



MICROCOPY

CHART







Recompression Facilities

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Preferred Design & Construction Practices

FPO-1-82(10)



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Two Lock Aluminum Two Lock Steel

Section I

General

1. The U.S. Navy's shore establishment includes more than fifty Recompression Facilities (RF). The RFs are used for the treatment of divers that have suffered an accident resulting in the bends, embolism or other medical problems. The U.S. Navy Diving Manual, change 2, dated June 1978 contains diving profiles for the treatment of these medical problems. In addition some design criteria are cited for the RFs.

2. CHESNAVFACENGOOM is tasked to provide the design, construction and facilities management of shore-based Hyperbaric Facilities of which RFs are a part. This document contains a summation of preferred practices in the design and construction of RFs. The cited practices are a product of CHESNAVFACENGOOM experience in the design and construction of many types of hyperbaric facilities. The recommended schematics, materials and construction methods are among many that are acceptable and certifiable. These practices however, constitute good advice that is the product of many "lessons learned".

3. RFs are composed of chambers, piping, communications, lighting and electrical power systems. As of this writing, piping systems for currently existing U.S. Navy standard two lock aluminum and steel chambers are discussed. Subsequent issues of this document will contain communication, lighting and electrical power systems data

4. The technical data in this report conforms to the treatment tables and technical requirements of the Diving Manual as a minimum. All characteristics cited are calculated to provide RFs that can perform the treatment tables. Further, the systems described herein are designed for fail-safe operation, that is, the failure of a system to function that results in risk to the chamber occupant is backed up by a totally independent capability. These guidelines are written in view of the fact that a majority of this type of work is accomplished by commercial contracts. Therefore, commercial standards (ie., ANSI B31.1) are cited rather than Military Standards.

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Section 11

SYSTEM OPERATIONAL RUQUIREMENTS

U.S. NAVY - STANDARD TWO LOCK ALUMINUM RECOMPRESSION CHAMBER

NSN 2H-4220-00-540-2785

Developed in accordance with the U.S. Navy Diving Manual Change 2 dtd June 1978.

A . RECOMPRESSION CHAMBER

| a . Maximum Allowable Working Pressure: 100 psig |
|---|
| b. Volume |
| 1. Inner Lock : 136 ft ³ |
| 2. Outer Lock: 65 fl^3 |
| c. Depth: 0-225 fsw |
| d. Dive Rates |
| 1. Inner Lock: 60 fsw/min @ 165 fsw; 25 fsw/min @ 165 fsw |
| 2. Outer Lock: 165 fsw/min @ 165 fsw |
| e. Ascent Rates |
| 1. Inner Lock: 26 fsw/min @ 60 fsw; 10 fsw/min @ 10 fsw; 1 fsw/min @ 10 fsw |
| 2. Outer Lock: 60 fsw/min @ 10 fsw |
| f. Ventilation Rate (either lock): 70 scf/min. |
| |

B. HIGH PRESSURE AIR SYSTEM

| a. Maximum Operating Pressure: | 3000 psig |
|---------------------------------|--------------|
| b. Minimum Operating Pressure: | 1000 psig |
| c. Maximum Operating Flow Rate: | 365 scf/min. |
| d. Storage Capacity | |
| 1. Primary: 3012 scf | |
| 2. Secondary: 3501 scf | |
| | |

e. Storage Recharge Rate: (primary storage) 3 hours

f. Suggested Pipe Size: 1" NPS (Nominal Pipe Size)

C . LOW PRESSURE AIR SYSTEM

| a. Maximum Operating Pressure: 350 psig |
|--|
| b. Minimum Operating Pressure: 250 psig |
| c. Maximum Operating Flow Rate: 365 scf/min. |
| d. Volume Tank Capacity: 16 ft ³ , water volume |
| e. Suggested Pipe Sizes (up to 100' length) |
| 1. Pressurization (both locks): 1" NPS |
| 2. Inner Lock Vent: 1 1/4" NPS |
| 3. Outer Lock Vent: 2" NPS |
| f. Air Flow LP Air Compressor: 70 scf/min. |
| g. Air Temperature LP Air Compressor: 90°F maximum |

D. OXYGEN SYSTEM

- a. Maximum Storage Pressure : 3000 psig
- b. Minimum Storage Pressure : 1000 psig

c. Low Pressure: 350 psig

- d. Storage Capacity: 1038 scf
- e. Supply Flow Rate : 21.7 scf/min.
- f. Vent Flow Rate : 22 scf/min. using overboard dump. 180 scf/min. interrupted vent. No dump.

Section II

SYSTEM OPERATIONAL REQUIREMENTS

STANDARD NAVY TWO LOCK STEEL RECOMPRESSION CHAMBER

NSN 2H-4220-00-368-3346

The data listed is in accordance with the U.S. Navy Dive Manual Change 2 dtd June 1978.

A . RECOMPRESSION CHAMBER

| a. Maximum Allowable Working Pressure : 200 psig |
|--|
| b. Volume |
| 1. Inner Lock : 335 ft ³ |
| 2. Outer Lock : 147 ft ³ |
| c. Depth: 0-450 fsw |
| d. Dive Rates |
| 1. Inner Lock: 60 fsw/min @ 165 fsw; 25 fsw/min @ 165 fsw |
| 2. Outer Lock: 165 fsw/min @ 165 fsw |
| e. Ascent Rates |
| 1. Inner Lock: 26 fsw/min @ 60 fsw; 10 fsw/min @ 10 fsw; 1 fsw/min @ 10 fs |
| 2. Outer Lock: 60 fsw/min @ 10 fsw |
| f. Ventilation Rate (either lock): 70 scf/min. |
| |

B. HIGH PRESSURE AIR SYSTEM

| a. Maximum Operating Pressure : 3000 psig | |
|---|------|
| b. Minimum Operating Pressure : 1000 psig | |
| c. Maximum Operating Flow Rate: 875 scf, | min. |
| d. Storage Capacity | |
| 1. Primary : 6624 scf | |
| 2. Secondary : 8225 scf | |
| | |

e. Storage Recharge Rate: (Primary storage) 3 hours
f. Suggested Pipe Size: 1 1/4" NPS (Nominal Pipe Size)

C . LOW PRESSURE AIR SYSTEM

| a. Maximum Operating Pressure: 450 psig |
|--|
| b. Minimum Operating Pressure: 350 psig |
| c. Maximum Operating Flow Rate: 803 scf/min. |
| d. Volume Tank Capacity: 16 ft ³ , water volume |
| e. Suggested Pipe Sizes (up to 100' length) |
| 1. Pressurization (both locks): 1 1/4" NPS |
| 2. Inner Lock Vent: 2" NPS |
| 3. Outer Lock Vent: 2 1/2" NPS |
| f. Air Flow LP Air Compressor: 70 scf/min. |
| g. Air Temperature LP Air Compressor: 90°F |

D. OXYGEN SYSTEM

| а. | Maximum Storage Pressure: 3000 psig |
|----|--|
| b. | Minimum Storage Pressure: 1000 psig |
| c. | Low Pressure : 350 psig |
| d. | Storage Capacity: 2500 psig |
| e. | Supply Flow Rate: 21.7 scf/min. |
| f. | Vent Flow Rate: 23 scf/min. with overboard dump. 182 scf/min. inter- |

Section III

System Operational Description

1. AIR PRESSURIZATION SYSTEM (APS):

1.1 The recompression chamber is pressurized and ventilated by means of the APS. The APS consists of high pressure and low pressure air systems with compression, storage and distribution capability.

1.1.1 The High Pressure Air System (compressors, filters, moisture separator, etc.) consists of primary and secondary subsystems that are totally independent of each other. Both systems are to be charged to maximum operating pressure prior to commencing a dive.

1.1.1.1 Primary high pressure air system is for the initial pressurization of the chamber. The storage volume, component and piping sizes are calculated to meet required pressurization rates and frequency. Once the chamber has been pressurized, a brief period of ventilation (approximately 2 minutes), while maintaining depth, is accomplished to reduce heat in the chamber due to compression. The primary system is then secured until needed for additional compressions such as; excursions of the outer lock to relieve attendants or repressurization of the chamber.

1.1.1.2 Secondary (Stand-by) high pressure air system is for the purpose of supplying emergency back-up air should component/system failure occur or the need of an emergency breathing air source become necessary. The secondary system is totally independent of the primary system; failure or contamination of the primary system will not impact the operability of the secondary system. The system contains sufficient stored air to conduct the first 30 minutes of a table 6A including two outer chamber "elevator" dives to 165 fsw. The secondary system shall be charged, and a certified air analysis made. The system shall not be used until an emergency arises.

1.1.2 Low pressure air system (compressor, coolers, filters, moisture separators, purifiers and volume tank) is a source of air for ventilation as required to reduce O_2 and O_2 (if overboard dump not in use) build up in the chamber. The low pressure air supply is put on line after pressurization, then used during the decompression schedule.

2. VENT SYSTEM:

2.1. The vent system is the means of exhausting gases out of the chamber, away from manned operating areas. In doing so, the vent system is required to control two functions.

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2.1.1 Control of Ascent Rates. The vent system valving is capable of accurately controlling all required ascent rates at respective depths.

2.1.2 The vent system, by means of the flow meter and necessary valving is capable of controlling and gauging the required ventilation rates at various decompression stops in order to prevent O_2/O_2 build-up.

3. BUILT-IN BREATHING SYSTEM (BIBS):

3.1 Oxygen is supplied by means of replacable oxygen cylinders. The oxygen cylinders may be interchanged during operation. The hand loaded regulator in the reduction station is set at a predetermined pressure, i.e., 350 psig. As part of the mask assembly, there is an adjustable demand regulator capable of reducing the pressure from the reduction station to approximately 50 psig, (or as specified by manufacturer of the particular mask) and maintaining the pressure differential throughout the operating range of the chamber.

3.2 Air from the primary air pressurization system is tied into the BIBS to provide breathing air to the masks in case of contaminated chamber atmosphere. The secondary air system is tied to the masks in the event the primary fails to function. A block and bleed system is in-line to prevent leakage of oxygen into the system while breathing air. When air is needed, the block valves are closed and the vent valve open to allow any "leaked" O_2 to vent to atmosphere, the air is then put on-line to the masks.

3.3 A negative biased back pressure regulator is in-line in the overboard dump subsystem. Its function is to control the differential pressure between the mask and outside atmosphere. This allows the occupant to exhale "overboard". The exhaust system is isolated from other chamber exhausts.

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Pressure / Gauge (typ. Globe Valve (17) ... Meedle Value (typ) Ball Value (ty: After-cocler. Sep, Purilier LP. Conp. Volume Tk Filter, Meist Chamber I Vent (typ) 13/82 FACILIT 50 1 Outer Lock Check Volve α Air Pressurization & Vent System $\langle \mathfrak{S} \rangle$ Pressure KH D Flew Secondary Pressure LTO BIBS. RECOMPRESSION KREILET VALVE (typ) Printary 5 1X Inner Lock Q PRST - Prs Red Sta-PRS d I. 20 1 Shewin cuter 2As. not Iock -:00 Pressurization Glas Storage (typ) Thru liner Deor 3-Way Ball Valve & Smilber (typ) HESNAVFACENGOOM FPO-1HF 14 July 1982 Cornpressed Filter, Drier, HP Compres. Puritier 9



max flow) Reverse (10% over Pressure Relief Valve (10% over mox 2P; 10% over - Pressure Gage (141) Ż FG 7/1/61 3 Wily Dall Valve. & Sinteder (typ) MUJJ <PRESSURE REDUCTION STATION Hand Lorded Pressure Reducer Needle Valve 垛 I C D BIBS 01 GIEDE VALVE (tYP) ¥ Filter FIOW CHESNAVFACENGCOM FPO-1HF 14 July 1982 11



Section IV

Piping Design, Construction, Cleaning and Inspection Guidelines (Note: This section is in specification format)

1. DESIGN GUIDELINES: Components and piping shall be selected to conform to the pressure requirements of ANSI B31.1 and for service, at the pressure, temperature and flow indicated in Section II, System Operational Requirements. The acceptability of pressure containing components is based upon ANSI B31.1, paragraph 104.7, "Pressure Design of other Pressure Containing Components". The following extract from the paragraph is the basis of judgement "... Pressure containing components not covered by the standards listed in Table 126.1 and for which design formulas or procedures are not given in this code, may be used where the design of similarily, proportioned and sized components has been proven satisfactory by successful performance under comparable service conditions..." In addition, components shall be those used in the diving industry; if not, submittals will be rejected.

1.1 Material and equipment installed in the piping systems shall be suitable for the gases and liquids contained and for the maximum operating temperature and pressures. All valves shall be placed so they can be easily reached and operated by a man without the aid of special equipment, such as a ladder, or provide other means of remote mechanical operation. Piping and tubing shall be protected from abuse and accidents and be placed for ease of operation, maintenance and replacement. All gauges and indicators shall be located for ease of reading and operating.

1.2 Connections to Equipment: The supply line to each major piece of equipment shall be equipped with a cut-off valve and union to enable isolation of the equipment for repair and maintenance without interferring with the operation of other equipment. A length of flexible hose shall be used in connections to reciprocating machinery.

1.3 Protection to Materials and Equipment: Pipe openings shall be closed with caps or plugs during installation. Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury.

1.4 Piping shall not run through nor encroach on the areas designated as passage ways or working areas and shall run only within the envelopes provided.

1.5 All piping shall be 1/2" NPs or larger. Piping unless otherwise specified shall be seamless annealed stainless steel conforming to ASTM A312 Type 304L or 316L.

1.6 All tubing shall be 3/8" or larger. Tubing unless otherwise specified shall be seamless annealed stainless steel conforming to ASIM A269 Type 304L or 316L.

1.7 Flexible hoses shall have a minimum working pressure of two times the system operating pressure and minimum burst pressure of three times the system operating pressure.

1.8 Pressurization piping shall be sized so that maximum gas velocity is .8 mach. "Flexible" inserts in piping shall exist between the chamber hull and the throttling valve.

1.9 All components in the oxygen system shall conform to Compressed Gas Association (CGA) pamphlet G-4.4, "Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems".

1.9.1 Breathing gas components shall have seats and seals that are suitable for oxygen service.

1.9.2 All lubricants shall be suitable for oxygen service.

1.9.3 Components specified as compatible with oxygen shall not react with oxygen or fluorinated compounds in any way that might cause generation of heat or the loss of oxygen to the surrounding atmosphere. Such components shall utilize tetrafluorethylene, polychlorotrifluorethylene or vinylidene fluoride hexafluoropropylene seals and gaskets. All other wetted parts shall be stainless steel unless othewise approved.

1.9.4 All O₂ piping shall be grounded.

1.10 Check Valves: All check valves shall utilize a soft sealing surface poppet or disc and spring.

1.11 Relief Valves: All relief valves shall utilize a soft sealing surface and be compatible with air and oxygen. The components material shall be brass or stainless steel. All relief valves shall be rated at a pressure and flow rating of 10% over maximum operating conditions of the component or piping system which the relief valve is installed. Relief valves shall be located so that the relief valve is no closer than 5 feet from the operators. Relief valves for all 0, piping and for others greater than 1" shall be piped to the outdoors. Relief valves on manned chambers shall conform to and be marked and stamped in accordance with ASME Section VIII, Division 2; and they shall be sized so that when open the rate of chamber depressurization shall be less than 60 feet of sea water per minute. All others shall conform to and be marked and stamped in accordance with ASME Section VIII, Division 1.

1.12 Moisture Separator: The moisture separator(s) shall be capable of removing the element without disassembling the body from the piping. The moisture separator(s) shall be capable of reducing the dewpoint of compressed air to a -40° F.

1.13 Filters: All filters shall be capable of having the filter element replaced without removing solid contaminents to a particle size of 15 microns nominal.

1.14 Pressure Gauges: Pressure gauges, except as otherwise specified, shall be 4 1/2 inch dial with phosphor bronze, 304 or 316 stainless steel helical bourdon coil or tube. The case shall be made of acylonitrile butadiene styrene plastic and shall have a blowout relief device. The dial shall be at least 30 percent but not more than 75 percent greater than the maximum working pressure of the line in which the gauge is installed. Oxygen gauges shall be cleaned and marked for oxygen service.

1.14.1 Provide a pressure gauge for each lock externally mounted to monitor chamber pressure, they shall have an 8 1/2" dial and shall be calibrated in feet of seawater (fsw). The gauges shall have a maximum pressure of 250 fsw and shall have an accuracy of plus or minus 1/4 of 1 percent. The smallest graduations shall be 2 fsw with numerical indication at 10 fsw graduations.

1.14.2 Provide a pressure gauge for each lock mounted inside the chamber to monitor chamber pressure. They shall be caised gauges with a 6" dial calibrated in feet of seawater (fsw). The gauges shall have a maximum pressure of 250 fsw and shall have an accuracy of plus or minus 1/4 of 1 percent. The smallest graduations shall be 2 fsw with numerical indications at 10 fsw graduations. They shall be mounted so that they may be seen by the outside operators.

1.14.3 The total range percentage of accuracy of a gauge shall be numerically less than:

$$\mathbf{P} = \frac{100 \text{ DE} - 2P}{DP}$$

where:

p = total percentage accuracy (sometimes cited as say 1% or 1/2% which are equal values for this purpose).

- D = diameter of arc on which graduation are located.
- P = maximum operating pressure (psi) or depth (fsw).
- E = desired reading error (psi) or depth (fsw).

1.15 Pressure Reduction Station: Provide each pressure reducing station with a regulator, a strainer in the entering line, two blocking valves and a globe or angle bypass valve. Size they bypass valve to restrict its

capacity to approximately that of the reducing valve. Provide each pressure reducing station with an indicating gauge to show the reduced pressure and a safety valve on the low pressure side with sufficient capacity to relieve the high pressure. The components shall be selected so that the downstream pressure is within the maximum and minimum pressures cited in the "System Operational Requirements" for all conditions of flow and upstream pressure.

1.16 Throttle Valves: The contractor shall submit to the Government the throttle valve manufacturer's "Cv vs. Number of Turns of Valve Handle" curve. The "Cv vs. Turns" curve shall be a straight line over the full range of Cv valves required. The slope of the "Cv vs. Turns" curve shall be such that the Cv set point -2% at any point within the Cv range may be set within no more than 20° of valve handle turn nor less than 5° of valve handle turn.

1.17 Low Pressure Air Compressor: The compressor type with it's lubricant shall be approved for breathing air service. On the discharge side of the volume tank, there shall be a filter assembly capable of main-taining air quality in accordance with (OGA Spec. G-7). The compressor package shall be mounted on a frame isolated from the main equipment frame. The air intake shall be piped from a location outside of the building.

1.18 Volume Tank: The air volume tank shall be built to ASME_Section VIII, Division 1. The tank shall have a minimum capacity of 16 ft.³ or approximately 120 gallons. The design working pressure shall be 250 psig.

1.19 High Pressure Air Compressor (s): The HP air compressor shall have an electric motor that is 3 phase dual voltage rated for continuous service as prime mover. The discharge of the compressor shall have a moisture trap/filter assembly capable of maintaining air quality in accordance with CGA-7. The dewpoint of compressed air to storage shall not exceed -40° F. The HP air compressor(s) shall have the capability of recharging the HP air bank in no more than 3 hours. The air intake shall be piped from a location outside of the building.

1.20 Provide a built-in breathing system (BIBS) for oxygen treatment and emergency air. There shall be four oral-nasal type masks in the main lock and four oral-nasal masks in the outer lock. The exhaust of the masks shall discharge to the outside the building atmosphere with the aid of a negative bias back pressure regulator.

1.21 Each vent line (i.e., BIBS exhaust, inner lock vent, outer lock vent) shall be dedicated to its respective system and piped to discharge outside of the recompression chamber facility building. Vent lines shall be provided with lightning protection.

1.22 All vents and relief valve penetrations internal to the chambers shall be arranged so that items will not be ingested into the line.

1.23 All powered hull valves shall be "fail-closed".

2. CONSTRUCTION GUIDELINES:

2.1 Installation shall conform to the requirements of ANSI B31.1.

2.2 Cutting and Repairing: The new work shall be carefully laid out in advance, and no excessive cutting of construction will be permitted.

2.3 Piping shall not run through nor encroach on the areas designated as passage ways or working areas. Shop drawings shall clearly indicate operating areas and maintenance areas.

2.4 Joints shall be butt weld, socket weld or flanged fitting. Threaded O-ring faced fittings may be used. Bite type fittings shall not be used. Brazed joints shall not be used. Threaded joints shall not be used. Oxygen piping shall be butt welded or suitable flanged joints may be used.

2.5 All tubing of a given diameter shall have the same wall thickness.

2.6 Unions and/or flanged fittings shall be placed so that the piping may be readily disassembled for maintenance purposes.

2.7 All values shall be placed so that they may be easily reached and operated without the need of special equipment such as ladders, reach rods, etc. Gauges related to the operation of values shall be efficiently located with respect to the value.

2.8 Piping and tubing shall be protected from abuse and accidents and be placed for the ease of operation and maintenance. Horizontal runs shall be supported at intervals not to exceed 100 pipe (or tube) diameters; vertical runs shall be supported at intervals not to exceed 300 pipe diameters. There shall be support in both directions at elbows.

2.9 Identification of Piping: Identify in accordance with MILSID 101, using adhesive backed or snap-on labels and arrows. Apply to finished paint or insulation at intervals of not more than 50 feet. Provide two copies of the piping identification code framed under glass and install where directed.

2.10 Values and components on lines shall be independently supported. In no case shall the force required to operate a component cause a deflection in excess of 1/32 inch.

2.11 All welding shall conform to the requirements of ANSI B31.1, which in turn specifies ASME Section IX, "Welding and Brazing Qualification". The contractor shall submit copies of the following prior to conducting welding.

2.11.1 "Procedure Specification", Form #QW482.

2.11.2 "Manufacturer's Record of Welder or Welding Operator Qualifications Tests", Form #QW484. All welders and welding operators shall be qualified by the contractor. Qualification forms #QW484 from previous employers of welder and welding operators is not acceptable. (See ANSI B31.1, paragraph 127.5.3(B)).

2.12 To facilitate cleaning and hydro-testing, each piping high point shall contain a vent, horizontal runs shall slope 1/16 inch per foot, trap and drain shall be at each low point.

2.13 Fabricated tees, elbows and branches shall not be used.

3. CLEANING GUIDELINES:

3.1 General: The contractor shall be responsible to clean piping and components as specified hereinafter. Equipment, materials, instruments, personnel and laboratory services required for cleaning and certification shall be provided by the contractor. Components which are certified clean upon delivery by the manufacturer will not require cleaning if the integrity is not violated. Components which have been shop cested and certified for cleanliness shall be isolated from the system during cleaning operations. Systems may be cleaned as a whole or in sections providing all clean piping is kept isolated and free of contamination while cleaning associated piping.

3.2 Cleaning Procedure: The contractor shall submit his cleaning procedure to the Contracting Officer for review. He shall prepare a sample of his constructed piping, which shall include fittings, clean it in accordance with his submitted procedures, test a gas sample, and show that analysis confirms the gas meets the acceptance standards outlined in paragraph 3.4.

3.3 Gas piping and tubing which have been certified clean by analysis of the gas sample shall be sealed and kept free of contamination until final acceptance of the system. After certification, lines shall be broken only for the length of time required to install components. Such components shall also be certified clean.

3.4 Gas Sample Analysis: After cleaning, hydrotesting and assembly, a gas sample shall be taken from each system that contains gases that will be breathed by humans and analyzed for trace contaminents. Trace contaminents and their maximum limits shall be in accordance with the following table or "Limits for Atmospheric Constituents, 90 Day Limit", Appendix E, Breathing Gas Requirements NAVMAT P-9290.

MAXIMUM CONCENTRATION OF SOME COMMON CONTAMINENTS

IN HYPERBARIC FACILITIES

(Surface Equivalent Values)

1000 ppm (3.8mmHg)(.001ATA) Carbon Dioxide Carbon Monoxide 10 ppm1000 ppm Methane Methanol 200 ppm Total Hydrocarbons (less Methane) 10 ppm Benzene 1 ppm Halogenated Hydrocarbons 1 ppm 3 Oil Mist plus Particulate Matter 5 mg/m~

PROHIBITIONS: The use of an organic solvent as a cleaning agent is prohibited (typical: petroleum solvents, chlorinated hydrocarbons).

4. INSPECTION GUIDELINES:

4.1 General: The contractor shall perform all examinations, inspections, and tests in conformance with ANSI B31.1; he shall complete and submit all records that are required thereby. The contractor shall notify the Contracting Officer at least 5 days in advance of all tests. Tests shall be conducted in the presence of the Contracting Officer or his duly authorized representative.

4.2 Equipment, materials, instruments and personnel required for the examination, inspection and tests shall be furnished by the contractor. All recording instruments and gauges used shall be calibrated and certified accurate by an independent laboratory normally engaged in this type work within 30 days prior to the test.

4.3 Test procedures and schedules shall be prepared by the contractor and submitted for approval by the Contracting Officer. The procedure and schedules shall be sufficiently detailed to permit evaluation of their completeness and sufficiency.

4.4 Test records and reports. All test records shall be of a permanent nature such as strip charts, disc charts or log forms. Test reports shall be furnished to the Contracting Officer before acceptance.

4.5 Examination of pressure welds and welds to Pressure Retaining Components shall conform to the following, and shall supercede the provisions of ANSI B31.1, Table 136.4, "Mandatory Minimum Non-Destructive Examinations for Pressure Welds or Welds to Pressure Retaining Components".

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Weld Type

Non-Destructive Examination

Buttwelds (Girth and Longitudinal)

RT for NPS over 2 inches, MT or PT for NPS 2 inches and less

PT or MT all sizes and thickness

Fillet, Socket Welds

Welded Branch Connections

NOTES:

1) All welds must be given a visual examination in addition to the type of specific non-destructive examination specified. Acceptance standards are those of American Welding Society. Dl.l, paragraph 8.15.1, "Quality of Welds".

RT

2) NPS - Nominal Pipe Size

3) RT - Radiographic Examination (see ANSI B31.1, paragraph 136.4.5)

4) PT - Liquid Penetrant Examination (see ANSI B31.1, paragraph 136.4.4)

5) MT - Magnetic Partial Examination (see ANSI B31.1, paragraph 136.4.3)

4.6 Piping shall be leak tested in conformance with ANSI B31.1, paragraph 137, "Leak Tests". Piping shall be subjected to "Hydrostatic Leak Tests" (ANSI B31.1, paragraph 137.3) and "Pnuematic Leak Tests" (ANSI B31.1 paragraph 137.4).

4.7 Leak Testing: All electrical penetrators shall be bubble tested to system rated pressure, 100 psig. Acceptance criteria shall be no bubbles evident. During hydrostatic test, the maximum test pressure shall be 1 1/2 design pressure or a pressure that is calculated to produce a hoop stress in the pipe equal to S_m , whichever is greatest.

Section V

Qualification for Use of Existing Equipment

Economies are often available in the use of existing equipment in the construction of Hyperbaric Facilities. Existing pressure chambers, atmosphere conditioning systems etc. that are available should be employed where applicable. It is encumbent upon the Project Management to assure that equipment meets current safety quality standards. It is mandatory that systems engineered in say, 1982 meet 1982 standards. It is irrationale to accept an existing chamber built and conforming to 1953 standards, to save money as it is to build a new chamber in 1982 to 1953 standards to save money.

Therefore, in order to assure conformance to appropriate standards, the following shall be done. These items follow the outline of inspection for new chambers as cited in ASME Section VIII, Division 1; modified to accommodate existing equipment.

- Determine if chamber was ASME stamped; if so get copy to "Data Report".
- Get copies of as-built drawings and calculations. Compare to chamber to determine if uncontrolled field changes have been made; if so determine a course of action. Update drawings and calculations.
- Obtain mill certs or sample material exercise caution with field modifications.
- Visual Examination
 - Note negative effects of corrosion, abuse and aging.
 - Assure that viewports, gaskets, seals, threads are adequate.
 - UT hull in areas of corrosion; thickness must be within nominal plate tolerance.
- Weld Quality
 - Obtain weld procedure and welder qualifications if not available take sample test to ASME standards.
- NDT Grind all Welds
 - Radiograph all butt welds.
 - Dye Pen all corner welds inside and outside.
- Hydrotest

The decision tree on the following page will aide in making a decision consistent with requirements.



| CHESNAVFACENGCOM Ocean Engineering & Construction Projec | t Office | | |
|--|--------------|------|-----------|
| Hyperbaric Facilities Division | | | |
| ASME New Pressure Vessel Quality Assurance Check-off List | | - | |
| | | | |
| Manufacturers Certificate of Authorization: #, exp | piration d | ate_ | |
| User's Design Specification: Certification by Registered Professional Engine Name, State | er; , No. | | |
| Manufacturer's Design Report Certification by Registered Professional Engine Name, State | er; , No. | | |
| Drawings; # Welds conform to PVNO-1? | | are | available |
| Calculations; | | are | available |
| | | - | |
| Partial Data Reports; | | | |
| Partial Data Reports; | ····· | | |

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| | | Initial/ |
|-----|--|----------|
| 7. | Materials | |
| | a. Mill Certifications | |
| | b. Inspection Records | |
| | (1) pre-fabrication: | |
| | <pre>o Thickness</pre> | |
| | c. QA Inspection | |
| | (1) Materials conform to certs. | |
| | (2) Traceability intact. | |
| 8. | Fabrication | |
| | a. Weld Procedure Qualifications (copies attached) | |
| | b. Welder Qualifications (copies attached) | |
| | c. Record of pre-welding inspection of prepared and fitted joints. | |
| | d. Repair Records | |
| | e. Post Weld Heat Treatment Records | |
| | f. Non-Destructive Examination (Test report attached) Any rejectable indications remain? Meet PVHO-1 requirements? | |
| 9. | Nydrostatic Test | |
| | a. QA Witness | |
| | b. Post Hydrostatic Test Dye Penetration Examination Report (per PVHO-1) | |
| 10. | Nameplate and Stamp attached to vessel | |
| | Manufacturers Data Report (attached) fully executed. | |

| QA Engineer Signature | Date | |
|--------------------------|------|--|
| Pressure Vessel Serial # | | |

| CHESNAVFACENCOM Ocean Engineering & Construction Project Office Hyperbaric Facilities Division Piping Systems Quality Assurance Check-off List Initial/ User's Design Specification: Initial/ L User's Design Specification: Calculations; Calculations; Calculations Cal | | these constants of the | |
|--|-----|---|--------------|
| Ocean Engineering & Construction Project Office Hyperbaric Facilities Division Piping Systems Quality Assurance Check-off List | | CHESNAVFACENGCOM | |
| Hyperbaric Facilities Division Piping Systems Quality Assurance Check-off List Initial/ 1. User's Design Specification: 2. Manufacturer's Design Report 3. Drawings; # are available 4. Calculations; b. Taspection Records (1) Materials conform to certs (2) Traceability intact 6. Fabrication a. Weld Procedure Qualifications (copies attached) c. Repair Records d. Post Weld Heat Treatment Records e. Non-Destructive Examination (Test report attached) Any rejectable indications remain? f. Location of piping supports per specification 7. Hydrostatic Test a. QA Witness 8. Gas Leak Test 9. Gas Cleanliness Report 10. Calibration Records | | Ocean Engineering & Construction Project Office | |
| Piping Systems Quality Assurance Check-off List Initial/ User's Design Specification: 2. Manufacturer's Design Report 3. Drawings; # | | Hyperbaric Facilities Division | |
| Imitial/ Initial/ Imitial/ | - | Piping Systems Quality Assurance Check-off List | |
| 1. User's Design Specification: | - | | Initial/Date |
| 2. Manufacturer's Design Report are available | 1. | User's Design Specification: | |
| 3. Drawings; #are available are available 4. Calculations;are available are available 5. Materials are available a. Mill Certifications are available b. Inspection Records are available (1) Materials conform to certs | 2. | Manufacturer's Design Report | |
| 4. Calculations; are available | 3. | Drawings; #are available | |
| 5. Materials a. Mill Certifications | 4. | Calculations;are available | |
| a. Mill Certifications | 5. | Materials | |
| b. Inspection Records (1) Materials conform to certs | | a. Mill Certifications | |
| 6. Fabrication a. Weld Procedure Qualifications (copies attached) b. Welder Qualifications (copies attached) c. Repair Records d. Post Weld Heat Treatment Records e. Non-Destructive Examination (Test report attached) Any rejectable indications remain? f. Location of piping supports per specification 7. Hydrostatic Test a. QA Witness 8. Gas Leak Test 9. Gas Cleanliness Report 10. Calibration Records | | (1) Materials conform to certs | |
| a. Weld Procedure Qualifications (copies attached) | 6. | Fabrication | |
| b. Welder Qualifications (copies attached) | | a. Weld Procedure Qualifications (copies attached) | |
| <pre>c. Repair Records</pre> | | b. Welder Qualifications (copies attached) | |
| d. Post Weld Heat Treatment Records | | c. Repair Records | |
| e. Non-Destructive Examination (Test report attached) Any rejectable indications remain? f. Location of piping supports per specification 7. Hydrostatic Test a. QA Witness 8. Gas Leak Test 9. Gas Cleanliness Report 10. Calibration Records | | d. Post Weld Heat Treatment Records | ····· |
| <pre>f. Location of piping supports per specification</pre> | | e. Non-Destructive Examination (Test report attached) Any rejectable indications remain? | <u></u> |
| 7. Hydrostatic Test | | f. Location of piping supports per specification | <u> </u> |
| a. QA Witness | 7. | Hydrostatic Test | |
| 8. Gas Leak Test | | a. QA Witness | |
| 9. Gas Cleanliness Report | 8. | Gas Leak Test | <u></u> |
| 10. Calibration Records | 9. | Gas Cleanliness Report | |
| 11 Final Bunchional Mark Bonark | 10. | Calibration Records | |
| TT. LINUT LAUCTORIAT LESC KEDOLC | 11. | Final Functional Test Report | |
| | | | |

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; }., Section VIII

Test Dive Scenario

| l. Rec | ord the following information prior to commencement o | f test. |
|--|--|--|
| a. | Primary air supply water volume | |
| b. | Primary air supply pressure | |
| с. | Secondary air supply water volume | |
| d. | Secondary air supply pressure | |
| e. | Under static conditions, pressure of | |
| | L.P. side primary pressurization regu- lator | |
| 2. Usi Maintai | ng primary pressurization system, dive inner lock to in a descent rate of 60 fsw/min. | 165 fsw. |
| a. | Output pressure of primary regulator during dive | |
| b. | Primary air supply pressure after pressurization | |
| c. | Record time/depth at one minute | |
| | intervals on Figure 1 | |
| 3. Ven Record: | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for | or two minutes. |
| 3. Ven Record: a. | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) fo Primary bank pressure | or two minutes. |
| 3. Ven Record: a. 4. Div. Maintai | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner lo n a descent rate of 165 fsw min. | or two minutes. |
| Ven Record: a. 4. Div Maintai a. | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner lo n a descent rate of 165 fsw min. Primary bank pressure | or two minutes. |
| 3. Ven Record: a. 4. Div Maintai a. b. | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner lo n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 | or two minutes. |
| Ven Record: a. Div. Maintain a. b. Sur | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner loc n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 face the outer lock maintaining an ascent rate of 60 | or two minutes. ock hatch). fsw min. to 10 fa |
| 3. Ven Record: a. 4. Div Maintain a. b. 5. Sur a. | <pre>intervals on Figure 1 intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) fo Primary bank pressure e outer lock to 160 fsw (do not break seal on inner lo n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 face the outer lock maintaining an ascent rate of 60 Record time/depth at one minute intervals on Figure 3</pre> | or two minutes. |
| Ven Record: a. Dive Maintain a. b. Sur a. Sur rate du | <pre>intervals on Figure 1 intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) f Primary bank pressure e outer lock to 160 fsw (do not break seal on inner le n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 face the outer lock maintaining an ascent rate of 60 Record time/depth at one minute intervals on Figure 3 face inner lock from 165 fsw to 60 fsw maintaining 26 ring excursion. Record time/depth at one minute intervals</pre> | or two minutes. ock hatch). fsw min. to 10 fs fsw/min. ascent rvals on Figure 1 |
| Ven Record: a. Div. Maintain a. 5. Sur a. 6. Sur rate du | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner le n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 face the outer lock maintaining an ascent rate of 60 Record time/depth at one minute intervals on Figure 3 face inner lock from 165 fsw to 60 fsw maintaining 26 ring excursion. Record time/depth at one minute interval | or two minutes. ock hatch). fsw min. to 10 fs fsw/min. ascent rvals on Figure |
| Ven Record: a. 4. Dive Maintain a. b. 5. Sur a. 6. Sur rate du | intervals on Figure 1 tilate inner lock (demonstrating 47 scfm flow rate) for Primary bank pressure e outer lock to 160 fsw (do not break seal on inner le n a descent rate of 165 fsw min. Primary bank pressure Record time/depth at one minute intervals on Figure 3 face the outer lock maintaining an ascent rate of 60 Record time/depth at one minute intervals on Figure 3 face inner lock from 165 fsw to 60 fsw maintaining 26 ring excursion. Record time/depth at one minute intervals | or two minutes. ock hatch). fsw min. to 10 fs fsw/min. ascent rvals on Figure 1 HESNAVFACENGCOM FO-1HF |

7. Surface the inner lock from 60 fsw to 10 fsw maintaining 10 fsw/min. ascent rate. Record time/depth at one minute intervals on Figure 2.

8. Dive inner lock to 165 fsw maintaining a descent rate of 25 fsw/min.

a. Record time/depth at one minute intervals on Figure 1b. Record primary air pressure

9. Surface the inner lock from 165 fsw to 60 fsw maintaining an ascent rate of 20 fsw/min.

a. Record time/depth at one minute intervals on Figure 2

10. Change primary air supply source from H.P. flasks to L.P. air compressor. Ventilate inner lock (demonstrating 70 scfm flow rate) for 2 min.

11. Surface the inner lock from:

- a. 60 fsw to 55 fsw, maintain a

 fsw/min. ascent rate, record
 time/depth at one minute intervals
 on Figure 2
- b. 55 fsw to 20 fsw at 60 fsw/min.
- c. 20 fsw to 10fsw, maintain a 1 fsw min. ascent rate record time/depth at one minute intervals on Figure 2

12. With secondary air supply (flasks fully charged, as noted in 1-D) dive both locks to 165 fsw, then ventilate chamber for 1 hour at 70 scfm. Record.

- a. Time to 165 fsw
- b. Secondary bank pressure after dive
- c. Secondary bank pressure after ventilation

13. With the chamber at the surface, demonstrate O₂ supply to masks in inner and outer locks and the ability to cross over from O₂ supply to secondary air supply.

Witnessed

Date

| Depth (FSW) | | | | | | | CHES Reco Maxi Maxi Desc (1) 0-16 (2) 0-16 (2) 0-16 | NAVFACEN T Lock and & Mi 5 fsw @ 5 fsw @ 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 | CCOM n Chambe 60 fsw/m 25 fsw/m 25 fsw/m | r Facilit In. (Tabl | و و م م | ه د د د د د د د د د د د د |
|----------------|----------|--|--|-------|----------|-------|--|---|--|------------------------|---------------|---|
| | PIGURE 1 | | | Tim T | e/Minute | 2 | | | | 5 5 | Ŀ | |





| | X1 nc |
|--|--|
| CHESAPEAKE DIVISION Naval Facilities Engineering Command NDW DISCIPLINE | PROJECT: <u>Recomposition Chamber</u> Station: E S R: Contract: |
| Calcs made by: <u>IPO UNE</u> date: <u>2/12/2</u> Calcs ck'd by: date: | Calculations for: <u>CLS.N. 2 Lock</u> |
| A) <u>Volumes</u> INNEr Lock 136 F1 ³ Outer Lock 65 F1 ³ Total 201 F1 ³ | |
| 2) Performance Requirement The following dive a. from "US NAVY Divers H. | nd ascent intes are taken |
| it is resumed that the be used to transit m dive, 60 tsw/m ascent. | culter christian will chical personnel @ 165 (sulph |
| It is assumed that the be used to tomisit m dive, 60 tow/m ascent. Immer Lock: Dive, 60 tow/m, 25 tow/m, 10 tow/m 1 (sw/m | 0 10 165 fsw 6 10 165 fsw 6 10 165 fsw 6 10 15w 6 10 15w 0 10 15w |
| It is assumed that the be used to transet m dive, 60 tow/m ascent. Immer Lock: Dive, 60 tow/m, 25 tow/m, 10 tow/m 1 tow/m 1 tow/m 1 tow/m | 0 to 165 fsw 0 to 165 fsw 0 to 165 fsw 0 to 165 fsw 10 fsw 0 to 165 fsw 165 fsw 10 fsw 165 fsw 10 fsw |

DIVISION PROJECT: Recompression Chember CHESAPEAKE NDW Station: Naval Facilities Engineering Command DISCIPLINE E S R: _____ Contract: _____ Calcs made by: FPO-INF date: 2/2/2 Calculations for: USN 2 Look _____ Bleningen Calcs ck'd by: _ date: _____ () Pressurization Note: Pressurization and Ascent Rates use FE psm K, " Max Length of Venting Pipe". See Crane Tech Bulliten 410. Inner Lock: Vol: 136 ft3 Hender pressure, 250 psis = 264.7 psia 60 fsw/m @ 165 fsw = 73. 43 psig = 87.13 psia DP= 264.7 - 87.13 = 177.57 psia P' = 264,7 psia AP= 177.57 = .66 :. Y= 0.7 264.7 pipe dia. 1/4" (1.38" 1.0, + =.022) = 3835 MAY light $\frac{U5E}{3/4} \xrightarrow{(1.049.0.)} = .023 = 1002 \xrightarrow{(1.01)} = .023 = 273' (ve/oc)$ = 273' (velocity greater than Machi) V= 685 ft/sec 1" pipe Note: MAY Allowable longth is return leigth of pipe. For resistance to Air flow it is assumed exit, entirace, 2 globe values, and one 90° elbow every 5 feet. Vol. = 65 ft3 Outer Lock: 165 (sw/m @ 165 / 5 w AP= 177.57 P'= 264.7 Y= 0.7 SCFM = 325 page ____ of . CHESNAVFACENGCOM GPO 942-951 FPO-1HF 31 14 July 1982

DIVISION PROJECT: CHESAPEAKE NDW Station: **Naval Facilities Engineering Command** 1 DISCIPLINE E S R: _____ Contract: _____ _____ date: _____ Calculations for: 2 lock plum Calcs made by: _____ date: __ Calcs ck'd by: __ () cont'd 1" (1.049" I.D., 4t. = .023) 561 ' MAX Longth 3/4" (0.824" I.D., .025) 162' MAX Longth Velocity 1" pipe = 901 tr/sec D) Ascent Inner Lock: Vol. = 136 143 10 towlow @ 10', (4.45 psig) (worse condition) AP = 4.45 psi P' = 19.15 psia $\frac{\Delta p}{p'} = \frac{4.45}{1617} = 0.23 \quad \therefore \quad Y = 0.90$ 19.15 1/2" (1.61 ID., fy =.021) = 831' MAY length USE → 1/4" (1.38 I.D., fy =.022) = 367 ← Outor: Vol= 65 ft3 60 tow/m @ 10 tow (4.45 psr) AP = 4.45 PS15 p'= 19.15 psin P= ,23 ... Y= 0.90 USE → 2° (2.067ID, .019) = 303', nor filh ← 1/2 (1.61 ID, .021) = 50' page ____ of . CHESNAVFACENGCOM GPO 942-951 FPO-1HF 14 July 1982 32

CHESAPEAKE DIVISION PROJECT: **Naval Facilities Engineering Command** NDW Station: _____ \mathbf{z} E S R: _____ Contract: _ DISCIPLINE Calcs made by: date: Calculations for: _2_lock plant Calcs ck'd by:. date: E) Pressure Reduction Station 1) Main Pressurization Input pressure 3000 psis max, 1000 psis min. Output pressure 350 psis max, 250 psis min. MAX Flow - 201613 x 60 (Sw/m x .445 11.7 - 365 SCFM F) Air Storage Note: From Divers Handbook ; Primmery Storage sufficient for 2 pressurizations to 165 fow, ventilation requirements to be handled by LP Compressor. Secondary, sufficient stored Mix to conduct the first 30 min, et a trentment table 6A including, 2 accursions of the outerlack to iss and I charge at inner lock propose no continous Vont. Primpry 201413 to 165 few 2012 165 2.445 = 1004 501 x 2 = 2008 504 Usable Gas (3000 10 100 ps1) :. Total stored sos = 3012 set page . CHESNAVFACENCOOM GPO 942-951 FPO-1HF 14 July 1982 33

| CHESAPEAKE | DIVISION | PROJECT: | · · · · · · · · · · · · · · · · · · · | |
|-----------------------------|---------------------------------|-------------------------|---------------------------------------|-------------|
| laval Facilities Engineerin | ng Command NDW | Station: | | |
| DISCIPLINE | | E S R: | Contract: | |
| Calcs made by: | date: | Calculations for | 2 lock plum | , |
| Calcs ck'd by: | date: | | | |
| F) Contil | | | | |
| Second | ary | | | |
| \mathcal{D}_{i} | ve Chen ber t. | 2 165 Face | | |
| | 201 X 165 X <u>-</u> 1 | 1 <u>11.5</u> 14.7 | 1004 5 | set. |
| | 10 Prennerners | olthe ca | lorkek | |
| 6 | 5 | XQ | 650 5 | Set. |
| | e change of , which lirst 30 | mor lock | 11-105- 61 6 A | |
| | - 136 × 165 × <u>-</u> 1 | <u>1145</u> 11. 7 | 680 | Scf |
| | See | condary Vo. | lunie 2334 | , |
| Uli | able Cas 3 | ooo psi to | 1000 \$51 | |
| • | Telel Store | and gris = | 3501 3 | scf |
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| | | | CHESNAVFACENCCOM FPO-1HF | GPO 889-526 |
| | | - • | 14 7.1. 1000 | |

DIVISION | PROJECT: CHESAPEAKE Naval Facilities Engineering Command NDW | Station: _____ E S R: _____ Contract: ____ DISCIPLINE _____ date: _____ Calculations for: 2 lock e lun Calcs made by: _ date: Calcs ck'd by: _ Gas from Pipe Size - Use 1" to match pressurization lines. G) Oz Stornge Adequate from 3000 to 1000 psi to supply one patient three table sig. Assume one policent of rest 1038 SCF, O2. Supply 6 minsks @ 2 acrm @ 60 fsw 12 perm x 60 x, 445 = 21.7 SCFM Of Reduction Station: Injust pressure, 3000 to 1000 ps19 Output 350 psig min Max Flow 21.7 SCFM Uso & pipe Vent Rite, Assume NO OVerborid dunge, Interruptar Sorvice 35 MOM NO MASS 150 Arm (260 KW 272 SCFN) Total 180 SCENI Innerhock page. Ot . CHESNAVFACENGCOM GPO 942-951 35 FPO-1HF 14 July 1982

| CHESAPEAKE DIVISION Naval Facilities Engineering Command NDW DISCIPLINE | PROJECT: USAL 2 lock STEEL Station: |
|---|--|
| Calcs made by: <u> </u> | Calculations for: |
| A) <u>Volumes</u> Inner Lock <u>335</u> ft ³ Cuter Lock <u>147</u> ft ³ Total 482 ft ³ B) <u>Performance Requiremant</u> The following Give and from "US Navy Divers F it is ussumed that the | ents nd ascent rates are taken tand book" In addition, |
| be used to transit med 60 fsw/, ascent. Inner Lock: Dive, 60 fsw/, 25 fsw/, Ascend, 26 fsw 10 fsw 10 fsw Outer Lock: Dwg 145 fsw | $\frac{1}{1641} & \frac{165}{5} \frac{100}{m}, \frac{100}{5} \frac{100}{m}, \frac{100}{5} \frac{100}{5}$ |
| be used to transit med 60 fsul, ascent. Inner Lock: Dive, 60 fsul, 25 fswl, Ascend, 26 fsu 10 fsu 1 fsu Outer Lock: Dive, 165 fsw Ascend, 60 fsu | $\frac{1}{100} = \frac{1}{100} = \frac{1}$ |
| be used to transit med 60 fsw/, ascent. Inner Lock: Dive, 60 fsw/, 25 fsw/, Ascend, 26 fsw 10 fsw 1 fsw Outer Lock: Dive, 165 fsw Ascend, 60 fsw | Incal & 165 fsw/m, dive. Incal & 165 fsw n, 0 to 165 fsw w/m & 60 fsw w/m & 10 fsw w/m & 10 fsw 1/m, 0 to 165 fsw w/m, 165 fsw to 10 fsw page of |

PROJECT: <u>A Lock STEEL</u> DIVISION CHESAPEAKE **Naval Facilities Engineering Command** NDW Station: _____ **DISCIPI INF** E S R: _____ Contract: Calcs made by: <u>______</u> date: <u>_____</u> Calculations for: Calcs ck'd by: _____ _____ date: ____ C) Pressurization Note: Pressurization and Ascont Rates Use FG pain K, " Max Length of Venting Pipe". See Crane Tech Builiten 410. Vol= 335 A3 Inner Lock: Header pressure, 350 psig. = 364.7 psig 60 fsw/m @ 165 fsw = 72.43 psig : 87.13psig AP= 364.7 - 87.13 = 277.57 psi P' = 364.7 psia <u>AP</u> <u>277.51</u> : 0.76 , Y = 0.76 USEL pipe dia 1/14, (1.38°10, tt=.022) = 1574' Max Allow Lq No psig=0 1, (1.049, .023) = 394' 976 Ft/sec 3/4, (0.824, .025) = 93' No psig = 0 Note: Max Allowable Length is actual length of pipe. For resistance to air flow it is assumed Exit, entrance, 2 globe values, and one 90° elbow every 5 feet. Outer Lock: 165 FSW & 165 FSW Vol = 147 f3 DP. 277.57 P' = 364.7 AP. 0.76, Y= 0.76 NEPSIGO 1", (1.049", .022 1175 41 212, (1.049", .023 USE -, . 023) = 255 Max Allow Lg 1176 ft/sec. $\frac{3}{12}$, $(0.824^{\circ}, 025) = 52$ $\frac{1}{2}$, $(0.622^{\circ}, 027) = -$ Dage _ . of CHESNAVFACENGCOM GPO 942-951 FPO-1HF 37 14 July 1982

DIVISION PROJECT: 2 LOCK STEEL CHESAPEAKE **Naval Facilities Engineering Command** NDW Station: DISCIPLINE _____ Contract: E S R: ____ Calcs made by: Gorman date: 1/2/82 Calculations for: Calcs ck'd by: _ date: D) Ascent Inner Lock: Vol = 335 ff 3 10 fsw/m @ 10', (4.45 psis) SP= 4.45 psi P'= 19.15 psi <u>AP = 4.45</u> 0.23 :. Y= 0.90 P' 19.15 Max Allow Lot 21/2°, (2.469, .018) = 1275' ~ 2", (2.067, .019) = 446 - USE 1/2", (1.61, .021) = 92' Check Itsulm @ 10'met by observation 26 four @ 60 four, (26.7 psig) AP= 26.7 psi P'= 41.40 psig <u>DP: 26.7</u> = 0.64 , Y= 0.75 2", (2.067, .019) = 602 ft allowable; not critical condition Outer Lock: Vol = 147 fx3 60 fow for & 10 fow (4.45 psig) DP= 4.45 psig P'= 19.15 psig AP: 0.23, Y=0.85 3" (3.066,018) - 314', Mox Allow Lath. - 2'/2" (2.469, 018) " 78', - USE 2" (2.007, 019) " page ____ of . CHESNAVFACENGCOM GPO 942-951 FPO-1HF 38 14 July 1982

| aval Facilities Engineering Command NDW | PROJECT: <u>Q Lock STEEL</u> Station: E S R: Contract: |
|---|--|
| Calcs made by: <u>Crorman</u> date: <u>1/2/82</u> Calcs ck'd by: date: | Calculations for: |
| E) <u>Pressure Reduction S</u> 1) Main Pressurization | tation_ |
| Input Pressure Output Pressure | 3000 psig may, 1000 psig min 400 psig may, 350 psig min |
| Mox Flow = 482 | fy3x 60 fsw/m x .445 |
| ² <i>8</i> 75 | SCFM |
| F) <u>Air Storage</u> Note: From Diver's Storage sufficient for 2 | Hondbook ; Primary pressurizations to |
| LP compressor. Secondary | , sufficient stored Air |
| 6A, including 2 executions 165' And I change of inno | s of the outer lock to |
| 6A, including 2 execusions 165' And 1 change of inne continues ventilation. | 5 OF THE OUTER 10 40 r 1004 p - 10 05 person - 10 |
| 6A, including 2 creations 165' And 1 change of inner continues ventilation. Primary 482 fl ³ to 163 182 fl ³ × 165 × | s of the outer lock to r lock prin osperiere, no stsw 2408 Sct X 2 = 4416 Scr |
| 6A, micheling 2 creations 165' And I change of inne continues ventilation. Primary 482 fl ³ to 163 182 fl ³ x165 x.145 = 3 141.7 Usable gas (between 3 Total stored | S OF THE OUTER FO r lock primesphere, no stsw 2408 Scf X 2 = 4416 Scf 200 And 1000 psi) SAS = 6624 Scf |
| 6A, micheling 2 creations 165' And 1 change of inne continues ventilation. Primary 482 fl ³ to 163 482 fl ³ x165 x. <u>145</u> = 3 141.7 Usable gas (between 3 Total stored) | 5 OF THE OUTER 10 r 10ck At a spectre, no 5 tow 2408 Sct X 2 = 4416 Ser 200 And 1000 psi) 5AS = <u>6624 Sct</u> page <u>1</u> of |

| CHESAPEAKE | DIVISION | PROJECT: _ | | |
|----------------------------|------------------------------------|---|----------------------------|-----------|
| Naval Facilities Engineeri | ng Command NDW | Station: | | |
| DISCIPLINE | | E S R: | Contract: | |
| Calcs made by: | date: | Calculations | for: <u>> hele eler</u> | ./ |
| Calcs ck'd by: | date: | ····· | | |
| F) Contid | | | | |
| Secondary | • | | | |
| Dive C. | hember to 16 | ; low | | |
| 482 | X 165 X .445 = 14.7 | - | 2408 | Sc F |
| Two exc | ursions of the | outerlo | : A | |
| 1473 | × 165 × <u>445</u> × = 14.7 | 2 = | 1 46 9 | scf |
| One cha during fi | ange of inner loc ist somin. of | K Atmos table 6A | phore | |
| 335 X | 165 × <u>445</u> 14.7 | <u>:</u> | 1673 | sef |
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DIVISION PROJECT: & Lock STEEL **CHESAPEAKE** Station: **Naval Facilities Engineering Command** NDW I E S R: _____ Contract: ___ DISCIPLINE Calcs made by: <u>Corman</u> date: 1/2/F2 Calculations for: ____ Calcs ck'd by: _____ date: _ Gas Farm pipe size - Arbitrary use 3/4 to match Pressurization lines 6) On Storage Adequate from 3000 to 1000 psi to supply one patient thru table six. Assume one patient at rest 1038 SCF, 02. Supply 6 mosks @ 2 ACFM @ 60' 12 ACFM × 60 × .445 = 21.7 SCFM 14.7 02 Reduction Station: Imput pressure, 3000 to 1000 psig Out put pressure, 400 psig mar, 350 psig min Max Flow 21,7 SCFTI. USE 3/8 pipe Vent Rate, Assume no overboard dump, Interrupted service 25 ACFM × 6 mosks = 150 ACFM @ 60'= 272 SCF/rl. Total 186 SCF/rl Inner chamber. page ___ -- of . CHESNAVFACENGCOM GPO 942-951 FPO-1HF 14 July 1982 41

