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SUPERSEDING
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MILITARY SPECIFICATION

CHAMBER; RECOMPRESSION, DIVERS: 100 PSI

This specification is approved for use within the USA Belvoir Research, Development, and Engineering Center, Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers a divers recompression chamber, 100 psi.

1.2 General. This specification establishes the design, construction and testing requirement for a double lock, 100 psi, aluminum recompression chamber. For the purpose of this specification the complete recompression system shall be referred to as the "unit". Material, manufacturers, and equipment used in construction of and in support of the recompression chamber is limited to those vendors and equipment on the "Approved for Navy Use List" (OPNAVINST 9597.1) or approved by the Supervisor of Diving and Salvage, NAVSEA. No substitutions are permitted.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Belvoir Research, Development and Engineering Center, ATTN: STRBE-TSE, Fort Belvoir, VA 22060-5606 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 4220

SPECIFICATIONS

FEDERAL

UU-T-81	- Tags, Shipping and Stock.
PPP-B-636	- Boxes, Shipping, Fiberboard.
PPP-T-60	- Tape, Packaging, Waterproof.

MILITARY

MIL-P-116	- Preservation, Methods of.
MIL-P-514	- Plates, Identification, Instruction and Marking Blank.
MIL-B-26195	- Boxes, Wood-Cleated, Skidded, Load-Bearing Base.
MIL-C-52950	- Crates, Wood, Open and Covered.

STANDARDS

FEDERAL

FED-STD-H28	- Screw-Thread Standards for Federal Services.

MILITARY

MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-130	- Identification Marking of U.S. Military Property.
MIL-STD-209	- Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment.
MIL-STD-889	- Dissimilar Metals.
MIL-STD-1186	- Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; with Appropriate Test Methods.
MIL-STD-1472	- Human Engineering Design Criteria for Systems, Equipment, and Facilities.
MIL-STD-1474	- Noise Limits for Army Materiel.

2.1.2 Other Government documents and publications. The following other Government documents and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DEPARTMENT OF THE NAVY

NAVFAC DM - 39	- Hyperbaric Facilities Design Manual 39.
NAVSEA 0994-LP-001-9010	- U.S. Navy Diving Manual (Vol. 1 and 2).

(Application for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, D.C. 20402 or to Department of the Navy Naval Facilities Engineering Command, 200 Stovall Street, Alexandria, VA 22332.)

OCCUPATIONAL SAFETY AND HAZARD AGENCY (OSHA)

OSHA 29 CFR 1910.423 and 1910.430

(Application for copies should be addressed to Superintendent of Documents, US Government Printing Office, Washington, DC 20402).

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents 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 document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the non-Government documents which is current on the date of the solicitation.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code, Section VIII, Division I Unfired Pressure Vessels. PVHO-1A and Appendix 15.

(Application for copies should be addressed to the American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 11017.)

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the reference cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained. The contracting officer shall request in writing from the Belvoir RDE Center Diving Liasion any issue regarding clarification to resolve conflicts between the contractor and manufacturer prior to the formal response answering manufacturer conflicts or questions.

3. REQUIREMENTS

3.1. Description. The recompression chamber shall be of double-lock, portable, skid mounted aluminum construction with medical lock, communication system, air and exhaust manifolds, oxygen manifold, lighting system, oxygen bib masks and overboard dump system, oxygen analyzers, CO_2 scrubbers and analyzers, heater/chiller environmental control unit, fire retardant clothing and bedding, oxygen high pressure storage system, high pressure reducing station, temperature probes/monitors ground fault isolator, power supply (28 V dc), relief valve (set at 110 psi), electrical penetrations (through viewport), medical kit, and

operation stations with the necessary controls and instrumentation to operate the unit and provide recompression treatment conditions dictated by U.S. Navy Diving Manual, NAVSEA 0994-LP-001-9010 and U.S. Navy Hyperbaric Facilities Design Manual 39, NAVFAC DM-39.

3.2 First article. Unless otherwise specified (see 6.2), a sample shall be subjected to first article inspection (see 4.3 and 6.3). Any changes or deviations of chambers from the approved first article during production will be subject to the approval of the contracting officer. Approval of the first article will not relieve the contractor of his obligation to furnish chambers conforming to this specification.

3.3 Material. Material shall be as specified herein. Materials not specified shall be selected by the contractor and shall be subject to all provisions of this specification. Brand names, where used, describe items known to be satisfactory for their intended use. Substitute items are permitted only with Government approval as taken from the Approved for Navy use list for diving and support equipment. No fittings or equipment shall be made of flammable material.

3.3.1 Material deterioration prevention and control. The recompression chamber shall be fabricated from compatible materials, inherently corrosion resistant or treated to provide protection against the various forms of corrosion and deterioration that may be encountered in any of the applicable operating and storage environments to which the recompression chamber may be exposed. The use of material to treat the items is limited to those items that are in NAVFAC Design Manual 39. Any substitutions are prohibited.

3.3.2 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless protected against galvanic corrosion. Dissimilar metals and methods of protection are defined and detailed in MIL-STD-889 and in NAVFAC Design Manual 39.

3.3.3 Identification of materials and finishes. The contractor shall identify and document the specific material, material finish or treatment for use with component and subcomponent, and shall make information available upon request to the contracting officer or designated representative for certification purposes.

3.4 Safety. Electrical equipment wires, and connectors shall be effectively grounded or insulated to protect all persons and objects from electrical shock hazard. Nonfunctional sharp edges, projecting points, and excessive length of fastening devices shall be avoided. All internal and external electrical circuits shall be weatherproof and explosion-proof. The recompression chamber shall be in accordance with OSHA 29 CFR parts 1910.423 and 1910.430.

3.4.1 Warning. A warning sign shall be posted inside and outside the chamber as follows:

WARNING
FIRE/EXPLOSION HAZARD
No Matches, lighters
electrical appliances
or flammable materials
permitted in chamber

Lettering: "Warning" shall be red and 2 inches high. "FIRE/EXPLOSION HAZARD" shall be in 1 inch high black letters. All other lettering shall be black and 1/2 inch high. Background shall be white.

3.5 Maintainability. All major assemblies shall be accessible for servicing, repair, and replacement without the removal of other major assemblies. Covers and guards which must be removed for component adjustment or repair shall be equipped with quick-disconnect fasteners. All fasteners shall be of corrosion-resistant material or shall be treated to be corrosion resistant. All screw threads shall be in accordance with FED-STD-H28. Maximum use shall be made of interchangeable hardware and fasteners. All maintenance, assembly, or disassembly operations shall be accomplished with common tools and special tools furnished with the unit.

3.6 Construction. The unit shall be constructed in accordance with the ASME Boiler and Pressure Code, Section VIII, Division I Unfired Pressure Vessels, PVHO-1A and appendix 15. The unit shall bear the ASME stamp. No welding or other actions shall be permitted after the unit has been ASME certified.

3.6.1 Design. The double-lock unit shall be designed to receive and maintain a pressure equivalent to 165 feet of sea water (6 atmospheres absolute) while ventilating in accordance with rates prescribed by U.S. Navy Diving Manual, NAVSEA 0994-LP-001-9010. The basic construction material for the unit shall be aluminum. The unit shall be skid mounted, and outfitted with communications, air and exhaust manifolds, oxygen manifold and overboard dump system, exterior and interior lighting, medical lock, oxygen analyzers, CO_2 scrubbers and analyzers, heater/chiller environmental control unit, fire retardant clothing and bedding, oxygen high pressure storage system, high pressure reducing station, temperature probes/monitors, ground fault isolator, power supply (20 V dc), relief valve (set at 110 psi), electrical penetrators (through viewport), medical kit as described in U.S. Navy Diving Manual Vol I, NAVSEA 0994-LP-001-9010, and operation stations, necessary controls and instrumentation to operate the unit and provide recompression treatment conditions dictated by U.S. Navy Diving Manual, NAVSEA 0994-LP-001-9010 Vol I and U.S. Navy Hyperbaric Facilities Design Manual 39, NAVFAC DM-39. Provisions for lifting, tie down, and movement by forklifts shall be incorporated into the design.

3.6.2 Human factors engineering. The unit shall conform to human factors engineering design criteria as specifed in MIL-STD-1472. Special design emphasis shall be given, but not limited to, general requirements (4), control/display integration (5.1), visual displays (5.2), audio displays (5.3), controls (5.4), labeling (5.5), ground workspace design requirments (5.7), environment (5.8), design for maintainability (5.9), and hazards and safety (5.13) of MIL-STD-1472, as applicable.

3.6.3 Noise levels. Noise levels inside the unit shall not exceed 70 dB(A) under normal operating conditions when measured in accordance with 4.5.2.6.

3.6.4 Compartment. The unit shall have an inner lock equipped to provide re-compression treatment, an outer lock for transport of personnel to and from the inner lock without interruption of inner lock pressure schedules, and a medical lock for rapid transport of medical supplies to and from the inner lock. The inner lock dimensions shall be 72 inches long from seam to seam and 60 inches diameter. The outer lock dimensions shall be 42 inches long from seam to seam and 60 inches diameter. The medical lock inside dimensions shall be 18 inches long and 12 inches diameter and shall be designed to prevent accidental opening. The medical lock shall be welded to exterior hull of the inner (or main) lock. All dimensions are nominal. The inner and outer compartment shall be equipped with an alumimum floor plate, and shall be grounded to the chamber bunk; bench, or folding shelf/seat.

3.6.5 Air manifold. The piping and valving shall be arranged to permit control of the the air supply and the ventilation (from both locks) from either outside or inside the chamber. Controls on the outside shall be able to over-ride the inside controls. The method for providing the dual control capability shall be provided through the use of two separate systems. Inlet ports shall be located in upper half of the chamber and exhaust ports shall be located in the lower half of the chamber with sufficient separation to prevent stratification of the air. Openings shall be guarded. The first system shall consist of a supply line and ventilation line which can only be controlled by valves outside the chamber. The second supply/ventilation system shall have a double set of valves, one on the inside and the other outside the chamber which permits the tender to regulate chamber pressure within the chamber, but subject to final control by outside valves. Control valves and piping for inside stations shall have the same flow capacity as the outside station. Dual connections shall be provided on the air manifold with external 1-1/16 inch - 17 submarine thread. The air manifold shall be designed for 200 psig working pressure. All lines and valves shall be identified and labeled to indicate function, content, and direction of flow.

3.6.6 Oxygen manifold. The unit should be equipped with a system for delivering oxygen to personnel in the inner and outer lock. The system shall be designed to operate from a 3000 psi pressure source and consist of a four-station manifold in each lock. Each station shall have a control valve and be equipped with demand-type oxygen inhalators for use with an overboard dump system. An over-board dump system shall be provided for eliminations of exhaled oxygen. The system shall be oxygen cleaned and sealed.

3.6.7 Oxygen analyzer. An oxygen analyzer shall be provided to monitor the partial pressure of oxygen inside the inner lock and inside the outer lock of the unit. The analyzer shall be a Teledyne O_2 Anaylzer model 320 BRC or equivalent. The instrument readout shall be located at the outside control station (console), and a sensing component shall be located outside the unit connected to the pressure gage lines. The instrument shall have an LED readout in accordance with the Army secure lighting system requirements.

3.6.8 Communications. The unit shall have a primary and secondary communications system. Each system shall provide communications between the outside control station, the inner lock control station and the outer lock control station.

3.6.8.1 Primary communications. The primary communications shall be provided through a battery powered amplifier system with one dual microphone/reproducer unit in the inner lock and another in the outer lock. The amplifier shall be Amron model CCK-01 Chamber Communicator Kit or equivalent with a frequency response of 300 Hz to 12 kHz, power output not greater than 12 watts to all speakers, input impedance of 3 to 16 ohms, and power supply from a standard built-in rechargeable 12 V battery and 115/220 V ac 50-60 Hz, internally selectable power source. It will include the following items: push to talk hand held (with minimum of 4 foot cord) microphone, have input/output connection, double lock capability, volume controls for operator, inner and outer locks, 2-wire "round robin" capability, cutoff switches to disable inner or outer lock communications, power and battery status indicator lights, and be operated locally or remotely. The inside lock speakers shall be Amron model 3115 decompression chamber speaker, with on/off switch, 5 watt, 8 ohm rating, a frequency range of 300 Hz to 12 kHz with a connecting wire of teflon coated twisted shielded wire 22 Awg.

3.6.8.2 Secondary communications. The secondary communication shall be provided through a sound powered telephone system, consisting of 3 noise attenuating handsets and appropriate jack plates and wiring accessories necessary to establish a three station system. Each station shall have a jack plate to accommodate two headsets. The headsets shall be Amrom (Western Electric) model # H203-U sound powered phone and an Amron A281 mounting hook or equivalents.

3.6.9 Silencers. Silencers shall be furnished on the air manifold system. One silencer shall be provided on the air inlet inside the inner lock, and another silencer shall be provided on the air inlet inside the outer locks. Silencers shall also be installed on the vent line for the inner/outer locks as well as all outside chamber (inner and outer locks) exhaust lines and overboard dump lines.

3.6.10 Flow meter. A flow meter shall be provided on the vent line outside the recompression unit. The flow meter shall be compatible with ventilation rates required by U.S. Navy Diving Manual, NAVSEA 0994-001-9010.

3.6.11 Pressure gages. Pressure gages shall be provided to monitor pressure in the inner and outer locks. Each lock shall have one gage at the inside control station and two gages at the outside control station. The gages shall be connected to hard plumbing on the unit with the flexible hose and quick-disconnect fittings; gages shall be mounted with hand tightened hardware to facilitate ease of removing for transport. Gages shall be located so that they may be read by personnel at the normal operating position for which the display is intended. On all gages, the gage case shall be of ABS plastic construction. Pressure sensing element shall be of a helical bourdon tube construction made of inconel X-750. Pressure range shall be 0-250 feet of sea water, 1 foot increments of 1/4 of 1 percent accuracy, 8-1/2 inch dual face, and bottom connection 1/4 NPT. The inside gages shall be caisson gage (3D Instrument

Incorporated part No. 25646-23B21-FAK or equivalent). The outside gages shall be the standard gage (3D Instrument Incorporated part No. 25546-23B11-FAK) or equivalent. In accordance with Army secure lighting system requirements, an additional set of LED gages shall be added to the outside control station. Each lock shall have its own gage. The gages shall be mounted as already described above. The gages shall be a Dresser Industry, Inc., Heise digital depth gage, part number 710A, or equivalent, have a range of 0 to 250 feet of sea water (FSW) with 1 foot increments and 1/4 of 1 percent accuracy.

3.6.12 Viewport. Six viewports with rubber O-ring gaskets on either side of the acrylic viewport for viewing inside the unit while standing outside shall be provided. Two viewports shall be provided on each side. One viewport shall be provided on each side of the outer lock. Each viewport shall have at least a 5 inch diameter clear viewing area. Viewports shall conform to ASME Boiler and Pressure Vessel Code, Section VII, Division I Unfired Pressure Vessels PVHO-1A and appendix 15 and NAVFAC DM-39.

3.6.13 CO_2 analyzer. A CO_2 analyzer shall be provided to monitor the partial pressure of CO_2 inside the inner lock and insde the outer lock of the unit. The CO_2 analyzer shall be an Analox CO_2 monitor model 3300F or equivalent and shall be a component of the Analox CO_2 hyperbaric monitor system consisting of a Bell display unit, hyperbaric sensor, Analox 3300F control monitor, and transducer. The instrument shall have a LED readout in accordance with the Army secure lighting system requirements. The instrument(s) readout shall be mounted on the outside control station, and the sensing component shall be located outside the unit on the inner and outer pressure gage line.

3.6.14 CO_2 scrubber. A CO_2 scrubber shall be provided to scrub the atmosphere inside the unit under pressure in order to reduce the partial pressure of CO_2 inside the unit. The CO_2 scrubber shall be a Kinergetics, Inc. model DH-10 or equivalent. The unit shall be a 23 V ac/dc, 2.7 amp (at the surface) 3.7 amp at 1500 FSW, with a flow rate of 15 acfm (actual cubic feet per minute) at the surface, with a sealed motor with magnetic drive. It shall be mounted vertically with enough clearance to easily remove and replace the scrubber chemicals (SODASORB) without interference.

3.6.15 Heater/chiller environmental control unit. A heater/chiller environmental control unit shall be provided in order to maintain a constant temperature level inside the inner and outer locks during recompression chamber treatment. The heater/chiller environmental unit shall be a Kinergetics, Inc. model CCU-1 chamber conditioning unit or equivalent. The unit shall pass cold fluid through the unit for cooling and dehumidification and pass hot fluid through the unit for heating. The unit shall provide a supply flow rate of 150 acfm of air, have a fan operated 24 V ac/dc totally enclosed motor and a magnetically coupled fan. The unit shall be mounted outside the chamber on a skid frame made of tubular steel. The frame shall have lifting points on all four corners and one in the middle of the top for a single point lift.

3.6.16 Fire retardant clothing and bedding. Fire retardant clothing and bedding shall be provided in order to provide adequate cover and comfort to the patient and tender during recompression chamber treatment (for reasons such as

shock, hypothermia, diving barotraumas that require using oxygen during treatment). The fire retardant clothing and bedding is required in accordance with FM 20-11-1 (NAVSEA 0994-LP-001-9010) appendix D pg D-7. The clothing and bedding shall be made of Durettte® in accordance with FM 20-11-1 (U.S. Navy Diving Manual). Two sets each of pajama (tops and bottoms) clothing will be provided in the following sizes S, M, L, XL; 4 blankets; 4 mattresses; 4 mattress jackets; 4 sheets; 4 pillows; 4 pillow slips.

3.6.17 Portable fire suppression system. A portable fire suppression system shall be provided consisting of an Amron International model 240 portable hyperbaric fire extinguisher or equivalent in accordance with directions in FM 20-11-1 (U.S. Navy Diving Manual, Vol I) appendix D.

3.6.18 Ground fault sentry isolator and power supply. The ground fault sentry isolator and power supply shall consist of a 120 volt, 10 amp, 1200 watt, 60 Hz unit. It will serve to interrupt and isolate the chamber from outside power surges and potentially hazardous "electrical shocks". The unit shall be mounted on the top of the chamber skid directly below the left side of the control console.

3.6.19 Temperature monitor and temperature probe. The temperature monitor shall be mounted on the control console and connected to the temperature probes mounted in the inner and outer locks, via a viewport penetrator plate. The unit shall be an Analox 401A or equivalent temperature monitor or controller with a ±1 percent accuracy, 0-100 °C or 32-212 °F, 24 V dc or 100-120 V ac with programmable alarm relay contacts.

3.6.20 Tiedown provisions. Permanently affixed provisions that permit fastening the unit to the floor or deck of a transportation medium shall be provided and shall conform to MIL-STD-209. Tiedown provisions may also be used as slinging provisions when such provisions conform to MIL-STD-209. Tiedown provisions shall not damage or interfere with other functional elements of the unit. Tiedown provisions shall be labeled "TIEDOWN".

3.6.21 Skids. The unit shall be mounted on steel skids which are positioned longitudinally to the unit and designed to accomodate handling by fork lift truck. Fork channels shall be at least 11 inches wide and 3 inches deep. Center to center distance of the channels shall be not less than one-third of the skid length and not more than 64 inches.

3.6.22 Slinging provisions. Permanently affixed slinging provisions that enable the unit to be lifted in its normal travel position shall be provided and shall conform to MIL-STD-209. Slinging provisions may be used as tiedowns when such provisions conform to MIL-STD-209. Slinging provisions when employed shall not damage or interfere with other functional elements of the unit. Slinging provisions shall be labeled "LIFT HERE".

3.6.23 Lighting. A J.M. Cantry, model HYL 250, fiber optics type lighting system or equivalent shall be provided to illuminate the inner and outer lock. The system shall be powered by an adjustable 110-120 volt, 60 Hz power source (in accordance with the Army Secure lighting system), and all wiring shall be

external. One wide beam adjustable 250 watt lighting element shall be provided in the outer lock and two adjustable 250 watt lighting elements shall be provided on the inner lock. The light level shall be continously adjustable from 0.1 Ft.c. to full brightness. The light source shall be weatherproof, splash proof, shock proof, explosion proof, and pressure proof.

3.6.24 Hatches. Hatches from outside to outer lock and from outer lock to inner lock shall be at least 28 inch diameter hinged to open inward and chamber pressure sealed. Opening and closing of hatches shall not interfere with any other functional element of the chamber. Seals shall be "O" ring type.

3.6.25 Valves. Air manifold control valves shall be 1/4 turn, full open to full close ball valves with lever type handles. Valves shall be positioned to preclude accidential operations. Oxygen supply regulation and dump regulator valves shall be of a type which requires a minimum of five full turns from full open to full close. All manually operated valve controls shall be provided with double-ended arrows showing direction of operation and shall be labeled at each end to indicated the functional result (i.e. open, close, etc).

3.6.26 Control station. All recompression chamber controls and instrumentation shall be arranged to establish a central control outside control station. The control station shall be provided with an aluminum weatherproof cover which is hinged and opens to form an overhead shelter. Control station shall be provided with an adjustable illumination 110-120 volt, 60 Hz lighting system, with power to be wired through the ground fault isolater and power supply unit. All gages and instruments shall be mounted be mounted plumb and straight. Each instrument shall be identified by a name plate mounted above the instrument. All controls which function in sequential operation necessary to a particular task, or which operate together, shall be grouped together with their assorted displays. Controls shall be arranged to facilitate sequential operation. A flow diagram shall be provided for the air manifold and ventilation system and for the built in breathing system for oxygen manifold and overboard dump.

3.7 Installation and calibration. All components shall be installed and calibrated in accordance with the component manufacturers instructions and recommendations.

3.8 Identification marking. The unit shall be identified in accordance with MIL-STD-130. The marking shall be applied to the chamber on identification plates conforming to MIL-P-514, type I, style 1, composition C, of type I, grade A, class 1 material. Plates shall be attached by screws, bolts or rivets in a conspicuous protected location.

3.9 Instruction plates. Each unit shall be equipped with instruction plates or diagrams, including warnings and cautions, describing any special or important procedures to be followed in assembling, operating or servicing the unit. Instruction plates shall conform to MIL-P-514, type III, composition C, of type I, grade A, class 1 material. Plates shall be attached by screws, bolts or rivets in a conspicuous protected location.

3.10 Workmanship. All parts, components and assemblies of the unit including castings, forgings, molded parts, stampings, bearings, seals, machined surfaces, and weld parts shall be clean and free from sand, dirt, fins, pits, sprues, scales, or any damaging extraneous material. The unit shall be free of any defect that could impair its operation and serviceability.

4. QUALITY ASSURANCE PROVISIONS

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

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

4.1.2 Component and material inspection. The contractor is responsible for insuring that components and materials used are manufactured, examined and tested in accordance with referenced specifications and standards. All records, calculations and computations, welders certifications, x-rays of welds (100 percent record for all welds), non-destructive test results, 0_2 cleaning procedures and results will be consolidated into individually serial numbered books for each chamber built and will be provided with each chamber.

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

a. First article inspection (see 4.3).
b. Quality conformance inspection (see 4.4).
c. Inspection of packaging (see 4.6).

4.3 First article inspection.

4.3.1 Examination. The first article recompression chamber shall be examined as specified in 4.5.1. Presence of one or more defects shall be cause for rejection.

4.3.2 Tests. The first article recompression chambers shall be tested as specified in 4.5.2. Failure of any test shall be cause for rejection. A first article test log shall be furnished.

4.4 Quality conformance inspection.

4.4.1 Examination. Each unit shall be examined in accordance with 4.5.1.

4.4.2 Tests.

4.4.2.1 Individual. Each unit shall be tested as specified in 4.5.2.4 and 4.5.2.2. Failure of a test shall be cause for rejection.

4.5. Inspection procedure.

4.5.1 Examination. Each unit shall be examined for the following defects:

101. Material not as specified.
102. Materials are not resistant to corrosion or deterioration or treated to be resistant to corrosion or deterioration for the applicable storage and operating environment as specified.
103. Dissimilar metals as specified in MIL-STD-889 are not effectively insulated from each other as specified.
104. Contractor does not have documentation available for identification of material, material finishes, or treatments.
105. Safety devices not as specified.
106. Warning sign missing or not as specified.
107. Human factors engineering not as specified.
108. Ease of maintenance not as specified.
109. Identification marking and instruction plates not as specified.
110. Interchangeability not as specified.
111. Assembly incomplete, components missing or not as specified.
112. Workmanship not as specified.
113. Parts, tools, and items to be furnished with recompression chamber missing or not as specified.
114. Controls not as specified.
115. Configuration not as specified.
116. Communications not as specified.
117. Instrumentation not as specified.
118. Illumination system not as specified.
119. Handling provisions not as specified.
120. Records of certification documentation as required by NAVFAC Design Manual 39 for chamber certification not as specified.
121. Nondestructive testing (NDT) of all welds in accordance with NAVFAC Design Manual 39 and ASME Boilers and Pressure Vessel Code, section VIII PVHO-1A and appendix 15 not as specified.

4.5.2 Tests.

4.5.2.1 Test conditions. Unless otherwise specified in a test, tests shall be performed without shelter and at the climatic conditions existing at the place of test. The unit shall operate as specifed herein without maintenance other than the contractor's recommended normal scheduled maintenance as established by a maintenance schedule prepared and submitted by the contractor prior to test. A test log shall be furnished tabulating all appropriate test

data and observations. Safety and human factors considerations shall be evaluated throughout testing.

4.5.2.2 ASME certification tests. The unit shall be tested in accordance with the ASME Boilers and Pressure Vessel Code, Section VIII. Failure of any ASME test shall constitute failure of this test. Presence of the ASME official code U-symbol stamped or marked on the unit and the furnishing of a copy of the ASME data sheet (form U-1) may be accepted as evidence that the unit conforms to Boilers and Pressure Vessel Code, section VIII, PVHO-1A and appendix 15. Presence of the ASME Official Code U-Symbol does not releive the manufacturer of providing all required documentation to the Government for systems certification.

4.5.2.3 Operational tests.

4.5.2.3.1 Air operational test. A test shall be conducted to demonstrate that the unit can provide recompression treatment conditions as specified in the U.S. Navy Diving Manual, NAVSEA 0994-LP-001-9010, chapter 8. The test shall consist of operating the inner lock to meet the depth time profile of treatment table 2A and ventilation requirements of table 8-2B. At each stop, the outer lock and medical lock shall be cycled by pressurizing to equal the inner lock pressure. The test shall be controlled from the outside control stations. Any equipment failure or failure of the unit to meet the controlled treatment conditions specified shall constitute failure of this test.

4.5.2.3.2 Air ventilation system test. A test shall be conducted to determine if the unit can meet minimum and maximum air ventilation rate requirements as specified by table 8-2B of U.S. Navy Diving Manuals. Tests shall be conducted to meet the following conditions:

Air supply pressure	Chamber pressure	Ventilation rate
200 psig	60 FSW	70.4 SCFM
200 psig	10 FSW	10.4 SCFM

A steady state ventilation rate for each condition shall be maintained for 10 minutes. Failure to meet the ventilation rate under conditions specified shall constitute failure of the test.

4.5.2.3.3 Oxygen operational test. A test shall be conducted to demonstrate the oxygen built-in-breathing-system can provide oxygen treatment conditions consistent with chapter 8 of the U.S. Navy Diving Manual. Test shall consist of donning and using each oxygen mask under variable chamber conditions as follows:

Chamber pressure	Test duration
Ambient	5 minutes
10 FSW	5 minutes
25 FSW	5 minutes

Caution: During testing, precautions shall be taken to prevent the tester from being subjected to oxygen depth/time limits in excess of guidance provided by U.S. Navy Diving Manual, chapter 13. Any equipment malfunction or failure of the equipment to provide breathable oxygen to the user without excessive inhalation/exhalation resistance or leakage shall be cause for failure of the test.

4.5.2.3.4 Communications test. A test shall be conducted to demonstrate communications systems can provide voice communications between the outside control station, inner lock, and outer lock. The test shall consist of utilizating both primary and secondary systems. With the chamber at ambient pressure and air flow conditions as specified each mode of communication shall be used to establish communications according to the following schedule:

Primary and secondary system	Air flow
Outside control station with inner lock	70 SCFM to inner lock
Outside control station with outer lock	70 SCFM to outer lock
Inner lock with outer lock	70 SCFM to inner lock
Inner lock with outer lock	70 SCFM to outer lock

Failure of the equipment to establish communications as specified or excessive static, hum, squeal, or feedback in the system which prevents the communications from being intelligible shall be cause for failure of the test.

4.5.2.3.5 Lighting tests. The inner/outer lock lighting system shall be turned on and operated for one hour. During operation the system shall be cycled twenty times from the off position thru the full range of illumination. Failure of the lighting system to provide variable illumination for both locks or malfunction of any lighting component shall constitute failure of the test.

4.5.2.3.6 CO_2 analyzer. A test shall be conducted to demonstrate that the CO_2 analyzer can detect hazardous amounts of CO_2 present in the breathing atmosphere inside the chamber. The amounts of CO_2 hazardous to humans is in accordance with specifications stated in NAVSEA 0994-LP-001-9010. The tests shall be conducted under the following depths chosen from U.S. Navy decompression treatment tables. The duration of each test shall be 30 minutes.

10 FSW
30 FWS
60 FWS
100 FWS
165 FWS

4.5.2.3.7 CO_2 scrubber. A test shall be conducted to demonstrate that the CO_2 scrubber unit can remove CO_2 from the chamber atmosphere and purify the atmosphere to U.S. Navy Air Breathing Specifications required for recompression chamber operation as stated in NAVSEA 0994-LP-001-9010 and NAVFAC Design Manual 39. Test shall be conducted under the following depths chosen from the U.S. Navy decompression treatment tables. The duration of each test shall be for one hour.

10 FSW
30 FSW
60 FSW
100 FSW
165 FSW

4.5.2.3.8 Heater/chiller environmental control unit. A test shall be conducted to demonstrate that the heater/chiller environmental control unit can continuously heat or cool in order to maintain a constant temperature inside the recompression chamber of 72 °F. The tests will be conducted in a hot environment (110 °F) and in a cold environment (10 °F). The duration of each test shall be 6 hours. The tests shall be conducted under the following depths and temperature conditions:

TEMPERATURE	DEPTH
110 °F	60 FSW
110 °F	90 FSW
110 °F	165 FSW
10 °F	60 FSW
10 °F	90 FSW
10 °F	165 FSW

Failure to meet the standards of the test as stated above will constitute failure of the test. To meet the standards of the test each phase must be successfully completed to the above stated standards.

4.5.2.3.9 Fire retardant clothing and bedding. A test shall be conducted to demonstrate that the Durrette clothing and bedding is fire retardent. A random sampling of each item of clothing and bedding (noting the batch number of material for the articles) shall be exposed to increasing heat/flame until the test article begins to burn. The temperature and time the article first begins to burn shall be recorded. The entire batch material shall be rejected if the test articles do not meet the manufacturer's specifications. A new batch of articles shall be provided by the manufacturer and tested as above until the articles meet the manufacturer's specifications.

4.5.2.3.10 Portable fire suppression system. A test shall be conducted to demonstrate that the portable fire suppression system can extinguish an electrical or oxygen induced fire inside the recompression chamber while the chamber is under pressure of 165 FSW. The test will be unmanned. The fire must be completely extinguished in less than 30 seconds with no smoldering or continuous off gassing once the flames are extinguished. The test shall be conducted using an article of Durrette® clothing or bedding as well as using a communication device similar to that provided for use inside the recompression chamber. Failure to completely extinguish the fire with no smoldering or continuous off gassing shall constitute a failure of this test. The fire suppression system must be reworked or redesigned and retested according to the above requirements in order to pass the required test.

4.5.2.3.11 Ground fault sentry isolator and power supply. A test shall be conducted to demonstrate that the ground fault isolator and power supply unit will prevent any electrical current from passing through the unit to the recompression chamber in the event of an outside power surge. The test shall be conducted with ever increasing amounts of electrical surge until the unit fails. The test will be considered a failure if the unit does not meet manufacturer's specifications. An electrical device of the testers choosing shall be conducted to the chamber side of the isolator to record the amounts of electrical current (if any), flowing around the isolator. Records of the test shall be provided as part of the documentation required for certification.

4.5.2.3.12 Temperature monitor and temperature probe. A test shall be conducted to demonstrate that the temperature monitor and probe will automatically trigger the heater/chiller environmental control unit to heat or cool as necessary and to demonstrate that the unit can monitor fluctuations of plus or minus 1/2 °F in the chamber environment at 60 FSW, 90 FSW, 100 FSW, and 165 FSW. The duration of the test will be the same as for the heater/chiller environmental control unit. The test can be performed simultaneously with the heater/chiller environmental control unit test. A separate calibrated temperature monitoring device shall be used to verify the accuracy of the tested temperature monitor and probe. Failure of the temperature monitor and temperature probe to automatically trigger into proper operaton the heater/chiller unit at the proper test temeperature shall constitute failure of the test. The monitor and probe shall be inspected for defects, which if present, shall be replaced and retested. If no defects are present, the heater/chiller unit shall be inspected for defects, which if found, shall be corrected. The test shall then be conducted again. If failure to trigger the heater/chiller unit occurs again, the heater/chiller unit and the monitor and probe shall be replaced and retested again as above.

4.5.2.4 Piping test. All piping shall be tested to 150 percent of normal working pressure as follows:

a. Air manifold medical lock and ventilation piping shall be static tested to 300 psig, for one hour duration. Any leaks, loss of pressure, or failure of any component shall constitute failure of the test.
b. Oxygen manifold piping shall be static tested to 4500 psig for one hour durations. Any leaks, loss of pressure ±5 FSW or failure of any component shall constitute failure of the test.

4.5.2.5 Lifting attachments. Lift the unit in its normal travel position using only the permanently affixed lifting attachments. Determine the force and angle of application for each attachment and clearance between each sling and the recompression unit. Anchor the unit and subject each attachment to a load equal to 2-1/2 times the load determine above at the same angle. Apply each load for not less than 2 minutes. Any weld failures, or permanent deformation of lifting attachments or structural members shall constitute failure of the test.

4.6.2.6 Noise levels. While the unit is operating under nomal operating conditions, noise measurements shall be made in accordance with MIL-STD-1474, 5.1.2. Nonconformance to 3.6.3 shall constitute failure of this test.

4.6 Inspection of packaging.

4.6.1 Quality conformance inspection of pack.

4.6.1.1 Examination. The preservation, packing, and marking of each chamber shall be examined for the following defects. Presence of one or more defects shall be cause for rejection. Prior to shipment, all defects shall be corrected.

122. Materials, containers, and procedures not as specified.
123. Preservation for levels A and C not as specified.
124. Packing for level A or C not as specified.
125. Chamber not secured within container for level A or C.
126. Marking illegible, incorrect, incomplete, or missing.

5. PACKAGING

5.1 Preservation. Preservation shall be level A or C, as specified (see 6.2). No contact preservative shall be used on any system component.

5.1.1 Level A.

5.1.1.1 Gages and electrical components. Interior and exterior gages and electrical components shall be removed and preserved in accordance with MIL-P-116, method II. All sockets and connections shall be matchmarked or tagged to facilitate reassembly. Tags shall conform to UU-T-81, type A. All electrical sockets and gage connections shall be capped or sealed with tape conforming to PPP-T-60, type IV.

5.1.1.2 Viewports. Exterior surfaces of viewports shall be covered with corrugated fiberboard. Fiberboard shall be secured in place with tape conforming to PPP-T-60, type IV.

5.1.1.3 Masks and breathing system components. Oxygen masks and built in breathing system components shall be left in sanitary wrap or unit pack in which item was received. If no fiberboard container is provided, components shall be placed in a close-fitting fiberboard container conforming to PPP-B-636, type CF, class weather-resistant, grade as appropriate.

5.1.1.4 Technical publications. Technical publications shall be preserved in accordance with MIL-P-116, method IC-1 or IC-3.

5.1.2 Level C. Preservation shall be as specified for level A except that removal of gages and electrical components shall be limited to exterior mounted ones.

5.2 Packing. Packing shall be level A or C, as specified (see 6.2).

5.2.1 Level A. All components shall be placed inside the chamber and secured to prevent movement. Blocking, bracing and anchoring shall be in accordance with MIL-STD-1186. Any unsecured flooring shall be secured to prevent movement. All doors and hatches shall be closed and secured. The chamber shall be placed in a box conforming to MIL-B-26195, type II, style A, class 2, with rubbing strips and plywood panels. The chamber shall be secured to prevent movement within the box.

5.2.2 Level C. Packing shall be as specified for level A except that the container shall conform to MIL-C-52950, type V.

5.3 Marking. In addition to any special markings which may be required, marking shall be in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The recompression chambers are intended to provide a means of recompression treatment for deep sea divers or special operations forces divers afflicted with gas embolism or decompression sickness.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of specification.
b. Time frame required for submission of first article model and number of units to be furnished (see 3.2).
c. When the Government will conduct any or all of the first article examination and tests. When the Government will conduct some but not all of the first article examination and tests, the contracting officer should specify which examination and tests will be conducted by the Government and which examination and tests shall be conducted by the contractor (see 3.2 and 3.3).
d. Levels of preservation and packing required (see 5.1 and 5.2).

6.3 First article. When a first article inspection is required, the items should be a preproduction model. The first article should consist of 1 or more units. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, tests, and approval of the first article test results and disposition of the first article.

6.4 Provisioning. The contracting officer should include provisioning requirements for repair parts and special tools as necessary, and instructions on shipment of compressors. A suggested paragraph is as follows:

"Shipment of units shall include repair parts, special tools, operational instructions, and accessories, unless exceptions are provided elsewhere in the contract."

6.5 Subject term (key word) listing.

Air manifold
Communication set

Control station
CO_2 analyzer
CO_2 scrubber
Double-lock
Environmental controls
Flow meter
Forklift skids
Hatches
Oxygen analyzer
Pressure gages
Temperature monitors
Viewports

Custodians:
Army - ME

Preparing activity:
Army - ME

Project 4220-A316

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-C-52988A(ME)	Chamber; Recompression, Divers: 100 PSI

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

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

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