of hose shall be suitable to meet shock and vibration motions and in no case shall be less than 9 inches exclusive of end fittings. Hose shall be arranged to preclude breakage or cracking. For fluid temperatures of 400°F or less, polytetrafluoroethylene or corrosion-resisting steel flexible hose shall be installed, except that flexible synthetic rubber hose may be used for fluid temperatures of 140°F or less. Hoses with materials subject to age or environmental degradation shall have a minimum burst pressure of at least four times the maximum working pressure of the system where installed. Metallic type flexible hose shall have a minimum burst strength of

at least two times the maximum working pressure of the system where installed. Hose connections shall be designed to facilitate hose removal without twisting the hose or equipment. Permanent markings shall be provided to clearly show the due date of manufacture and manufacturer's trademark. Flexible hose shall not be used in any system exposed to submergence pressure. Hose clamps may be used for service under 15 lb/in^2 and shall be designed for a tight seal and to facilitate easy removal without the use of special tools. Special tools are defined as those tools not listed in the Federal Supply Catalog. (Copies of this catalog may be consulted in the office of the Defense Contract Administration Service Management Area (DCASMA)). A portable flexible hose shall be provided to facilitate pressurizing the boiler-stripper by connecting the compressor discharge vent valve and a connection such as the CO_2 line wye strainer. This portable hose shall be used during start-up and flushing operations. Means shall be provided to store and secure the portable hose to the plant.

(e) Pipe shall be structurally sound and shall be furnished with means to minimize noise transmission through the hanger from the pipe to other portions of the plant. Pipe hangers shall be installed for every unsupported length of piping in excess of 3 feet and for every unsupported length of piping that forms a cantilever of 1 foot or more. Pipe joints with equipment which is mounted securely to supports, foundations or the base are considered to be supported. Pipe hangers shall be welded or bolted to the absorber base, boiler-stripper or foundations.

(f) Brass or bronze vent fitting(s) shall be installed to vent the chilled water system.

(g) A fresh water filling funnel shall be installed. Funnel shall be constructed of corrosion-resisting steel and shall have a screen to prevent foreign objects from entering the absorber. Funnel shall have a socket weld connection.

(h) Flowmeters shall be installed to indicate the quantity of CO_2 leaving the CO_2 cooler, MEA to the boiler-stripper, and MEA to the MEA filter. The scale ranges shall be selected to facilitate accurate readability. MEA flowmeter scale shall be graduated in gal/min and fractions thereof and so marked. The CO_2 flowmeter scale shall be graduated in pounds per hour at normal operating temperature and pressure and so marked. Scales shall have black markings on a white background and shall have ranges as close as practical to 1-2/3 times the normal operating flow. Flowmeters shall be designed so that moving parts will not bind or remain in their static location when flow commences. If stops are used, a graduation mark and the appropriate flow rate corresponding to the stop position

shall be shown. A means shall be provided to minimize the effect of pump and compressor pulsations on flowmeter readability. This means may be internal or external to the flowmeters. Instrumentation piping shall be in accordance with Dwg 810-1385850.

(i) Pressure gages shall be installed to indicate the CO_2 pressure at the inlet and discharge of the back pressure regulator, and at the discharge of the MEA pump. Pressure gages shall conform to MIL-I-18997, with Bourdon tubes of corrosion-resisting steel or equal. The scale range shall be in accordance with MIL-I-18997 and shall be as close as practical to 1-2/3 times the normal operating pressure. A pressure gage shall be used to indicate the inlet pressure to the back-pressure regulator, and a compound gage shall be used to indicate its discharge pressure. Snubbers shall be installed to reduce pressure pulsations in the pressure gages. Materials in contact with CO_2 shall be of corrosion-resisting steel.

3.3.11.7 Threaded connections. Taper pipe threaded connections including "Dryseal" or equal between piping and equipment and within piping systems and equipment shall not be permitted. For size 1 inch and below, flareless mechanical "bite" type fittings in accordance with MIL-F-18866 are acceptable when installed with corrosion-resisting steel tubing except unions shall be as specified herein. For sizes larger than 1/2 inch outside diameter (o.d.), mechanical "bite" type fittings with SAE straight threads and "O" rings for boss mounting may be used for connection to components. Female threads in threaded connections shall be in accordance with MS16142.

3.3.12 Gage board. A gage board may be installed for mounting plates and pressure gages. Gage board shall in no way interfere with the operation and maintenance of the CO_2 removal plant (see 3.2.14). Gage board shall not obscure the observation of items such as gages, meters, plates and indicators nor require removal for maintenance of the plant. No threaded components, including valves, shall be located behind the gage board. Gage board shall not be used to support piping (excluding pressure gages) except by means of bolted pipe hangers. Where piping passes through the gage board, hole dimensions shall be large enough to permit removal of the piping and associated fittings.

3.3.13 Insulation. Insulation materials shall be in accordance with Dwg SS501-818415. Adequate insulation shall be provided for heat and cold conservation, personnel safety, and where condensation is likely to form on the external surface of piping. Insulation, as required, for valves, unions, flanges and special fittings, except pipe hangers shall be capable of being removed and shall be reusable.

3.4 Electrical system requirements. In general, the electrical system shall include motors, boiler heater, level detection and alarm system, temperature indicator system, and control panel. The electrical system shall conform to MIL-E-917, as applicable, and shall be similar to that shown on figure 3.

3.4.1 Circuitry. Power supply to the plant disconnect switch, motors, controllers, boiler heaters, and primary side of a control transformer shall be 440 volts, 3-phase, 60 Hz, type I power in accordance with DOD-STD-1399, section 300. Control circuits for the motors and heater shall be 440 volts. The secondary side of the control transformer shall be 110 volts and shall govern the voltage input to other electrically operated components.

3.5 Electrical equipment design.

3.5.1 Motors. Single speed motors of the smallest required size shall be furnished. Motors shall be in accordance with MIL-M-17060, except that the structureborne noise level of integral horsepower motors shall not cause the carbon dioxide removal plant to exceed the requirements of the structureborne acceptance criteria curve shown on figure 2. Motors shall be capable of starting, accelerating, and operating the driven auxiliaries under all maximum load conditions. Motors shall operate on 440 volts, 3-phase, 60 Hz power and shall conform to the following requirements and characteristics:

(a) Type: Squirrel-cage induction.
(b) Voltge: 440 volts, 60 Hz, 3-phase.
(c) Enclosure: Dripproof protected 45 degrees (DPP).
(d) Horsepower: As required.
(e) Speed: As required.
(f) Bearings: Ball.
(g) Duty: Continuous.
(h) Service: A.
(i) Ambient: 50°C.
(j) Insulation: Class B, F, or H.
(k) Temperatures at rated load shall not exceed class B rises for 50°C ambient.
(l) Motor shall be for submarine service.
(m) Motor balancing rings are required.

Individual controllers and control circuits shall be provided for each motor. Each motor shall be grounded.

3.5.2 Boiler immersion heater assembly. Boiler immersion heater assembly shall be capable of supplying a constant (within voltage limitations) rate of heat to reactivate the MEA solution in the boiler and shall consist of heater elements, mounting plate, jackets, terminal box and associated fasteners. Caution shall be taken to minimize MEA breakdown due to excessive heat. Heating elements shall conform to type III of MIL-H-22577, with hermetic end seals and threaded terminals. Each element shall conform to the dimensions shown on figure 4 to maintain interchangeability with heater elements now installed in ships. Heating elements shall be provided with corrosion-resisting seamless pipe sheaths. Sheaths shall be designed to minimize stress corrosion and shall be electropolished to minimize corrosion pitting. Heater element gaskets shall be fiberglass-impregnated polytetrafluoroethylene and shall be restrained to prevent flow under pressure. A brace bar shall be installed on the heater elements to prevent twisting of the elements during installation on the mounting plate. Mounting plate shall be corrosion-resisting steel and shall facilitate mounting on the boiler section (see 3.3.2.2). Element

terminals shall be enclosed in a dripproof terminal box conforming to MIL-C-2212. Terminal box shall have a terminal access cover. A controller, control circuit and "heater-on" indicating light (see 3.5.5.3) shall be provided for specific control of the heater. Watt density of the heater elements shall be a maximum of 25 watts per square inch.

3.5.3 Level detectors and alarm system. A level detection and alarm system shall be installed to monitor the MEA liquid level in the boiler section. Level detection system shall contain sensing probes fitted with air gaps through which an ultrasonic signal is transmitted when filled with liquid. System shall include liquid level detectors for both high and low levels, necessary electrical and electronic assemblies, and an alarm bell. Bell shall be type 1C/B1S4 in accordance with Dwg 9000-S6504-73904 and shall sound at both high and low levels. Indicating lights (see 3.5.5.3) shall be provided to indicate both normal and abnormal levels for both high and low levels. Green lights shall indicate normal; red lights with flashers shall indicate abnormal. An electrical interlock device shall be provided to automatically shut off the heaters, compressor and air blower at the low level condition. An electrical interlock device shall be provided to automatically shutoff the heaters and all motors at the high level condition. The low level limit shall be above the top of the boiler heater. The high level limit shall be located below the packing and at a level which will permit adequate heating and will avoid nuisance shutdowns (see 3.3.2.2). A device(s) shall be provided to de-energize the bell when the levels are high or low, and when in this de-energized position, the alarm shall sound when the level once again becomes normal. This same device(s) shall be used to test the alarm bell. A separate device shall be provided to silence the alarm under any condition. A red indicating light shall be provided to indicate that the alarm is in the silent position. Level detection system indicating lights shall remain lit as appropriate when the alarm bell is de-energized. In the event of failure of the internal wiring of the electronic assemblies, the alarm shall sound and level indicating lights shall indicate abnormal conditions. Unless previously considered satisfactory for CO_2 plant service, the electronic assemblies associated with level detection shall be subject to NAVSEA review.

3.5.4 Temperature indicating system. A temperature indicating system shall be provided to indicate the temperatures of the CO_2 leaving the CO_2 cool, rich MEA in the absorber sump, and inlets and outlets of the MEA heat exchanger (4 places). Except as specified herein, the temperature indicating system shall include resistance elements, protecting covers (thermowells), leads, selector switch and temperature indicator. Resistance elements shall be readily replaceable and shall include resistors and protective sheaths retained by corrosion-resisting steel protective covers. Selector switch and temperature indicator shall be mounted adjacent to each other on the front of the control panel, and the enclosures of those portions extending outside the control panel shall be dripproof or watertight in accordance with MIL-C-2212. Points on the selector switch shall be plainly marked. An information plate (see 3.3.10) shall be mounted on or adjacent to the selector switch and shall be marked

to identify the point where the temperature is read and the normal operating temperature range. Temperature indicator shall have a scale range of 50°F to 350°F. Scales shall have black lettering and graduations on a white background. Unless previously considered satisfactory for CO_2 plant service, the temperature indicating system shall be subject to NAVSEA review.

3.5.5 Control panel. Except as specified herein, the control panel shall conform to MIL-C-2212. Control panel shall have a drippproof 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 and shall be designed for operation at the conditions prevailing within the control panel, when the ship's ambient conditions are as specified in 3.2.3. Control panel cover shall be hinged and provided with captive screws. Cover design shall facilitate complete access when open to electrical components mounted within the enclosure. Components such as indicator lights, switches, information and identification plates, fuse receptacles, and similar devices shall be mounted conveniently on the front of the control panel (see 3.5.4 and 3.3.10). Cable entrance plate shall not be at the top or front of the control panel. Control panel shall have removable structural bracing and flexible wiring to prevent breakage of components during shipboard vibrations as specified in 3.2.8.

3.5.5.1 Disconnect switch. Disconnect switch shall conform to types 3SR3A2 or 6SR3A2 of MIL-S-15291.

3.5.5.2 Controllers, relays, and control circuits. Controllers and relays, and the motor and heater control circuits shall conform to MIL-C-2212 and shall have the following characteristics:

(a) Operation: Magnetic.
(b) Type: Across-the-line.
(c) Performance: Nonautomatic (see 3.5.3).
(d) Protection: Low voltage protection (LVP).
(e) Function: As applicable.
(f) Master switches: Local pushbuttons.
(g) Enclosure: Open (inside control panel).

3.5.5.3 Indicating lights. Indicating lights shall conform to types B-27A and B-27B, as applicable, of Dwg 9000-S6202-73907, or types B-41C and B-41D, as applicable, of Dwg 9000-S6202-73919. Lenses shall be permanently marked to indicate plant condition. Lenses shall be flat, slightly raised above the mounting surface, and translucent except for marking. The lens colors shall be as specified herein. The two "abnormal level" lights shall have flasher units.

3.5.5.4 Plates for control and indicator. Information and identification plates shall be provided to indicate the function of each control and indicator, and shall be as specified in MIL-C-2212. Plates

shall be mounted adjacent to the applicable control or indicator and shall show information such as, heater-on, heater-off, No. 2 motor start, No. 2 motor stop, high boiler level, heater fuse, and similar information (see 3.3.10).

3.5.5.5 Fuseholders. Fuseholders shall conform to type FHL12G of MIL-F-19207.

3.5.5.6 Other electrical equipment. Other electrical equipment such as toggle switches and cable clamps which are not specified in MIL-C-2212 shall be in accordance with the selection of parts requirements of MIL-E-917.

3.5.6 Wire and cable. Wire and cable shall be installed and arranged to minimize slack. However, sufficient slack shall be provided to preclude breakage and chafing, particularly between hinged parts. Wire and cable shall be bundled, and laced or clamped or both. Lacing shall be accompished with cordage of slow burning fungus resistant type. Clamping shall be accomplished with polyamide clamps. Metal clamps may be used but shall not form complete loops around the wire. Nylon cloth shall be placed under cordage or metal clamps to preclude breakage or chafing of the wire or cable. Ends of braided coverings shall be protected to prevent fraying. Where wires or cable, single or in groups, pass through metal, the passage holes shall be provided with grommets or other devices to prevent breakage or chafing. Wire and cable shall be color coded or tagged on each end to facilitate shipboard testing and locating of faults. Color coding, if used, shall be in accordance with the identification of conductor requirements of MIL-E-16400.

3.5.6.1 Wiring inside the control panel shall conform to MIL-W-16878.

3.5.6.2 Interconnecting cable between points outside of the control panel to points inside the control panel shall conform to MIL-C-915 and MIL-C-17.

3.6 Test kit. Test kit shall conform to Dwg SS501-1524716, except that the methyl purple indicator shall be replaced with bromophenol blue indicator conforming to MIL-B-11722, and 0.5 normal nitric acid shall be used in lieu of 0.5 normal sulfuric acid. Test kits shall not be installed in the plant. One test kit shall be furnished with each plant.

3.7 Reliability and maintainability requirements.

3.7.1 Reliability. The specified mean-time-between failures (MTBF) of the plant shall be not less than 350 hours. A failure is defined as when either of the following conditions occur:

(a) A condition resulting in an unavoidable, forced shutdown of the plant, that can not be restored without some degree of disassembly to repair or repalce an internal element. This includes any requirement for maintenance during test not specifically identified as scheduled (preventive) maintenance prior to initiation of the test.
(b) When either the plant ceases to function or its performance degrades below the requirements of this specification.

3.7.2 Maintainability. The mean-time-to-repair (MTTR) of the plant shall be not more than 2.5 hours when determined in accordance with MIL-STD-471. The plant shall be designed so that the maximum time to replace the most inaccessible component shall not exceed 5 hours.

3.7.3 Failure mode and effects analysis. The contractor shall perform a failure mode and effects analysis (FMEA) in accordance with MIL-STD-1629. The analysis shall be conducted to the functional subassembly level, except for those failure modes with a level of severity of 4. For these failure modes, the analysis shall be extended to the individually replaceable item level. The FMEA shall identify the design provisions that have been incorporated to inhibit or limit the frequency of occurrence of failure modes with a level of severity of 3 or 4.

3.7.4 Maintenance engineering analysis. The contractor shall perform a maintenance engineering analysis in accordance with MIL-M-24365. The maintenance engineering analysis record (MEAR) forms shall be prepared by the contractor on durable white paper for review of format, scope, and content by the contracting activity. In addition, the contractor shall also prepare for review, a detailed list of equipment assemblies, sub-assemblies, modules and special support equipment to be analyzed. As MEARs are prepared they shall be progressively revised and returned after comment/review to the contractor for correction, if required. Copies for retention are not required. However, the contractor shall make the MEARs available for Government inspection and use, as required. The MEARs will ultimately be used to establish the total support requirements for all levels of maintenance including repair parts, rotatable pools, maintenance plans, manpower, training, and support and test equipment.

3.7.5 Reliability program plan. The contractor shall prepare a reliability program plan conforming to MIL-STD-785 and shall provide for the formal application of the reliability design requirements therein as specified herein. The program shall include:

(a) Reliability management procedures:
  (1) Reliability organization.
  (2) Management and control.
  (3) Subcontractor and contractor reliability program.
  (4) Program review.
  (5) Status reports.

(b) Reliability design procedures:
  (1) Design techniques.
  (2) Reliability analysis.
  (3) Parts reliability.
  (4) Failure mode and effects analysis.
  (5) Reliability critical items.
  (6) Effects of storage, shelf-life, transportation, handling and maintenance.
  (7) Design reviews.

3.7.6 Maintainability program plan. The contractor shall prepare a maintainability program plan conforming to MIL-STD-470 and shall provide for the formal application of the maintainability requirements therein specified herein. The program plan shall include the following elements of the detailed requirements of MIL-STD-470:

(a) Perform maintainability analysis.
(b) Prepare inputs to the detailed maintenance plan.
(c) Perform design trade-offs.
(d) Predict maintainability values.
(e) Incorporate and enforce maintainability requirements.
(f) Integrate other items.
(g) Participate in design reviews.
(h) Establish data collection, analysis, and corrective action system.
(i) Perform maintainability demonstration.
(j) Prepare maintainability status reports.

3.7.7 Reliability demonstration test plan. The contractor shall prepare a reliability demonstration test plan in accordance with NAVSEA 0900-LP-084-6010.

3.7.8 Maintainability demonstration plan. The contractor shall prepare a maintainability demonstration plan in accordance with MIL-STD-471.

3.7.9 Support and test equipment. The contractor shall establish and document the requirement for support and test equipment at the operational, intermediate, and depot level for repair, overhaul, performance monitoring, alinement, calibration, and preventive maintenance.

3.7.10 Time totalizing meter. Plant shall contain a time totalizing meter in accordance with MIL-M-7793. It may be incorporated in lower assemblies if sufficient operational and cost effectiveness can be established.

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

3.8 Technical data. The contractor shall prepare technical data in accordance with the data ordering documents included in the contract (see 6.2.2) for the following, and as specified in 3.8.1 through 3.8.2.4:

(a) Mercury free certification documentation (see 3.1.6).
(b) System safety program plan (see 3.2.13).
(c) Failure mode and effects analysis (see 3.7.3).
(d) Maintenance engineering analysis (see 3.7.4).
(e) Reliability program plan (see 3.7.5).
(f) Maintainability program plan (see 3.7.6).
(g) Reliability demonstration test plan (see 3.7.7).
(h) Maintainability demonstration plan (see 3.7.8).
(i) Microfilming of engineering documents (see 3.8.1).

3.8.1 Drawings. In addition to the drawing content required by the data ordering document (see 6.2.2), the unique features specified in 3.8.1.1 through 3.8.1.6.3 shall be included.

3.8.1.1 Drawings shall indicate any exceptions to the requirements of this specification. A complete set of drawings shall consist of the following:

(a) Diagram and certification data.
(b) Machinery arrangement.
(c) Piping arrangement.
(d) Assembly drawings.

Drawings shall provide an orderly and systematic presentation and shall be reviewed by NAVSEA. The number of sheets shall be kept to a minimum insofar as is practical and shall be consistent with the requirements specified herein. Drawings shall be reproduced for inclusion in the manual (see 3.8.2).

3.8.1.2 Skeleton outlines shall consist of a series of dashes to illustrate an outline. Identifying numbers and descriptive names for equipment shall be consistent on all drawings except assembly drawings. Identifying numbers shall be V-1, V-2, etc. for valves and special valves; P-1, P-2, etc. for pipe; F-1, F-2, etc. for fittings and special fittings; and 1, 2, etc. for other equipment.

3.8.1.3 Diagrams and certification data drawings. Diagrams and certification data drawings shall include the following:

(a) Shipboard installation data.
(b) Piping schematic diagram.
(c) Electrical elementary diagram.
(d) Electrical connection diagram.
(e) Mechanical equipment list.
(f) Electrical equipment list.
(g) Piping and insulation material list.
(h) Certification data.

3.8.1.3.1 Shipboard installation data. Shipboard installation data shall serve as the certification data for the complete plant and shall show all information needed for installation by the installing activity. Data shall include the following:

(a) Plant serial number(s) (U.S. and contractor's).
(b) Ship hull number(s).
(c) Contract number(s).
(d) Simplified outline of plant.
(e) Overall dimensions.
(f) Loaded and unloaded vertical dimensions of the four main mounts relative to their respective mounting supports and the base.
(g) Location (three directions each) of the four main mounts relative to the centerline of the plant.
(h) Type of main mounts.

(i) Location (three directions) of the center of gravity and the radii of gyration about the 3 principal axes.
(j) Wet and dry weights.
(k) Location (three directions each), size, type, materials, type, and orientation of the electric, CO_2 discharge, MEA supply, MEA waste drain, drainway drains, MEA drain from absorber, fresh water supply, chilled water supply and return, air inlet and air discharge service connections. Service connections shall be located relative to the centerline of the plant and where applicable to the depth of sockets.
(l) Skeleton outline of the maintenance space requirements.
(m) Arc through which the control panel door swings.
(n) Latent and sensible heat dissipation.
(o) MEA pump performance curve (gal/min versus discharge pressure at speed used on plant).
(p) Power requirements which include volts, number of phases, frequency, normal amperage, inrush amperage and power factor.
(q) Direction of rotation of motors.
(r) Types of lubricant required for specific equipment.
(s) Special handling procedures, as required.
(t) Other necessary installation instructions and precautions.

3.8.1.3.1.1 It is realized that certain information required for this data duplicates information on other drawings. The intent of this data requirement is to facilitate shipboard installation without reference to other sheets or drawings or assistance from the contractor.

3.8.1.3.2 Diagrams shall show by symbolic representation all equipment except mounts, belt guards, machinery beds, foundations, plates, fittings (but including special fittings), gaskets, pipe hangers, gage board, insulation, test kit, fuseholders, and components such as cable clamps. Piping diagram shall include a table showing the design quantities, pressure and temperature ranges of fluids entering and leaving the plant, absorber, boiler-stripper, coolers, heat exchangers, and back pressure regulator. Wiring diagrams shall be in accordance with MIL-C-2212. Figure 3 is a typical elementary wiring diagram. All equipment as represented in the piping diagram shall have an identifying number. Diagram should include all information necessary to evaluate the process flows.

3.8.1.3.3 Mechanical and electrical equipment lists shall be separate lists and shall be in a columnar form. Lists shall include all equipment except piping, insulation, individual foundations and individual plates. Together these lists shall also serve as a complete list of the drawings specified in 3.8.1.1. Lists shall show an identifying number, descriptive name, quantity required per plant, actual manufacturer's name, part number and drawing number with revision symbol, weight if in excess of 10 pounds, remarks, and shall reference certification data where applicable. Where the contractor is the actual manufacturer, a dash shall be placed in the actual manufacturer column.

3.8.1.3.4 Piping and insulation material list shall be in a columnar or table form. List shall include all piping and insulation except gaskets. The portion pertaining to piping shall show the identifying number, descriptive name, service, size, quantity per plant, type of connection, schedule or pressure rating, material, specification or standard (Military or commercial such as ASTM or ANSI), actual manufacturer, actual manufacturer's part and drawing number with revision symbol, weight of components over 5 pounds, and remarks. Information pertaining to the actual manufacturer need not be shown for pipe, tube, flanges, fittings, unions, tailpieces, and pipe hangers. List shall not show quantities of fittings when submitted for review. Insulation information shall be the same as listed for piping above or shown as a drawing note. The equipment insulated, the materials, and the thickness of each material shall be identified.

3.8.1.3.5 Certification data shall be shown in columnar or table form. Certification data shall include the information necessary to specifically verify or supplement drawings. Typical information required for certification data is the actual manufacturer's serial numbers, speed, design rating, conditions, design capacity, horsepower, type of drive, design fluid quantities, heat rejection capacity, power requirements, and design, operating and test pressures.

3.8.1.4 Machinery arrangement drawing. Machinery arrangement drawing shall delineate outline details of all equipment, except foundation, supports, plates (except as specified herein), test kit and those portions of equipment within the closed control panel need not be shown. Drawing shall be drawn to an accurate scale to illustrate the physical arrangement of equipment and does not require dimensions. Outlines of the instruction plate and plant identification plate shall be shown. Insulation shall be shown as skeleton outlines. This drawing shall include identifying numbers, descriptive name and shall reference the diagram and certification data drawing for complete descriptions of equipment. Machinery arrangement drawing shall show necessary views and cross-sections to evaluate the arrangement design.

3.8.1.5 Piping arrangement drawing. Piping arrangement drawing shall include the details of all piping except gaskets. Where piping is shown as part of an assembly on an assembly drawing, it shall be shown as a skeleton outline on the drawing. Drawing shall be drawn to an accurate scale to illustrate the piping arrangement and does not require dimensions. Descriptive information such as air in, MEA waste, and similar information shall be shown for service connections. Insulation shall be shown with skeleton outlines. This drawing shall include identifying numbers, descriptive names and service, and shall reference the diagram and certification data drawing for complete description of components. A symbolic means shall be used to distinguish the various piping systems. Piping arrangement drawing shall include all necessary views, cross-sections, and skeleton outlines of equipment to evaluate the arrangement design.

3.8.1.6 Assembly drawings. Assembly drawings shall include the following as applicable to the plant:

(a) Absorber and base.
(b) Boiler-stripper.
(c) Air blower.
(d) CO_2 compressor.
(e) Machinery beds and foundations.
(f) Coolers and heat exchangers.
(g) Separators.
(h) Purifier.
(i) Plates.
(j) Panel board.
(k) Boiler heaters.
(l) MEA pump.
(m) Motors.
(n) Control panel arrangement.
(o) Valves.
(p) Special valves.
(q) Special fittings excluding gaskets, "O" rings; hose, and pipe hangers.
(r) Liquid level detection system assemblies such as the sensing element, associated fasteners, and electronic and electrical component assemblies.
(s) Temperature indicating system assemblies such as the resistance elements, protective covers, selector switch and temperature indicator.

3.8.1.6.1 It is preferred that assembly drawings be combined, where practical, to minimize the number of drawing sheets.

3.8.1.6.2 Machinery bed and foundation drawing. Machinery bed and foundation drawing shall include bed plates, guards, V-belt systems, foundations and supports. It shall also include necessary skeleton outlines of components to illustrate their physical relationship to machinery beds and foundations.

3.8.1.6.3 Each assembly drawing shall show outline mounting and connection dimensions including methods, sizes, and types of fastenings and dimensions and clearances required for installation and servicing plus supplementary data as necessary to permit installation without the contractor's assistance. Assembly drawing shall include the necessary cross-sections, dimensions, and identity and nomenclature of parts required for maintenance and to evaluate the design and construction. Assembly drawings shall also include general performance data or curves. Assembly drawings shall also list any special tools and their functions, that may be required for shipboard maintenance. Assembly drawings for the absorber and base, and boiler-stripper shall identify the fluid and mounting connections such as recycled MEA to absorber, MEA pump suction, and similar connections. O-rings, gaskets, and similar devices shall be completely described on applicable assembly drawings. Assembly drawings shall be sufficiently complete to reflect compliance with specification requirements. As applicable (see 3.3.4.1.1), notes shall indicate the type of replacement

bearings. Where assemblies are commercial equipment or commercial equipment with minor modifications, and drawings are not readily available, catalog sheets or other documents may be furnished. However, the catalog sheets, documents, or supplemented catalog sheets or documents shall contain all the information required for assembly drawings, shall provide for satisfactory reproductions for the manual (see 3.8.2), and a complete description of the modification shall be included as certification data on the diagram and certification data drawing. Where equipment is furnished in exact accordance with a NAVSHIPS drawing, the drawing shall be cited, where applicable, on the diagram and certification data drawing along with the manufacturer's drawing. Review of the manufacturer's drawing in this case is not required. It is the contractor's responsibility to assure that the equipment furnished conforms to the NAVSHIPS drawing.

3.8.2 Manuals. In addition to the general requirements covered by the data ordering documents (see 6.2.2), the unique features specified in 3.8.2.1 through 3.8.2.4 shall be included.

3.8.2.1 Manuals shall be reviewed by NAVSEA prior to printing. Manuals shall not include classified information. The "approval and record page" shall have an "EQUIPMENT U.S. SERIAL NUMBERS" column in lieu of a "QUANTITY OF EQUIPMENT" column. The illustrations shall include reproductions of the drawing specified in 3.8.1, and other illustrations required. Exploded views of the air blower and CO_2 compressor shall also be included.

In addition, the parts list shall indicate the actual part manufacturer's name and identifying number. The parts list shall designate parts as either repairable or throw-away and indicate the recommended level for such action. The onboard allowance quantity and National stock number need not be shown. Separate manuals shall be furnished to describe detailed maintenance procedures for the blower and compressor. If the installed blower and compressor are identical to blowers and compressors installed in previous CO_2 plants, these separate manuals are not required. Separate

manuals for individual equipment such as a motor, pump, and similar equipment, shall not be furnished. This information shall be incorporated in the plant manual.

3.8.2.2 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.

3.8.2.3 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.

3.8.2.4 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.

3.9 Workmanship.

3.9.1 Cleaning. Parts, especially machine surfaces and passages, piping and tubing for the MEA solution, cooling water, air, CO_2, and lubricating oil shall be kept clean and protected during storage, fabrication, and assembly. Burrs, chips, shavings, refuse, pipe dope, dirt, scale, and water shall be removed.

3.9.2 Alinement. Piping and tubing shall be so alined that the halves of flanges or unions, when disconnected, shall not move more than 1/4 inch from the centerline and mating surface of the mating half of the mating flange or union.

3.9.3 Deficiencies. The following typical deficiencies are listed for guidance in determining workmanship defects. These and similar workmanship defects shall be avoided during the manufacturing and packaging of the plant.

(a) Miscellaneous damage during shipment. Damage is caused by loose mounting bolts, capillary tubes and cable and unprotected gages and meters.
(b) Leaks in vessels, piping, shaft seals, heat element gaskets.
(c) Cracked gage glass and misalined level gage.
(d) Noisy blower.
(e) Regulator malfunction.
(f) Compressor would not rotate.
(g) Chafing of flexible hose, flexible hoses not bonded at compression fitting, flexible hose bends too sharp.
(h) Lock washers or similar locking devices missing, causing loose or missing bolts. Threads not fully engaged (2 to 3 threads should extend beyond nut).
(i) V-belts and sheaves rubbing on components and belt-guard.
(j) Inadequate welding and misalined piping.
(k) Inadequate valve handwheel clearance.
(l) Carbon steel bolts used.
(m) Float valve binds.
(n) Design did not permit examination. For example, a nipple may be so small that the weld completely covers the nipple. Government representative has no visual means to certify that the nipple has been installed. If design requires such a joint, the joint should be certified and tagged by the Government representative.
(o) Foreign matter found in items such as absorber, boiler, piping and control panel.
(p) Broken coaxial connectors.
(q) Cable and wire loose or not bundled properly, locking devices missing, cable and wire markers missing, unacceptable code markers used.
(r) Electrical connection diagram missing from controller.
(s) Cable and wire markers missing E-Z code markers used.

(t) Markers missing from inside control panel, metal markers in the control panel came loose which can cause shorts or operator hazard.
(u) Heater insulation resistance meggers low.
(v) Panel door binds.
(w) No protection where cable passes through metal openings.
(x) Damage to heat exchanger tubing and gaskets dur to freezing of residual water in system.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 for in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208.

4.2 Examination. Each plant shall be examined to determine conformance to the requirements of this specification for materials, general design, mechanical design, electrical requirements, electrical design, test kit, reliability and maintainability, and workmanship.

4.3 Tests.

4.3.1 Pressure tests. The pressure test shall be conducted on each plant. If any portion of the plant is tested at a pressure higher than the minimum and fails to meet the requirements specified herein, the plant shall be considered as having failed at the minimum pressure. For purposes of this specification, pneumatic tests shall be conducted with air or noncorrosive gas as the pressurizing media. The complete plant shall be pneumatically or hydrostatically tested, except that the compressor test and 5 lb/in^2 tests shall be pneumatic tests only. CO_2 compressor discharge connection shall be leak-tested externally (with a leak-test fluid) while the compressor is discharging gas (air or CO_2) at the pressure shown in note 1(b) of Dwg SS501-1517738. Pressures shall be held for 1 hour after which the plant shall be examined and tested for leaks, deformation, and failure, any of which shall be cause for rejection. The minimum pressure applied to each portion shall be a minimum of 1.5 times the maximum

pressure which a given portion will encounter in service, but shall be not less than 5 lb/in^2. In addition, relief valves shall be tested to relieve at their respective pressure settings while installed in the plant, except that the CO_2 compressor discharge relief valve shall be tested and re-set in accordance with note 2(b) of Dwg SS501-1517738.

4.3.2 Electric circuit test. Independent electrical circuits on each plant shall be checked at room temperature to determine the leakage of current from the circuit to ground and from the circuit being tested to other circuits. The test shall be conducted in such a way so as to reveal any defects in materials and workmanship.. Circuits shall be tested using a 500 volt direct current (d.c.) constant voltage type instrument with a 0 to 100 megohm scale.

4.3.3 Capacity and operation tests. Each plant shall be tested in accordance with 4.3.3.1 and 4.3.3.2 and shall be operated with 440 volt maximum, 3-phase, 60 Hz power and 49°F minimum, cooling water for a minimum of 16 hours, except the first CO_2 plant on each contract, which shall be operated for a minimum of 30 days continuously (if not already accomplished on a previously supplied identical unit) to demonstrate the ability to meet the requirements specified herein. The MEA normality shall be a maximum of 4.0. Antifoam agents shall not be used during the entire 30 day test. MEA shall not be changed during the entire 30 day test. A synthetic atmosphere consisting of CO_2 and air shall be used for the test process air. Where percentages of CO_2 are specified herein, they shall be by volume, measured directly at the time of sampling by either infrared analysis or gas chromatography, to an accuracy of plus or minus 0.04 percent CO_2. Except as specified herein, the CO_2 compressor discharge pressure shall be two-thirds of the maximum working pressure. Air to be used for all tests shall conform to the conditions of 3.2.4.1. The differential pressure of the cooling water shall not exceed 26 lb/in^2 during testing.

4.3.3.1 Liquid level in the boiler-stripper shall be raised and lowered to demonstrate satisfactory operation of the liquid level detection and alarm system, including the indicating lights and automatic plant shutdown and by-pass at low level. Plant shall be operated to demonstrate satisfactory operation of indicating lights, temperature and pressure indicators, and switches. Compressor shall be subjected to discharge pressures of 0 to maximum in a period of 18 to 22 minutes at least three times.

4.3.3.2 Each plant shall be tested for two separate, 6 consecutive hour tests at 0.5 and 1.0 percent CO_2 inlet concentrations respectively. The tests shall not begin until equilibrium flow conditions for 0.5 and 1.0 percent CO_2 as applicable, have been established. Plants shall be operated at optimum stripper feed rates. During each of these tests, the CO_2 compressor discharge gage pressure may be maintained at 100 lb/in^2 for a maximum of 4 hours to facilitate noise testing. After establishment of steady flow conditions, the following data shall be measured at the frequency indicated for each 6-hour test:

Data	Frequency
Date and time of measurement	As applicable
Input power for each motor (kW)	Every 4 hours
Input power for heater (kW)	Every 4 hours
Speed of each rotating component	Every 4 hours
Ambient temperature (^oF)	Hourly
Relative humidity (percent)	Hourly
Barometric pressure (Hg)	Hourly
Temperature, pressures and flows from all gages and indicators installed in the plant	Hourly
Gage pressure of CO_2 from compressor unless classified (lb/in^2)	Hourly
Cooling water flow (gal/min)	Hourly
Plant inlet and discharge cooling water temperature (^oF) and gage pressure (lb/in^2)	Hourly
Absorber liquid level (gallons) - This level should be measured before start-up and 5 minutes after pump shut-down	Hourly
MEA normality	Every 4 hours
Stripper feed rate (gal/min)	Hourly
Air rate (ft^3/min), actual	Hourly
Corrected air rate (at 70^oF - std ft^3/min - calculated)	Hourly
Percent CO_2 in entering and processed air	Hourly
Cumulative pounds of CO_2	At time zero and hourly
Amount of water and MEA make-up (gallons)	As applicable

The amount of CO_2 leaving the compressor shall be measured with a totalizing positive deplacement type meter with appropriate corrections for moisture, temperature, and pressure. The capacity of each CO_2 plant shall be determined in pounds of CO_2 (dry basis) per hour by dividing the cumulative 6 hour total of CO_2 discharged from the compressor by six. This capacity shall be noted in the reports of 4.5.

4.3.3.3 Following the tests of 4.3.3.1 and 4.3.3.2, the first plant on each contract shall be operated continuously for a total of 30 days. The inlet CO_2 concentration shall be maintained at 0.5 percent for the first 15 days, at 1.0 percent for the next 10 days, and at 1.5 percent for the remaining 5 days. The results of the 30 day test shall be reported in the reports of 4.5. Data to be reported shall include, in addition to the data of 4.3.3.2, the pressure drops through each equipment in the air system, and each cooler and heat exchanger, at hourly intervals, and ammonia and monoethanolamine in effluent air before and after the air purifier every 8 hours.

4.3.4 Center of gravity. Dry center of gravity and weight of the first plant on each contract shall be measured. This data shall be included in the report specified in 4.5.

4.3.5 Noise tests. Structureborne and airborne noise tests shall be performed on each plant to demonstrate its ability to meet noise level requirements specified in 3.2.8. Instrumentation and methods for noise measurement shall conform to MIL-STD-740, except as specified herein. A structural steel test stand may be used for noise tests provided the plant noise levels are less than the limits specified without corrections for the test stand.

4.3.5.1 All testing shall be accomplished with the plant suspended from the four main mounts only and operating under normal rated conditions and acter the plant has been in operation for at least 1 hour. Compressor discharge gage pressure shall be 100 lb/in^2 during the tests.

4.3.6 Shock. One plant shall be shock tested to determine conformance to the requirements specified in 3.2.10 (if not already accomplished on a previously supplied identical unit). The contractor shall be responsible for the modification of each plant under the contract for any deficiencies noted as a result of this test. The inclined shock tests shall be conducted on equipment inclined 30 degrees from the vertical in both the front-to-back and side-to-side directions. A minimum of 9 blows is required. Equipment shall be tested while operating, using water in lieu of MEA and pressurizing the boiler with compressed air. Compressor discharge gage pressure shall be 100 lb/in^2 during the test.

4.3.6.1 Equipment shall be considered to have failed to pass the shock test in the event of any of the following:

(a) Breakage of parts, including mounting bolts.
(b) Appreciable distortion or dislocatin of any part.
(c) Significant effect on performance (more than 10 percent reduction in CO_2 capacity).
(d) Leakage of pressurized gas or liquid.

4.3.6.2 Equipment which has successfully passed the high-impact shock test shall be reconditioned by the contractor as follows:

(a) All bearings shall be replaced.
(b) Minor deformations shall be corrected.
(c) Each part shall be carefully examined, and all substandard parts replaced.
(d) Plant shall be cleaned and tested in accordance with the requirements specified herein.

4.3.7 Life. Compressor and blower shall be given a 500-hour life test. Compressor and blower shall be operated intermittently or continuously for a total of 500 hours. At the conclusion of this time, compressor and blower shall be dismantled and visually examined for wear and appearance. Breakage, distortion, or detectable wear shall be cause for rejection. Tests shall be conducted under the conditions which will be encountered in plant application.

4.3.8 Vibration test. A vibration test shall be performed on one plant to determine conformance to the requirements specified in 3.2.8 (if not already accomplished on a previously supplied identical unit). The testing shall be accomplished with the plant attached without mounts and operating under normal rated conditions. Compressor discharge gage pressure shall be 100 lb/in^2 during the tests. Plant shall demonstrate continuous proper functioning during and subsequent to the specified tests.

4.3.9 Reliability demonstration test. A failure is defined in 3.7.1. The contractor shall subject the equipment to a 910 hour endurance test with no failure (if similar tests have not already been accomplished on a previously supplied identical unit). This test and the test specified in 4.3.3.3 may be conducted simultaneously. The following test provisions apply:

(a) Definition of failure. The test failure shall not be considered to have occurred if the event is the result of a cause such as variation of input voltage beyond specified limits, input power interruption, operator error, ambient temperature over specified limit, or other extraneous causes, determination of which shall be subject to acceptance by the contracting activity.

(b) Failure data collection, analysis, and corrective action. Provisions shall be made by the contractor for complete reporting on every malfunction, or performance degradation, its diagnosis, and any corrective action taken (design modification, etc.). A report shall be prepared covering all testing performed by the contractor.

4.3.10 Maintainability demonstration test. The contractor shall conduct a maintainability demonstration test to verify the requirements specified in 3.2.14 and 3.7.2.

4.3.10.1 Maintenance task selection. Proposed maintenance tasks shall be selected by the contractor in accordance with the procedure outlined in appendix A of MIL-STD-471 and shall be included as part of the maintainability demonstration test plan. Actual task selection will be made by the contracting activity at the time of test.

4.3.11 Failure of reliability and maintainability tests. In the event of inability to reach an "accept" decision, the contractor shall perform an analysis to determine the cause, perform corrective action, and propose appropriate modifications to the design. Verification of success of any modifications made shall be accomplished by a period of re-test to be determined by the contracting activity.

4.4 Rejection. Breakage, deformation, or failure to meet the requirements of this specification when examined and tested in accordance with 4.2 and 4.3 shall be cause for rejection.

4.4.1 Mercury contamination. Mercury contamination or reasonable cause to suspect material of being contaminated by mercury, shall be cause for rejection.

4.4.5 Test procedures and reports. The contractor shall prepare test procedures and reports in accordance with the data ordering documents included in the contract (see 6.2.2) for the following, and as specified in 4.5.1 and 4.5.2:

(a) Factory acceptance (see 4.3.3).
(b) Noise (see 4.3.5).
(c) Shock (see 4.3.6).
(d) Vibration (see 4.3.8).
(e) Failure/malfunction (see 4.3.9(b)).
(f) Maintainability demonstration report (see 4.3.10).

4.5.1 Prior to testing, two copies of a test procedure manual delineating the methods, instruments, and procedures used to accomplish the tests specified herein shall be furnished to NAVSEA for review. The manual shall also contain forms to indicte how the results of tests will be recorded. The results shall be recorded in an orderly manner to facilitate an engineering evaluation. The form for reporting noise tests shall be the chart from the graphic recorder. The acceptance of this manual does not relieve the contractor of his responsibility to perform accurate tests (see 4.3.4).

4.5.2 Within two weeks after completion of the examination and tests of each plant on the contract, two copies of the measured and calculated data and the results of tests on the plant shall be furnished to NAVSEA. Within two weeks after completion of noise tests on each plant, copies of a manual containing the noise test procedures and a chart from the graphic recorder showing the noise test results shall be furnished.

4.6 Packaging inspection. Preservation-packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.5.)

5.1 General requirements.

5.1.1 Technical data. Technical data depicting the preservation-packaging, packing, and marking; packaging and transportation data for transportation support; and reports of the preservation-packaging and packing tests shall be prepared by the contractor in accordance with the data ordering documents included in the contract (see 6.2.2).

5.1.2 Previous submittal. Data submitted under 5.1.1 for evaluation on previously acquired identical equipment and parts is not required.

5.1.3 Packaging of first article sample. When specified (see 6.2.1), prior to beginning package production, a first article pack of the equipment and its shipping container(s) shall be tested as specified in MIL-E-17555.

5.1.3.1 Dummy load. When a dummy load is substituted for the item(s) in performing the rough handling test(s), instrumentation of the item(s) is required. The details of instrumentation and location of accelerometers shall be furnished as part of the required test report specified in 5.1.

5.2 Disassembly and matchmarking.

5.2.1 Disassembly. Equipment disassembly shall be the minimum necessary to make accessible for cleaning and preservation of all machined or critical internal surfaces. Removal of secondary assemblies, accessories, or projecting parts which will facilitate protection of the equipment from damage, pilferage and loss, or reduction of cube is permitted where such removal will not affect permanent settings or alinements and where the removed part can be readily reassembled at the installation site without the need for special tools or gages. Removed hardware (bolts, nuts, pins, screws, washers, and others) shall be reinstalled in mating parts and secured to prevent their loss.

5.2.1.1 Matchmarking. Removed parts of the equipment shall be matchmarked to facilitate reassembly. Removed parts shall be tagged with cloth shipping tags. The tags shall be attached to each of the mating parts. The tags and printing thereon shall be resistant to water, oil, and fading.

5.3 Painting. Painted surfaces on which the paint is damaged or defective shall be cleaned and repainted with the original specified paint of the same quality and color.

5.4 Lubrication. Rotating joints, bearings, and similar moving parts shall be thoroughly lubricated with the libricant specified in the equipment specification. Excess lubricants shall be removed prior to packaging or packing operations.

5.5 Drive belts, pulleys, and sheaves. Drive belts shall be removed or released from tension. When level A preservation-packaging is specified (see 5.6), pulley faces, grooves and sheave grooves shall be coated with a light coat of clear, air drying insulating compound conforming to MIL-I-24092 or MIL-V-13811. When drive belts are not removed for shipment, strips of grease-proof barrier material conforming to grade A of MIL-B-121 shall be placed between belts and pulleys after the insulation compound has dried. The pulleys and belts shall not be rotated thereafter. When drive belts are removed for shipment, they shall be wrapped either individually or in sets and packaged in unit containers as specified in MIL-E-17555.

5.6 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2.1).

5.6.1 Level A. Each plant shall be preserved-packaged in accordance with MIL-E-17555, method IIA and as follows:

(a) Absorber (MEA) shall be preserved-packaged separately in accordance with the level A preservation-packaging requirements of MIL-M-23573.

(b) Resin bags shall be removed from the plant and individually packaged in minimum 4 mil polyethylene bags. Bag closure shall be by heat sealing or with a press fit type closure. Packaged resin bags shall be placed in a fiberboard box conforming to PPP-B-636, class domestic and secured within the main equipment container. Fiberboard containers shall be closed method I in accordance with the appendix to PPP-B-636.

(c) Test kit. Each test kit and its carrying case shall be preserved-packaged method III in accordance with MIL-P-116 and shall be secured within the main container.

(d) Desiccant. Desiccant shall not be placed in any interior spaces of the plant. 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. Openings into the plant shall not be capped, sealed, or plugged to insure effective action of the desiccant.

(e) Method of mounting of the unit within the shipping container shall insure the integrity of the requirements of MIL-STD-740. Where shipboard mounts are used, the barrier shall be placed between the shipping frame and the mounts (see 5.7.1).

5.6.2 Level C. Each plant shall be preserved-packaged to afford protection against corrosion, deterioration, and physical damage during shipment from the supply source to the first receiving activity for immediate use. Caution shall be exercised to insure integrity of the requirements specified in 5.6.1(e). The contractor's normal retail preservation-packaging methods may be utilized when such meets the requirements of this level.

5.7 Packing.

5.7.1 General. Plants shall be packed and shipped (with the 4 main mounts installed) in a structural steel shipping frame which can also be used for testing in the shipyard. Plants shall be mounted on the shippng frame to prevent damage which would affect the performance or noise characteristics of the plants. All securing hardware in mounts, suspension brackets, and similar items of the shipping frame shall be secured by means of positive locking devices such as double nuts or nicked threads, to prevent loosening during shipment. Tack welding and other means are not permitted. Shipping frames will be used for shipyard testing and storage at no additional expense to the Government. Frames are the contractor's property. The contract shall adivse the consignee whether the shipping frames shall be scrapped or returned at the contractor's expense.

5.7.2 Each plant preserved-packaged as specified in 5.6, installed on a shipping frame, shall be packed level A, B, or C, as specified (see 6.2.1) and marked in accordance with MIL-E-17555. For levels A and B, the shipping containers shall conform to MIL-C-104, type II, class 1 or 2, style optional.

5.7.3 In addition to the marking required by 5.7.2, each container shall have a placard attached conspicuously and secured to the exterior shipping container in addition to a placard attached to the unit as soon as tests have been completed. The placards shall remain on the plant and shipping container after delivery. The placards shall read as follows:

"This unit has been completely noise tested and components have been precision balanced. Handle with extreme care to prevent mechanical shock and exposure to atmospheric corrosion."

In addition to other marking requirements, the resin bags shall be marked as follows:

"Resin bags - Use for CO_2 plant, shipyard testing - install in purifier."

5.8 Technical manuals and data. Technical manuals shall be prepared for shipment in accordance with MIL-E-17555 as specified for the level of packing required (see 5.7.2). Data shall be packaged and packed level C in accordance with the applicable data specification, or where no preparation for delivery requirements exist, data shall be prepared in accordance with the level C requirements of MIL-E-17555.

6. NOTES

6.1 Intended use. The Mark IIIB carbon dioxide (CO_2) removal plant is intended for use in removing CO_2 from a submarine atmosphere and discharging this CO_2 overboard against variable submergence pressures.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Quantity of CO_2 plants required.
(c) Location of service connections, if other than as specified (see 3.2.7).
(d) When a first article pack test is required (see 5.1.3).
(e) Levels of preservation-packaging and packing required (see 5.6 and 5.7.2.).

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

Paragraph	Data requirement	Applicable DID	Option
3.8	Certification data/report	UDI-A-23264	------
3.8	Failure mode and effects analysis	DI-R-2115	------
3.8	Maintenance engineering analysis report	UDI-L-26377	------
3.8	Reliability program plan	DI-R-2113	------
3.8	Maintainability program plan	UDI-R-23558	------
3.8	Plan, reliability test	DI-R-7033	------

Paragraph	Data requirement	Applicable DID	Option
3.8	Maintainability demonstration plan	DI-R-2129	------
3.8	Imaged aperture/ tabulating cards	DI-E-20477	------
3.8.1 & 5.1.1	Drawings, engineering and associated lists	DI-E-7031	Level 3 Design activity designation - Government Drawing number - Government Delivery of hard copy - contracting activity
3.8.2	Manual, technical, preliminary	DI-M-2043	Type I of MIL-M-15071
3.8.2	Manual, technical, standard, basic issue	DI-M-2044	Type I of MIL-M-15071
3.8.2	Technical manual quality assurance data	DI-M-2051	------
4.5	Factory acceptance test procedures	UDI-T-23982	------
4.5	Noise test reports	UDI-T-23764	------
4.5	Equipment shock test reports	UDI-T-23753	------
4.5	Vibration testing report	UDI-T-23762	------
4.5	Failure/malfunction report	UDI-T-23724	------
4.5	Report, maintainability demonstration	DI-R-2130	------
4.5.1	Procedure, test	UDI-T-23732	------
4.5.2	Reports, test	UDI-T-23729	------
5.1.1	Packaging and transportation support data	UDI-P-23508	------
5.1.1	Report, preservation-packaging and packing test	UDI-T-23766	------

(Copies of data item descriptions required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract, regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.3.1 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.

6.4 Definitions. The following definitions apply to terms used in this specification:

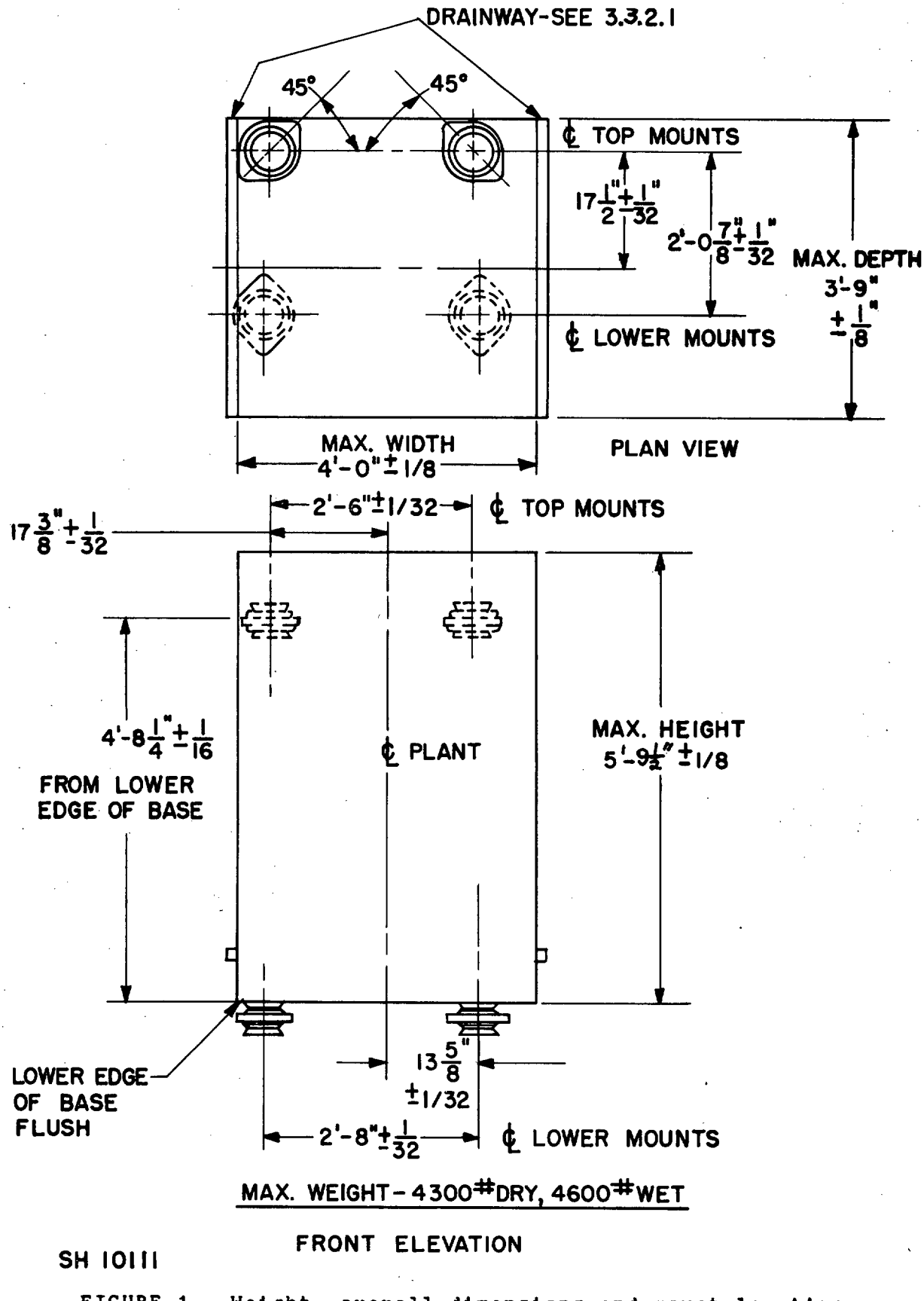
(a) MEA. Water solution of monoethanolamine, chelated, in accordance with MIL-M-23573.
(b) Rich MEA. MEA from absorber sump.
(c) Lean MEA. MEA leaving stripper.
(d) Recycled MEA. MEA pump from the absorber sump to the absorber top without a change in CO_2 concentration.

6.5 U.S. Navy serial numbers. The U.S. serial numbers will be furnished to the contractory the by Gas Processing and Cryogenics Branch of the Naval Sea Systems Command, upon request.

6.6 Sub-contracted material and parts. The preparation for delivery 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.

6.7 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.

Preparing activity:
Navy - SH
(Project 4460-N032)



SH 10111

FIGURE 1. Weight, overall dimensions and mount location.

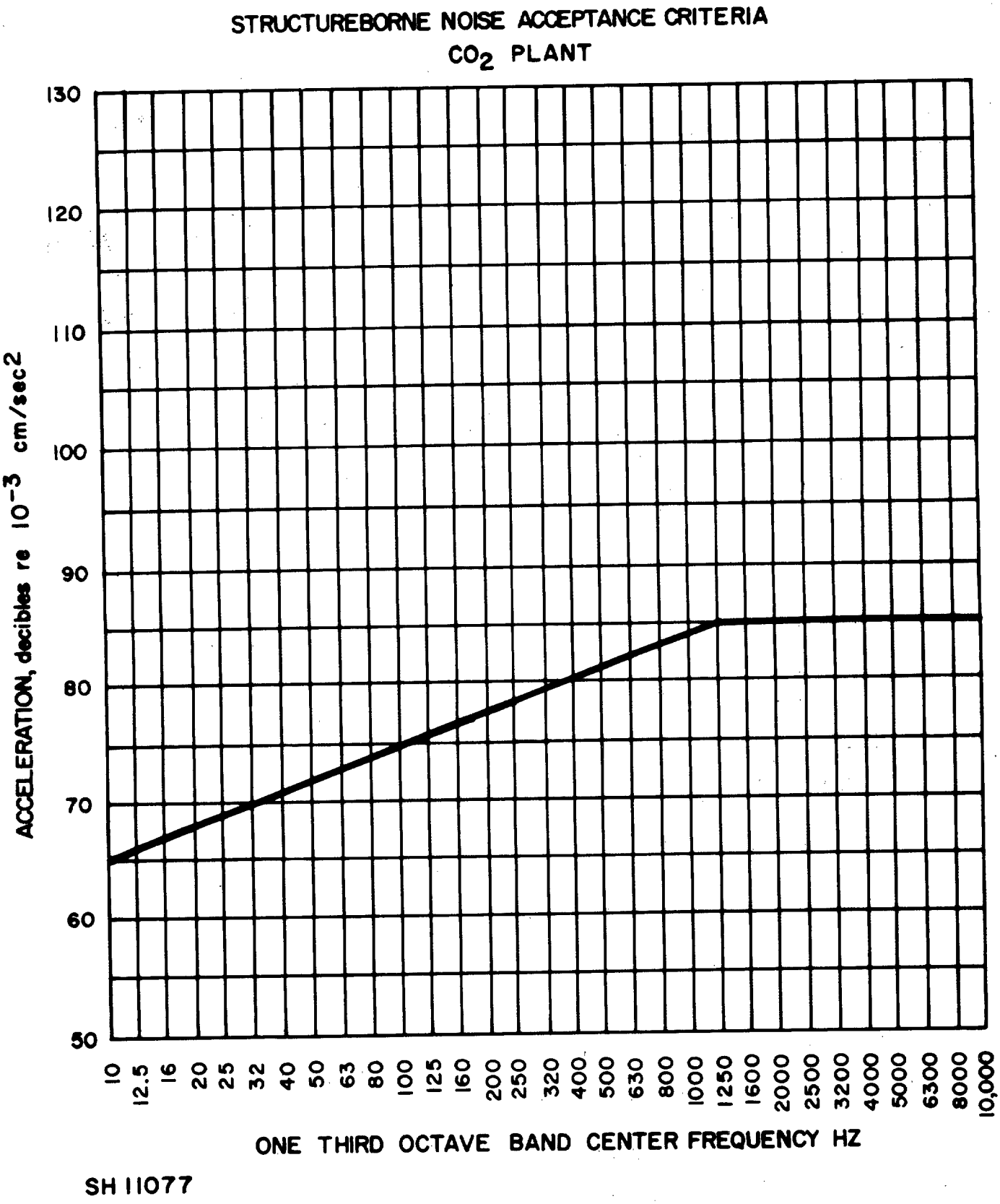


FIGURE 2. Structureborne noise acceptance criteria.

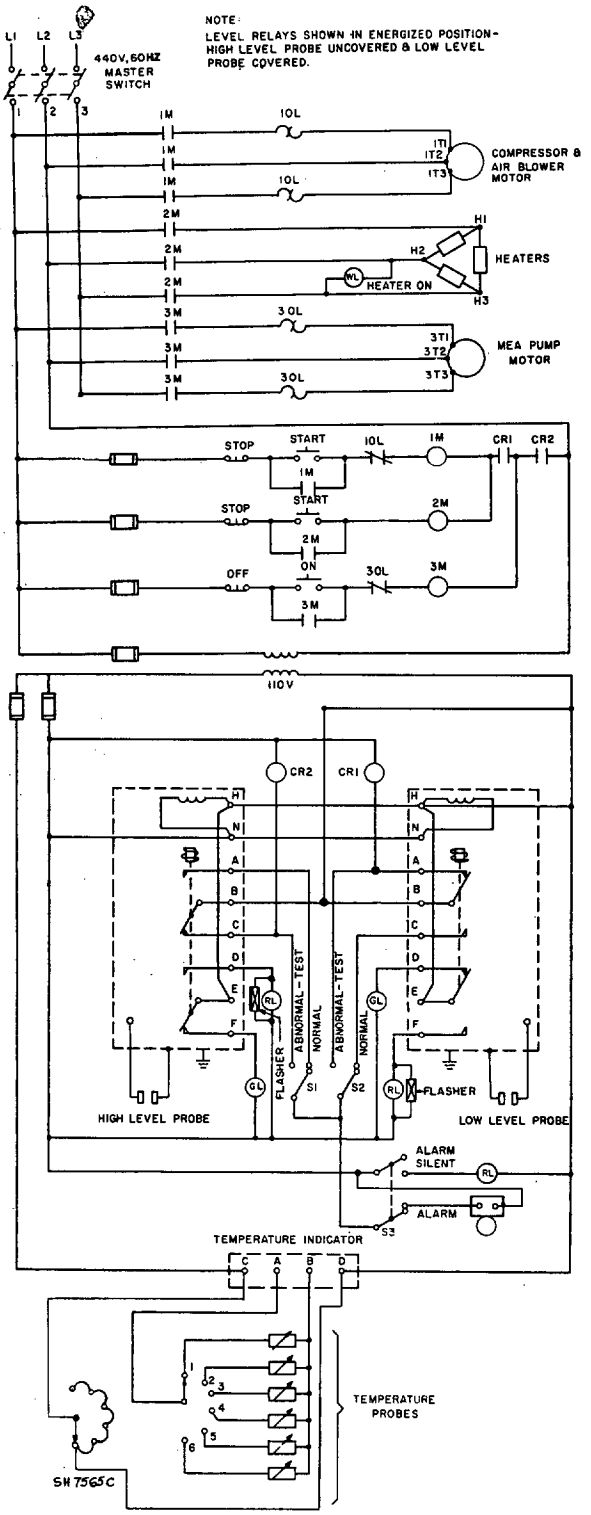


FIGURE 3. Elementary wiring diagram.

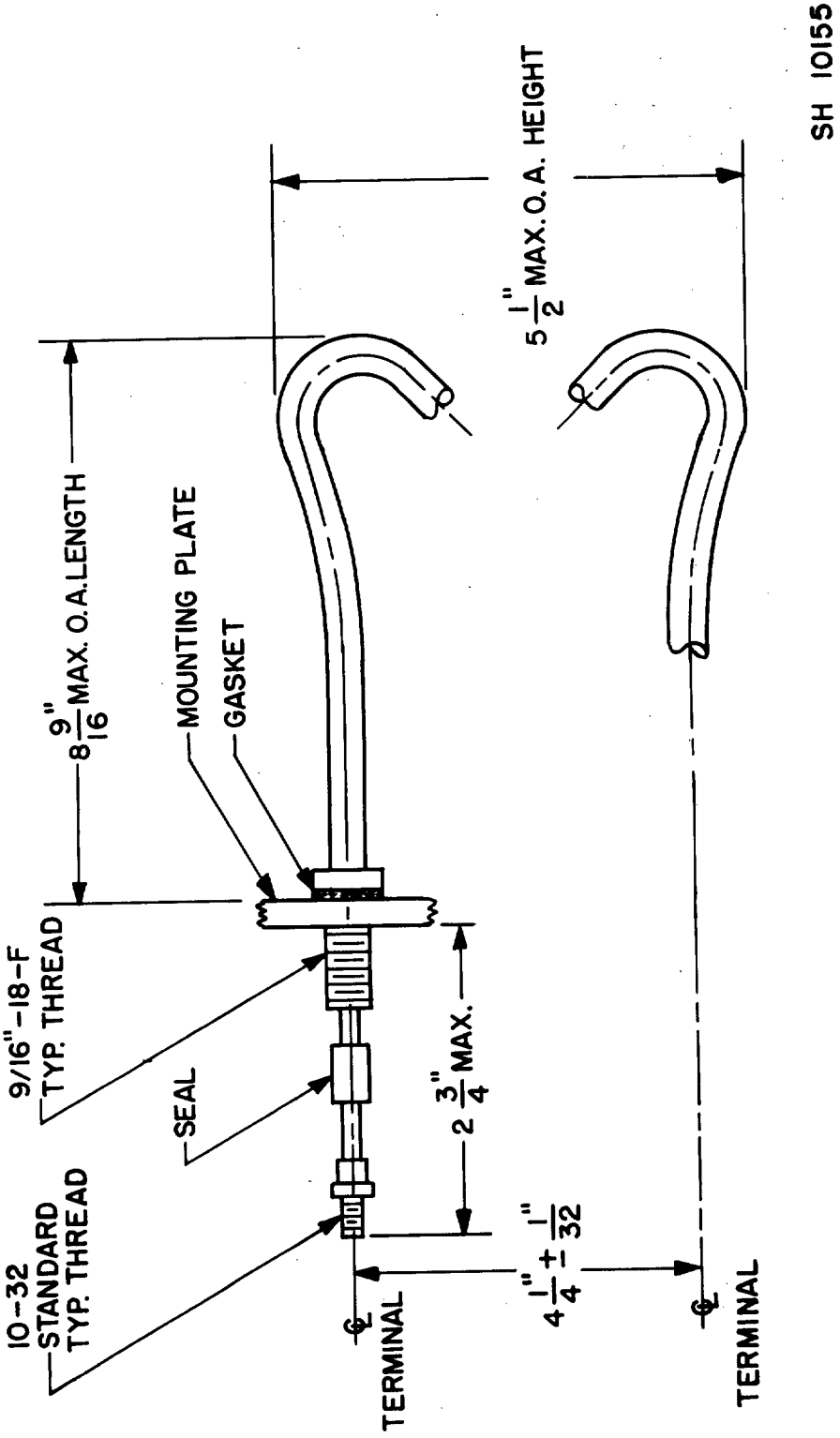


FIGURE 4. Heater, physical dimension requirements.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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DOCUMENT IDENTIFIER AND TITLE

MIL-P-24082C(SH)

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?

   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*

TELEPHONE NO.

DATE

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