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MILITARY STANDARD

CLEANING AND TESTING OF SHIPBOARD OXYGEN, NITROGEN AND HYDROGEN GAS PIPING SYSTEMS

FSC 4730

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362

Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping Systems.

MIL-STD-1330C(SH)

1. This Military Standard is approved by the Naval Sea Systems Command for use by Naval stations, submarine tenders, destroyer tenders, submarine bases, Naval shipyards or repair facilities and private firms performing services as prime or sub-contractors for the Naval Sea Systems Command. It is available for use by all Departments and Agencies of the Department of Defense.

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

FOREWORD

1. Explosions are known or suspected to have occurred in high pressure oxygen and nitrogen gas systems which were not properly maintained. To ensure safe operation of these systems, the accumulation of hydrocarbons in the systems must be eliminated; subsequently the systems must be cleaned for oxygen service.

2. This standard provides a procedure for cleaning and testing oxygen, nitrogen and hydrogen gas piping systems. Requirements for cleaning the nitrogen system shall be invoked only when the nitrogen is used for purging the oxygen system and oxygen generator.

3. This standard also provides a procedure for cleaning the demineralized water piping and air separation type oxygen-nitrogen plants.

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TABLES

1. SCOPE

1.1 Scope. This standard provides the requirements for cleaning and testing oxygen, nitrogen and hydrogen gas system piping and components. It also provides the requirements for cleaning the demineralized water piping and air separation type oxygen-nitrogen plants.

1.2 Application. This standard is applicable to all surface ships and submarines which have oxygen, nitrogen or hydrogen gas piping systems. The application of this standard to the cleaning of nitrogen gas systems is based on the use of the nitrogen for purging the oxygen system or oxygen generator. Nitrogen gas systems arranged so that it will not permit such use of the nitrogen are to be cleaned to the standards of MIL-STD-1622.

1.2.1 This standard is not applicable to electrolytic oxygen generators.

2. REFERENCED DOCUMENTS

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

SPECIFICATIONS

FEDERAL

A-A-1586	- Tape, Pressure - Sensitive Adhesive (Waterproof).
O-S-642	- Sodium Phosphate, Tribasic, Anhydrous; Dodecahydrate; and Monohydrate; Technical.
BB-F-1421	- Fluorocarbon Refrigerants.
BB-N-411	- Nitrogen, Technical.
QQ-N-281	- Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
ZZ-R-710	- Rubber Gasket Material, 35 Durometer Hardness.

MILITARY

MIL-I-18997	- Indicator, Pressure, Panel Mounted or Case Supported, General Specification.
MIL-B-22191	- Barrier Materials, Transparent, Flexible, Heat Sealable.
MIL-V-22549	- Valves, Angle, Relief, for Gas and Oxygen Service (Sizes 2-inches IPS and Below); Naval Shipboard.
MIL-L-25567	- Leak Detection Compound, Oxygen Systems (Metric).
MIL-H-25579	- Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure.
MIL-C-52211	- Components and Assemblies for Industrial Gas Production, Storage and Transport Equipment, Packaging of.
MIL-C-81302	- Cleaning Compound, Solvent, Trichlorotrifluoroethane.

STANDARDS

FEDERAL

FED-STD-209 - Clean Room and Work Station Requirements, Controlled Environment.

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-767 - Cleaning and Cleanliness Control Requirements for Special Purpose Equipment.

HANDBOOK

MIL-HDBK-407 - Contamination Control Technology Precision Cleaning Methods and Procedures.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

0389-LP-015-2000 - Water Chemistry Control, Nuclear Propulsion Plant.
0900-LP-001-7000 - Piping Systems Brazed, Fabrication and Inspection.
0901-LP-480-0002 - NSTM, Piping Systems, Chapter 9480 (505).
0901-LP-490-0003 - NSTM, Compressed Air Plants, Chapter 9490 (551).
0987-LP-022-3010 - Oxygen Gas System In Place and On Site Calibration of Pressure Instruments (Other Than Gas Generating Plants).
S9086-HT-STM-000 - NSTM, Lubricating Oils, Greases and Hydraulic Fluids and Lubrication Systems, Chapter 262.
S9086-SX-STM-000 - NSTM, Industrial Gases - Generating Handling and Storage, Chapter 550.
S9551-AM-PRO-010 - Cleaning Procedure for Gas Flasks, High-Pressure Non-Nuclear.
OD45845 - Metrology Requirements List.

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

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

ASTM

D 471 - Rubber Property - Effects of Liquids, Test Method for. (DoD adopted)
D 1414 - Rubber O-Rings, Methods of Testing. (DoD adopted)

(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, PA 19103.)

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

3. DEFINITIONS

3.1 Oxygen clean. Oxygen clean is the absence of all loose scale, rust, grit, filings, oil, grease, other organic materials and foreign substances as specified in 4.2.3.

3.2 Cleaning agents.

3.2.1 Cleaning solution. A cleaning solution is a cleaning medium containing water and dissolved tribasic sodium phosphate (TSP).

3.2.2 Cleaning solvents. Cleaning solvents are trichlorotrifluoroethane (R-113) in accordance with MIL-C-81302, type I and trichloromonofluoromethane (R-11) used in cleaning only oxygen-nitrogen plants as specified in 5.10. Cleaning solvents may be reused when purified by distillation as specified in 4.2.1.2.

3.3 Components. Components are valves, fittings, gauges and regulators in the system.

3.4 Dead end piping. A dead end piping system is one through which the flow of a gas or liquid cannot be accomplished without cutting or removing a pipe or component.

3.5 Deliquescent. Deliquescent describes a substance which becomes a liquid by absorbing moisture from the air.

3.6 Laboratory. A laboratory is a facility where assigned analyses, specified herein, are performed.

3.7 Nitrogen. Nitrogen refers to gaseous nitrogen in accordance with BB-N-411, type I, class 1, grade A or B.

3.8 Sample. Sample is a representative amount of cleaning solvent, cleaning solution, rinse water or pressurized nitrogen collected in clean containers at selected sample points specified by the cleaning activity.

3.9 Standard conditions. Standard conditions are an atmospheric pressure of 14.7 pounds per square inch (lb/in^2) absolute or 0 lb/in^2 gauge and a temperature of 68 degrees Fahrenheit ($^{\circ}F$).

3.10 Water. Water, unless otherwise specified, refers to distilled water, grade B or better in accordance with MIL-STD-767.

3.11 Clean air. Clean air is air which meets the cleanliness requirements of class 100,000 in accordance with FED-STD-209.

4. GENERAL REQUIREMENTS

4.1 Space ventilation. The compartments with oxygen piping and ballast tanks containing oxygen system piping shall be well ventilated so that the leak detector will not pick up any foreign gases such as paint fumes or fluorocarbon refrigerants from other equipment. Tests shall be made to ensure that ship's compartments are free of agents detectable by the leak detector.

4.2 Cleaning and testing agents.

4.2.1 Cleaning with trichlorotrifluoroethane (R-113). R-113 shall be used as the preferred cleaning agent for oxygen and nitrogen gas piping systems as specified in 5.5.2 and 5.5.4. The maximum allowable contamination limit for hydrocarbons in new or reclaimed cleaning solvent is specified in 4.2.1.2 and the maximum allowable contamination limit of hydrocarbons to certified oxygen cleanliness is specified in 4.2.3.2. Alternately, TSP solution may be used as the cleaning agent as specified in 4.2.2 and 5.8.

4.2.1.1 A sample of cleaning solvent shall be taken from each drum, tank or other storage container prior to each use and analyzed by the laboratory for total contamination levels of moisture content, hydrocarbon content or residue to ensure compliance as specified in 4.2.1.2.

4.2.1.2 Used or contaminated R-113 or R-11 solvent may be reclaimed for use if it is purified by distillation in accordance with MIL-C-81302, type I with the following exceptions:

Property	Requirement	Test method
Moisture content, p/m maximum (by weight)	35	MIL-C-81302
Hydrocarbon content, p/m, maximum (by weight as n-hexane equivalent)	3	See 4.2.1.3
or		
Residue, p/m, maximum (by weight)	3	MIL-C-81302

4.2.1.3 R-113 has a strong attraction for hydrocarbons and can be readily analyzed to determine if contamination is within allowable limits. Testing for hydrocarbon content by infrared spectroscopy is preferred since volatile hydrocarbons can be detected. This method is specific for hydrocarbons, sensitive and very rapid once a calibration curve is established. Reagent grade n-hexane shall be used as the hydrocarbon standard material. To prepare calibration standards, densities shall be used to convert milligrams (mg) n-hexane to microliters and grams R-113 to milliliters (mL). Calculated volumes of reagent grade n-hexane shall be measured with a microliter syringe and diluted in volumetric glassware with R-113 which has been certified to meet the residue requirement in accordance with MIL-C-81302, type I. A series of weight per weight standards to establish a calibration curve of parts per million (p/m) n-hexane versus

absorbance shall be prepared. On a single beam spectrophotometer, the meter shall be zeroed with a specimen of certified R-113 in a 5 centimeter (cm) pathlength near-infrared silica cell. On a double beam instrument, certified R-113 shall be used in 5 cm cells in the reference and sample beams to zero the chart pen. Replace the R-113 in the sample cell with a calibration standard or sample. The absorbance in the 3.4 micron wavelength region shall be determined. For calibration standards, p/m n-hexane versus absorbance shall be plotted. For samples, the calibration curve shall be referred to determine p/m hydrocarbon content corresponding to the absorbance obtained.

4.2.1.4 R-113 shall not be used on rubber or plastic components or painted or coated components with which it is not compatible. Where specific information with respect to compatibility is lacking, tests shall be conducted. A repair activity, if qualified and equipped, may conduct these tests. Compatibility tests shall consist of immersion of test specimens in the cleaning solvent at 80 ± 9°F for 16 ± 1 hours. Conditions of immersion and testing shall be in accordance with ASTM D 471 and ASTM D 1414. Test specimens shall be completely surrounded by the solvent during immersion. The solvent volume shall be not less than 12 times the total volume of the specimen. Tensile strength, elongation and hardness shall be determined in accordance with ASTM D 471. Test requirements to establish compatibility shall be as follows:

(a) Volume change - minus 0 percent, plus 10 percent.
(b) Retention of tensile strength - minimum 85 percent.
(c) Retention of ultimate elongation - minimum 85 percent.
(d) Change in durometer hardness - maximum durometer unit - plus or minus 5 points.

4.2.1.5 If water is used for any reason in the oxygen or nitrogen gas piping system prior to cleaning or testing with R-113, the system shall be purged with nitrogen until the dewpoint of the discharging gas is minus 40°F, or less, at standard conditions.

4.2.2 Cleaning with tribasic sodium phosphate (TSP) solution. Components determined to be incompatible with R-113 shall be cleaned with TSP solution as specified in 5.8.1. If approved by NAVSEA, oxygen and nitrogen gas piping systems may also be cleaned with TSP solution as specified in 5.8.2. The maximum allowable contamination limit for hydrocarbons to certify oxygen cleanliness is 5 p/m.

4.2.2.1 Cleaning solution is prepared by dissolving 2 pounds of type I, or 4.5 pounds of type II TSP in accordance with O-S-642 per 5 gallons water. Water shall be heated and agitated to dissolve TSP and the solution maintained at 160 to 190°F when used for cleaning.

4.2.2.2 When cleaning with TSP, samples of the cleaning solution shall be analyzed by the laboratory for hydrocarbon content to verify component or system cleanliness. Hydrocarbon content shall be determined by acidifying the solution with sulfuric or hydrochloric acid (to obtain a hydrogen-ion concentration (pH) below 7) and extraction with an equal volume of R-113 in accordance with MIL-C-81302, type I. The extraction shall be performed in two steps so that the final volume of R-113 extract is equal to the volume of the TSP solution analyzed. The extract shall be analyzed as specified in 4.2.1.3 for hydrocarbon content.

4.2.2.3 Alternatively, if an infrared spectrophotometer is not available, the residue test may be used. A portion of the used TSP cleaning solution shall be extracted with R-113 in two increments. The extract shall be filtered through medium grade filter paper to remove suspended TSP, evaporated to dryness and the residue weighed. An equivalent volume of unused cleaning solution shall be processed in the same manner as the sample. The weight of residue shall be used to calculate p/m (by weight) contamination in the sample and unused solution. The contamination content of the sample shall not exceed that of the unused solution by more than 5 p/m.

4.2.3 Allowable contamination levels.

4.2.3.1 Particulate contamination. Samples of cleaning solvent or rinse water shall be visually inspected for particulate contamination. Inspection shall be performed by a person with normal visual acuity, natural or corrected, under bright white light of at least 100 foot-candles. Samples shall be inspected in clear glass sample bottles or a clean white dish. Any visible particles shall be cause for rejection.

4.2.3.2 Hydrocarbon contamination. The maximum contamination limit for hydrocarbons to certify oxygen cleanliness is 5 p/m by weight which corresponds to 0.005 mg hydrocarbons as normal hexane per gram solvent or 7.8 mg residue per liter solvent at standard conditions, when analyzed in accordance with this standard.

4.2.4 Bagging material. Certified oxygen cleaned components shall be properly identified as specified in 5.14.3 and sealed in clean 6 mil thick (minimum) polyethylene plastic bags conforming to MIL-B-22191, type I, to maintain cleanliness. If the component is heavy or contains sharp edges, double bagging is required. If the cleanliness of the bag material is in question, filter swipes may be taken and examined under an ultra-violet light for any evidence of fluorescent contamination. Cleanliness shall be verified if there is no discernable fluorescence on the filter swipe and no visible contaminants are present on the bag material when examined under bright white light.

4.2.5 Testing medium. R-113 or water shall be used as the hydrostatic testing medium for oxygen and nitrogen gas piping systems. Water shall be used as the hydrostatic testing medium for hydrogen gas piping systems. NAVSEA approval shall be required prior to testing the oxygen and nitrogen gas piping systems with water. If water is used, it shall be removed from the system as specified in 4.2.1.5.

4.3 Vendor furnished components. Oxygen or nitrogen gas system components which are received from a manufacturer with a certification that they have been cleaned for oxygen service as specified herein, need not be recleaned provided that the means for protecting cleanliness is intact as specified in 4.2.4.

4.4 Flushing and testing equipment. Temporary piping and components required for system flushing and testing shall be cleaned as specified for system piping before each use and tested to the hydrostatic test pressure specified for the system. Flexible metallic hose or flexible hose, in accordance with MIL-H-25579,

shall be used for transferring the solvent from storage containers to the system being cleaned or tested. Aeroquip hose no. 2807 or equivalent can also be used. Transfer equipment used in the flushing procedure shall be compatible with the cleaning agent and shall be oxygen clean.

4.5 Nitrogen. The purity of nitrogen shall be verified prior to its usage. Shipboard produced nitrogen shall be certified by the laboratory as being in accordance with BB-N-411. The laboratory shall test for liquid pump lubricant and hydrocarbon contamination in accordance with BB-N-411. Nitrogen acquired from a vendor shall also meet the requirements specified in BB-N-411.

4.6 Shipboard conditions. If shipboard conditions are such that a particular system cannot be flushed or tested as a single unit, this system may be divided into sections and flushed or tested accordingly. Portions of these systems may be flushed or tested as required by production to facilitate interference problems, ship's schedule event completion and so forth. Caution shall be used to ensure that portions of the system which have been certified oxygen clean by the laboratory are not flushed with contaminated cleaning solvent or solution.

4.7 Safety precautions.

4.7.1 Personnel. Personnel involved with cleaning and testing oxygen and nitrogen gas piping systems shall be qualified as specified in 5.13. They shall also be familiar with the applicable safety precautions as specified in 4.7.4.3 before conducting any work on oxygen, nitrogen or hydrogen gas systems. While working with oxygen clean systems, the safety precautions specified in NAVSEA S9086-SX-STM-000, Chapter 550 and the following shall be observed:

(a) Always open system valves very slowly so as to pressurize the system slowly. If valves are opened rapidly, sudden pressurization of downstream piping will occur and compression ignition can result.
(b) Do not smoke when operating an oxygen system or performing a maintenance action on an oxygen system.
(c) Do not use oil, grease, or flammable substances on or near an oxygen system, nor allow flammable materials to come in contact with an oxygen system.
(d) Do not allow personnel around the oxygen system unnecessarily. However, responsible personnel shall be in attendance at all times when the system is open. Only authorized personnel trained in the hazards of oxygen systems shall perform oxygen system repair services.
(e) Thoroughly clean hands before handling or packaging oxygen components. Lint-free gloves shall be used to handle components after they are cleaned.
(f) Keep oxygen gauges properly capped, plugged, or otherwise protected after cleaning. Use only approved capping, plugging, and packaging materials.
(g) Restrict the cleaning equipment to the cleaning of oxygen components only.
(h) Use clean, oil-free tools. Exclude unauthorized tools or equipment from clean work area.

4.7.2 High pressure gas. High pressure gas systems constitute a hazard in themselves in addition to the hazards involved when hydrocarbons and other contaminants are present. Energy is added as a gas is compressed. The gas may get hot enough to ignite any hydrocarbons in an air or oxygen system. Pressure may increase enough to cause component failure. To prevent the possibility of a fire, explosion and component failure, the presence of hydrocarbons or other contaminants in high pressure gas systems shall be eliminated and subsequently the systems maintained oxygen clean.

4.7.3 Hearing protection. Ear protective devices shall be worn during bleed off or pressure relief of high pressure gas systems. Sound pressure levels can reach intensities high enough to cause damage to the ears.

4.7.4 Trichlorotrifluoroethane (R-113). Pure R-113 is a colorless liquid at room temperature. It has a pronounced odor similar to the dry cleaning fluid (tetrachloroethylene). It has a boiling point of 118°F at 1 atmosphere. The solvent is chemically and thermally stable. The liquid or vapor is nonflammable and nonexplosive and its air mixtures are not capable of propagating a flame. R-113 vapors are several times heavier than air and tend to collect in low places. The solvent is noncorrosive to most metals when free of water especially for short exposure times used for cleaning. R-113 has minimal effect on most elastomers and plastics, however, it does extract the plasticizer from polyvinylchloride tubing. This tubing shall not be used in handling the solvent in order to avoid contaminating the solvent with plasticizer.

4.7.4.1 R-113 can decompose to phosgene (toxic gas) and other poisonous products when exposed to open flame or hot surfaces having temperatures of 400°F or greater. The products of decomposition have a pungent odor and are very irritating, so they are noticeable in minute quantities.

4.7.4.2 Although R-113 is considerably less toxic than many other widely used solvents, exposure to large amounts can cause death. The vapors are toxic in high concentration and may also cause suffocation due to the displacement of air. Fluorocarbons such as R-113 in high concentrations have an anesthetic effect (causing incoordination such as stumbling), can affect the heart beat (causing irregular beats and even stoppage) and can cause tremors, convulsions and death.

4.7.4.3 The following safety precautions shall be followed when using R-113:

(a) At least two people shall be present at all times while solvent is being used. Do not leave the area unattended while cleaning is in progress.
(b) When R-113 is being transferred by hose or pipe from a remote location, telephone communication shall be established between the pumping station and the space involved.
(c) To permit escape in the event of an accidental spill, a self-contained breathing device shall be immediately available to each person in any space where operations involving R-113 are taking place or occupied spaces where R-113 leaks may occur while systems containing fluorocarbons are being cleaned, tested, serviced or repaired. Each person shall have received instruction and practice in the use of the particular self-contained breathing device to be used. When a spill occurs, a high con-

centration of solvent vapor may rapidly fill the space and dilute the air in the space. Breathing this diluted, contaminated air can result in rapid (10 to 15 seconds) loss of consciousness because oxygen is washed out of the lungs. It is, therefore, necessary to stop breathing until the self-contained breathing device has been put on and is supplying air. The Navy "Emergency Escape Breathing Device" (EEBD) may be used for emergency escape.

(d) All hot work in the space shall be suspended before introducing the solvent into the system. An exception is that aboard ship during overhaul in a shipyard, hot work may be performed while systems are being flushed (not pressure tested) with fluorcarbon compounds if each operation is authorized by a gas free engineer, everyone is instructed to leave the area immediately if anyone experiences any irritation of the eyes, nose or throat. Also during this specially authorized hot work, a self-contained breathing device for emergency escape is not required in spaces where all lines being flushed contain only welded joints (no flanges, valves or other fittings having mechanical joints). The following caution sign shall also be displayed at the entrance to all work spaces: "CAUTION: FLUOROCARBON (FREON) OPERATION; DO NOT ENTER UNOCCUPIED SPACE WITHOUT FIRST TESTING FOR FLUOROCARBONS; NO HOT WORK ALLOWED IN THIS SPACE EXCEPT WHEN AUTHORIZED BY A GAS FREE ENGINEER; LEAVE SPACE IMMEDIATELY IF ANYONE NOTICES ANY EYE, NOSE OR THROAT IRRITATION."

(e) Carefully check the system for leaks before pumping solvent through the system, (see 5.5.1.10 and 5.6.1.5).

(f) Chemical safety goggles or a face shield shall be used while handling the solvent. If splashed into the eyes, flush the eyes with water for at least 15 minutes and obtain prompt medical attention.

(g) Repeated contact with the skin may cause cracking and irritation. Wear solvent resistant rubber gloves if contact with the hands cannot otherwise be prevented. Clothing that becomes wet with solvent should be removed at once.

(h) The atmosphere in the space where this solvent is used shall be continuously monitored with a halide monitor with alarm or equivalent instrument. The concentration of R-113 shall not be allowed to exceed the threshold limit value (TLV) of 1000 parts of solvent per million parts of air during a normal working day. If the alarm sounds, immediately put on the EEBD and promptly leave the space. Anyone re-entering the space should wear a self-contained breathing apparatus operated in pressure-demand mode.

(i) Be sure ventilation in the space is adequate to keep the concentration of R-113 below 1000 parts of solvent per million parts of air during anticipated operations, excluding accidents or spills. If necessary use portable blowers. Exhaust ventilation is preferable to blowing air into the space.

(j) Should someone be overcome in a space which lacks oxygen or because of the presence of a high vapor concentration, the person should be removed immediately and given artificial respiration if necessary.

NOTE to Physician: Since fluorocarbons cause cardiac sensitization, the attending physician must not administer an injection of epinephrine or similar heart stimulant as cardiac arrhythmias, including ventricular fibrillation, may result. The patient should be given fresh air immediately, and should not be allowed to exert himself or herself.

(k) A caution sign shall be posted in the area and at all entrances to the area. The sign should read: "CAUTION: NO OPEN FLAMES. DO NOT ENTER UNOCCUPIED SPACE WITHOUT TESTING THE AIR FOR FLUOROCARBONS."

(l) When drying out the system with dry nitrogen be sure the solvent vapors and the nitrogen are vented to the outside. If they cannot be vented to the outside a gas free engineer should be consulted as it may be necessary to use an oxygen monitor to be sure there is not excessive dilution of oxygen in the air which could result in death by suffocation.

(m) Emergency rescue procedures shall be established and proficiency documented to ensure that personnel can be safely removed from potentially hazardous exposures.

4.7.5 Trichloromonofluoromethane (R-11) solvent and dichlorodifluromethane (R-12).

4.7.5.1 R-11 is a colorless liquid or gas at room temperature. It has a slight etheral odor (smells like ether or the dry cleaning fluid tetrachloroethylene). It has a boiling point of 74.9°F at atmospheric pressure. In cylinders or drums at room temperature of 70-75°F it is a liquid. R-11 has toxic properties similar to R-113 as specified in 4.7.4.

4.7.5.1.1 The safety precautions listed for R-113 as specified in 4.7.4.3 shall be as followed when using R-11.

4.7.5.2 R-12 is a colorless and odorless gas at room temperature. In high concentrations it has a slight ethereal odor (smells like ether or the dry cleaning fluid tetrachloroethylene). It has a boiling point of minus 21.7°F at atmospheric pressure. In cylinders or drums at room temperature of 70 to 75°F it is a liquid under pressure of 70-75 lb/in^2. R-12 has toxic properties similar to R-113 as specified in 4.7.4. Because R-12 boils at such a low temperature it may cause freezing if splashed into the eyes or onto the skin.

4.7.5.2.1 The following safety precautions shall be followed when using R-12:

(a) All the precautions listed for R-113 as specified in 4.7.4.3.

(b) Wear a long sleeve shirt, protective gloves and a leather or rubber apron.

(c) R-12 should be added to the system as a gas unless otherwise specifically directed by NAVSEA-approved procedures.

(d) If splashed into the eyes, flush with potable water for at least 15 minutes then seek prompt medical attention. Do not put anything except potable water into the eyes and avoid rubbing the eyes.

(e) Should liquid R-12 come into contact with skin, injury should be treated as though the skin had been frost bitten or frozen.

4.7.6 Tribasic sodium phosphate. Tribasic sodium phosphate is a solid, crystalline material which has a caustic action upon the skin, eyes and mucous membranes. Repeated or prolonged contact with the solid material or its solutions shall be avoided. Chemical safety goggles, rubber gloves and rubber aprons or coveralls shall be worn to prevent skin contact. If skin contact occurs, exposed areas shall be washed with large amounts of potable water. If irritating dust or solution mist is present, approved respirators shall be worn to avoid inhalation.

4.7.7 Nitrogen. For the purpose of this standard, nitrogen will be considered a nontoxic inert gas. Care shall be exercised in small, closed or confined spaces to ensure that an excess of nitrogen does not cause suffocation. If any doubt exists, an oxygen monitor with alarm shall be used to monitor the area. Be sure there is adequate ventilation during release of nitrogen in confined spaces.

4.7.8 Chemical compounds. All chemical compounds prescribed in this standard, except those used in connection with ultrasonic cleaning, shall not be stored on board submarines.

4.7.9 Dye. Prior to evacuation of a system, dye and developer used in dye penetrant (PT) nondestructive tests shall be removed to prevent drawing them into the system.

4.7.10 Oxygen. Oxygen will not burn but supports combustion and will cause spontaneous combustion in as oxygen-rich atmosphere.

4.8 Cleaning solvent and solution. R-113 and R-11 cleaning solvent is an environmental pollutant. The disposal procedure specified in 5.11 shall be followed for R-113, R-11 and TSP.

4.9 Over pressure protection. Over pressure protection requirements (that is, test and backup gauges, manual relief valves, red hand settings) in accordance with NAVSEA 0901-LP-480-0002, Chapter 9480 shall be invoked when testing oxygen, nitrogen and hydrogen gas piping systems.

4.10 Removal and replacement of components in oxygen clean systems.

4.10.1 Procedure. To open or remove a component from a certified oxygen clean system for repair or maintenance, or to replace a component in a certified oxygen clean system with another oxygen clean component without the necessity of recleaning the entire system, the procedure shall be as follows:

4.10.1.1 The component to be repaired, removed or replaced and the adjacent piping or equipment shall be cleaned to remove scale, dust, dirt and other foreign materials and shall be throughly washed externally with the cleaning solvent being used.

4.10.1.2 A shipboard oxygen clean area as specified in 5.12.1.3 shall be constructed around the component to be replaced. Tools, handling equipment and clothing worn by personnel shall be as specified in 5.12.2.

4.10.1.3 That portion of the system to be entered shall be depressurized and purged of dangerous gases (that is, oxygen, hydrogen) by using nitrogen. The affected portion of the system to be entered shall be isolated by shutting the boundary isolation valves. A convenient bleed point within the affected boundary shall be allowed. After the affected portion has been bled down to zero pressure, nitrogen purging equipment shall be installed through an isolation valve bonnet (which is located within the affected area's boundary or another entry point) and a slow positive nitrogen purge 5 to 10 lb/in^2 pressure shall be established. To verify that the dangerous gas has been purged by the nitrogen, the exit bleed stream shall be tested by use of colorimetric, gas detector tubes such as manufactured by Draegar Manufacturing Co., or an equivalent sampling technique. The system shall not be entered until the dangerous gas concentration has been reduced to safe levels. Current standards require a maximum oxygen volume of 22 percent and a maximum hydrogen volume of 3 percent.

4.10.1.4 The system shall be opened and necessary repairs or replacements shall be made. Items shall be certified oxygen clean before being installed into the system. Oxygen clean components removed for transportation to shop for calibration, repair, cleaning or other maintenance shall be immediately packaged and sealed in a clean 6 mil thick plastic bag as specified in 4.2.4 and labeled or tagged with proper identification. Open ports of components that are too large to bag shall be covered with oxygen clean plugs or caps as specified in 5.12.2.2.

4.10.1.5 The component shall be maintained oxygen clean. If cleanliness accountability is lost or the component becomes contaminated because of machining, repair, calibration and so forth, it shall be recleaned and recertified oxygen clean before installation into the system.

4.10.1.6 Oxygen component internals touched with bare hands shall be considered contaminated. When handling oxygen component internals in contact with the cleaning solvent, clean, solvent-resistant gloves (such as polyethylene, latex or neoprene) shall be worn. Where doubt exists as to compatability or solvent-resistance, laboratory tests shall be conducted to ensure that hydrocarbons or other residues are not extracted from the gloves by the cleaning solvent. Clean gloves made of plastics or elastomers (such as polyvinyl-chloride or nylon) incompatible with the cleaning solvent may be used for assembly of oxygen cleaned components provided the cleaning solvent has been completely removed. Inspections shall be performed during and after assembly processes to verify that glove material is not left inside assembled components.

4.10.1.7 When the system is open, a slight positive nitrogen purge of 5 to 10 lb/in^2 pressure shall be maintained within the system to prevent possible entry of airborne contamination. If there is any unscheduled delay whatsoever between the time that the system is opened and the time that the replacement component is installed, the open portions of the system shall be sealed with clean polyethylene plastic conforming to MIL-B-22191, type I. The plastic shall be taped in place using tape in accordance with A-A-1586 or equal. No tape shall be placed on open portions of the system. The system shall not remain in this condition for more than 24 hours. After this period and before the component is installed, the open portions of the system shall be inspected for contamination as specified in 4.10.1.9.

4.10.1.8 Parts shall be assembled into the system dry unless the use of approved lubricants or sealants is required. These materials shall be in accordance with NAVSEA 09086-HT-STM-000, Chapter 262.

4.10.1.9 After repairs are completed, the nitrogen purge exit point shall be checked for fluorescence with a long wave ultraviolet light (3600 angstrom units). Oils and contaminants not detectable with ultraviolet light shall be checked by examining the exit point with bright white light for liquid residue, particles and fibers. The absence of hydrocarbons shall be verified when there is no discernible fluorescence or visible contamination.

4.10.1.10 To verify that no residual solvent used during repairs remains in the system, the nitrogen purge shall be continued and the exit stream shall be checked for the presence of halogenated hydrocarbons with a halide torch or halide leak detector. Purging with nitrogen shall be continued until no trace of the solvent is detected with a leak detector.

4.10.1.11 Test requirements depend on the type of work accomplished on the system. If hot work is performed, hydrostatic testing shall be accomplished before inspection procedures as specified in 4.10.1.9 and shall be in accordance with applicable portions as specified in 5.6.2. If the system is open at valve bonnets or other mechanical joints, tightness testing shall be performed after the procedure specified in 4.10.1.10 and shall be as specified in 5.6.2.7 through 5.6.2.11.

4.10.1.12 The system shall be restored to normal operation.

4.11 Potassium hydroxide (KOH) inspection and flush.

4.11.1 Requirements. This inspection is only applicable to submarines that have an electrolytic oxygen gas generator. The oxygen system shall be visually inspected for KOH contamination before the system is flushed. Entry into the system shall be made at mechanical joints. KOH is a whitish deliquescent solid that may occur as a scale on the inside of pipes and components.

4.11.1.1 The piping to the oxygen generator union connection shall be examined for KOH contamination. If no KOH is found, no further inspection shall be required.

4.11.1.2 If KOH is found in the piping as identified in 4.11.1.1, downstream piping to the isolation valves in the fore and aft distribution header shall be visually inspected. If no KOH is found in this section, no further inspection is required. The contaminated section shall be flushed with water heated to 130 ± 10°F. Flush until the conductivity of the effluent is within 2 micromhos of the influent, or the ph of the effluent is less than eight. The piping shall be purged with nitrogen until the dewpoint of the discharge gas is minus 40°F, or less, at standard conditions.

4.11.1.3 If KOH is found in the downstream piping as identified in 4.11.1.2, the remainder of the system shall be visually inspected. The contaminated sections of piping shall be flushed and dried as specified in 4.11.1.2.

4.12 Open ended piping.

4.12.1 Requirements. Open ended oxygen system piping such as that downstream of the oxygen regulator to the diffuser shall be free of loose scale, rust, grit, filings, oil or grease that could be blown into the atmosphere when the oxygen system is used.

4.12.2 Operational tests. Oxygen piping from the regulators to the diffusers requires an operational test to prove unobstructed flow.

4.12.3 Vents and drains. Vents and drains handling oxygen for oxygen-nitrogen plants on surface ships shall be oxygen cleaned up to the applicable check or drain valves.

4.13 Normal work, test and flush sequence.

4.13.1 Sequence. The following sequence is considered to be the normal method of conducting work, testing and flushing of oxygen, nitrogen and hydrogen gas systems. Deviations from this sequence shall be permitted with local engineering approval.

4.13.1.1 Authorized work on the system shall be completed.

4.13.1.2 A preliminary system tightness test shall be conducted if cleaning solvent is used.

4.13.1.3 A system hydrostatic flush shall be conducted.

4.13.1.4 A final system flush shall be conducted.

4.13.1.5 Oxygen clean components and internals removed prior to a system hydrostatic test or flush shall be reinstalled.

4.13.1.6 A system tightness test shall be conducted.

4.13.1.7 Valve seat leakage tests shall be conducted.

4.13.1.8 System operational testing shall be conducted.

5. DETAILED REQUIREMENTS

5.1 Material and equipment. The following equipment and materials include:

(a) Vacuum pump - Capable of pulling a minimum of 25 inches mercury (Hg) vacuum. Vacuum pump design shall preclude pump lubricant from being drawn into the system being cleaned in the event of a pump failure or stoppage. It shall be compatible with the cleaning agent.

(b) High-pressure pumps - Capable of obtaining a maximum pressure of 8800 lb/in^2 for hydrostatic testing of systems up to 4500 lb/in^2 and capable of obtaining a maximum pressure of 6600 lb/in^2 for hydrostatic testing of systems up to 3000 lb/in^2. Pumps shall be compatible with the cleaning agent.

(c) Transfer pump - Capable of providing 6.5 gallons per minute (gal/min) minimum. It shall also be compatible with the cleaning agent.
(d) Test gauge - Gauges shall meet the requirements of MIL-I-18997.
(e) Relief valve - Relief valves shall meet the requirements of MIL-V-22549.
(f) Hose - Flexible metallic hose or hose in accordance with MIL-H-25579. Aeroquip hose number 2807 or equivalent can also be used. Hoses shall be compatible with the cleaning agent.
(g) Clean sampling containers as specified by the laboratory.
(h) Leak detector - General Electric Model H-10 halide leak detector, or equivalent.
(i) Supply of nitrogen as specified in 3.7.
(j) Supply of cleaning solvent or solution as specified in 3.2.
(k) Ultraviolet light lamp, Magna Flux Model ZB26 (3600 angstrom units), or equivalent.
(l) Lubricants as specified in NAVSEA 09086-HT-STM-000, Chapter 262.
(m) Bagging and packaging materials as specified in 4.2.4 and 5.15.

5.2 Cleaning and certifying system components.

5.2.1 Removal of components from oxygen clean systems shall be as specified in 4.10.

5.2.2 Each component shall be tagged with proper identification.

5.2.3 Each component shall be repaired as required.

5.2.4 Parts of the component shall be cleaned as required using a cleaning agent specified in 3.2 and 4.2.2.1 that is compatible with the parts.

5.2.5 If lubrication of parts is required, the lubricant shall be in accordance with NAVSEA S9086-HT-STM-000, Chapter 262.

5.2.6 Each component shall be reassembled under oxygen clean conditions and tested in accordance with requirements as specified in 5.6.2.10.

5.2.7 After completion of assembly and successful testing, the component shall be certified oxygen clean and bagged as specified in 4.2.4.

5.2.8 Replacement of oxygen clean components into oxygen clean systems shall be as specified in 4.10.

5.3 Cleaning and calibration of test and monitoring systems.

5.3.1 Cleaning and calibration of test and monitoring systems shall be in accordance with the applicable procedures specified in NAVSEA OD45845.

5.3.2 Cleaned instruments shall be reinstalled into the system maintaining oxygen clean conditions as specified in 4.10.

5.3.3 Oxygen and nitrogen system pressure gauges can be calibrated in place by a comparative calibration procedure specified in NAVSEA 0987-LP-022-3010.

5.4 Cleaning silver-brazed piping. To remove residual silver brazing flux remaining in the system piping after fabrication, the piping shall be flushed as specified in NAVSEA 0900-LP-001-7000.

5.5 Cleanliness flushing. The accomplishing activity shall integrate sequence of testing and flushing procedures to ensure compliance with all technical requirements outlined herein and to expedite completion of system work.

5.5.1 System preparation.

5.5.1.1 Component internals shall not be exposed to the cleaning solvent until it is determined, as specified in 4.2.1.4, that the internals are compatible with the solvent. If incompatibility exists, the internals shall be removed before the system flush, cleaned, certified oxygen clean and replaced after the system flush as specified in 5.2.

5.5.1.2 Repairs to the piping system shall be completed before shipboard flushing is started.

5.5.1.3 Flow paths and sampling locations shall be selected by the cleaning activity to provide a complete flush and adequate samples.

5.5.1.4 Pressure regulators shall be disconnected from the system at the inlet union joint and open ended pipes shall be blanked or covered with clean polyethylene plastic conforming to MIL-B-22191, type I. Seal welded regulators may be left in place if the high pressure chambers are disassembled and the nozzles removed. Flow restrictors if installed in the supply nipple upstream of the oxygen regulators shall also be removed. Removed or disconnected parts shall be cleaned and certified oxygen clean in accordance with 5.2. When flushing is complete, the regulators shall be reconnected and the nozzles and flow restrictor (if originally installed) shall be reinstalled under oxygen clean conditions as specified in 4.10.

5.5.1.5 Oxygen clean containers, as specified by the laboratory, shall be available to collect samples of the cleaning agent.

5.5.1.6 New silver-brazed piping shall be flushed for flux removal as specified in 5.4 before the system cleanliness flush.

5.5.1.7 Valves or valve internals that will interfere with the flow of cleaning solvent shall be removed. Valve internals having soft seals that can be damaged during flushing shall also be used. Removed internals shall be cleaned, certified oxygen clean and reinstalled after the flush as specified in 5.2.

5.5.1.8 Components such as pressure gauges, which are not free draining and may restrict flow and trap dirt or cleaning solvent, shall be removed, cleaned, certified oxygen clean, calibrated and reinstated after the flush as specified in 5.2 and 5.3.

5.5.1.9 The minimum flow rate of the cleaning solvent through the system being cleaned shall be 6.5 gal/min. Where jumpers are used, their inside diameter shall not be less than the piping they are bypassing.

5.5.1.10 A preliminary tightness test shall be performed on the system before introducing the cleaning solvent into the system piping. The system shall be pressurized with nitrogen to a minimum of 75 lb/in^2. Accessible mechanical joints, seal welds and disturbed welded joints shall be checked for leakage using a leak detection compound in accordance with MIL-L-25567, or equivalent. No leakage shall be allowed.

5.5.1.11 If flasks are to be flushed in place, each flask drain connection shall be checked to ensure that no drains are plugged with any foreign material.

5.5.2 Oxygen and nitrogen gas system flush.

5.5.2.1 System preparation shall be as specified in 5.5.1.

5.5.2.2 Hydrostatic testing as specified in 5.6 should normally be accomplished before final flush.

5.5.2.3 Dead end piping shall be flushed as specified in 5.5.4.

5.5.2.4 The system piping shall be flushed with cleaning solvent for not less than 30 minutes. If the flushing circuit is through parallel paths, the flow paths shall be isolated as necessary to ensure that each path is flushed with full flow for at least 5 minutes followed by a 30-minute flush of the entire system without full flow required in each leg.

5.5.2.5 A sample of cleaning solvent shall be collected from all sampling locations. The laboratory shall analyze the samples for hydrocarbon content or residue as specified in 4.2. The maximum allowable hydrocarbon contamination limit shall be 5 p/m. The samples shall also be inspected for particulate contamination as specified in 4.2.3.1. If the hydrocarbon content (or residue) limit is exceeded, or if visible particles are present, the piping shall be flushed until acceptable samples are obtained.

5.5.2.6 When the piping is certified oxygen clean by the laboratory, the cleaning solvent shall be removed by draining, and then purging with low pressure nitrogen. A vacuum pump may be used in the final stages of solvent removal. Heat (200°F maximum) may be applied to the external surfaces of the piping to facilitate removal of the cleaning solvent.

5.5.2.7 The nitrogen exhaust shall be checked for traces of the cleaning solvent with a halide leak detector. Evacuating and purging shall be continued until no trace of the solvent is detectable.

5.5.2.8 The system shall be charged with nitrogen at 100 to 125 lb/in^2. Samples of nitrogen under pressure shall be taken after a period of 1 hour and analyzed by the laboratory for solvent content. Samples shall be analyzed by gas chromatographic or equivalent procedures. The solvent content shall not exceed 10 p/m (by volume) at standard conditions. If this limit is exceeded, the system shall be purged with nitrogen until acceptable samples are obtained.

5.5.2.9 A 100 to 125 lb/in^2 nitrogen pressure shall be maintained in the system until the system is charged with oxygen or nitrogen. If the pressure should drop below 100 lb/in^2 before charging the responsible authority shall investigate circumstances associated with the pressure drop to ensure that no contamination could have entered the system which would require repeating the cleanliness flush.

5.5.2.10 If required, the piping system shall be recleaned by the same procedure as specified in 5.5.2. Clean piping shall be kept isolated and free of contamination while flushing connected piping.

5.5.2.11 After the piping has been cleaned and certified, any further work on the system shall be accomplished under oxygen clean conditions as specified in 4.10.

5.5.3 Hydrogen gas system flush.

5.5.3.1 Prior to flushing, a visual inspection for hydrocarbons at the oxygen generator union connection and of accessible system piping shall be performed using ultraviolet light, bright white light, swipes, and so forth. If visible traces of hydrocarbons are present, the piping shall be cleaned as specified in 5.5.2 or 5.8.2. If no visible traces of hydrocarbons are found, the hydrogen piping shall be flushed to remove loose scale, rust, grit, filings and other foreign substances.

5.5.3.2 The piping shall be flushed for 1 hour with hot water. Water temperature shall remain at or above 100°F in any part of the piping. After the hot flush, the piping shall be cold flushed with water for 15 minutes.

5.5.3.3 As an alternate to the hot flush, the piping shall be cold soaked for 12 hours with water not less than 60°F. After the 12-hour soak, the piping shall be flushed for 4 hours with water at a minimum of 60°F.

5.5.3.4 A sample of the final flush water shall be inspected for particulate contamination as specified in 4.2.3.1.

5.5.3.5 Following either flush, the piping shall be purged with low pressure nitrogen until the dewpoint of the discharging gas is minus 40°F or less at standard conditions.

5.5.3.6 For flushing procedures as specified in 5.5.3.2 and 5.5.3.3, the minimum flow rate in gal/min shall be 1.5 times the internal pipe diameter in inches. The piping shall be full of water so that joints are completely submerged at all times.

5.5.3.7 Testing shall be as specified in 5.6.3.

5.5.4 Dead end system flush.

5.5.4.1 System preparation shall be as specified in 5.5.1.

5.5.4.2 Hydrostatic testing as specified in 5.6 shall be accomplished before the final flush if the system has been maintained oxygen clean. If the system has not been so maintained due to the performance of overhaul or maintenance work, affected portions of the system shall be flushed prior to hydrostatic testing.

5.5.4.3 Oxygen and nitrogen piping systems containing dead ends shall be evacuated to a minimum of 25 inches of Hg vacuum broken with cleaning solvent. A nitrogen pressure of 50 lb/in^2 may be applied to ensure complete filling of the system.

5.5.4.4 After soaking for not less than 1 hour, the cleaning solvent shall be removed by alternating cycles of pressurizing to 100 lb/in^2 with nitrogen and depressurizing through the bleed off valves, allowing the solvent to flow out. A vacuum pump may be used to facilitate removal of the cleaning solvent from the piping.

5.5.4.5 A sample of cleaning solvent shall be collected from all sampling locations. The laboratory shall analyze the samples for hydrocarbon content or residue as specified in 4.2. The maximum allowable hydrocarbon contamination limit shall be 5 p/m. The samples shall also be inspected for particulate contamination as specified in 4.2.3.1. If the hydrocarbon content (or residue) limit is exceeded, or if visible particles are present, the piping shall be flushed until acceptable samples are obtained.

5.5.4.6 When the piping is certified oxygen clean by the laboratory, the cleaning solvent shall be removed by draining, and then purging the piping with low pressure nitrogen. A vacuum pump may be used in the final stages of solvent removal. Heat (200°F maximum) may be applied to the external surfaces of the piping to facilitate removal of the cleaning solvent.

5.5.4.7 The nitrogen exhaust shall be checked for traces of the cleaning solvent with a halide leak detector. Evacuating and purging shall be continued until no trace of the solvent is detectable.

5.5.4.8 The system shall be charged with nitrogen at 100 to 125 lb/in^2. Samples of nitrogen under pressure shall be taken after a period of 1 hour and analyzed by the laboratory for solvent content. Samples shall be analyzed by gas chromatographic or equivalent procedures. The solvent content shall not exceed 10 p/m (by volume) at standard conditions. If this limit is exceeded, the system shall be purged with nitrogen until acceptable samples are obtained.

5.5.4.9 A 100 to 125 lb/in^2 nitrogen pressure shall be maintained in the system until the piping is charged with oxygen or nitrogen. If the pressure should drop below 100 lb/in^2 before charging, the responsible authority shall investigate circumstances associated with the pressure drop to ensure that no contamination could have entered the piping, which would require repeating the cleanliness flush.

5.5.4.10 If required, the piping system shall be recleaned by the same procedure as specified in 5.5.4. Clean piping shall be kept isolated and free of contamination while flushing connected piping.

5.5.4.11 After the piping has been cleaned and certified, any further work on the piping shall be accomplished under oxygen clean conditions as specified in 4.10.

5.6 Testing. The accomplishing activity shall integrate sequence of testing and flushing procedures to ensure compliance with all technical requirements specified herein, and to expedite completion of system work.

5.6.1 System preparation.

5.6.1.1 Component internals shall not be exposed to the testing solvent until it is determined that the internals are compatible with the solvent as specified in 4.2.1.4. If incompatibility exists, the internals shall be removed before the system tests.

5.6.1.2 Repairs to the piping system shall be completed before shipboard testing is started.

5.6.1.3 Components which may be damaged by the test pressure shall be isolated. Valve internals which may be damaged at the test pressure shall be removed and the valve bonnet joint shall be blanked.

5.6.1.4 Ball valves shall not be used for boundaries during hydrostatic testing at pressures exceeding 6750 lb/in^2. If they are in the system during testing at these pressures, they shall be in the fully opened position.

5.6.1.5 A preliminary tightness test shall be performed on the system before introducing the cleaning solvent into the system piping. The system shall be pressurized with nitrogen to a minimum of 75 lb/in^2. All accessible mechanical joints, seal welds and disturbed welded joints shall be checked for leakage using a leak detection compound in accordance with MIL-L-25567, or equivalent. No leakage shall be allowed.

5.6.2 Oxygen and nitrogen gas system tests.

5.6.2.1 System preparation shall be as specified in 5.6.1.

5.6.2.2 A hydrostatic test shall be accomplished before the final system flush. Testing after the final system flush will necessitate cleanliness sampling and solvent removal as specified in 5.5.2. If the samples indicate that the system has been contaminated, the contaminated portion of the system shall be reflushed as specified in 5.5.2.

5.6.2.3 The system shall be evacuated to a minimum of 25 inches Hg vacuum and the vacuum broken with cleaning solvent. The entire system shall be positively filled and gradually pressurized to the applicable system hydrostatic test pressure (see table I or II). The system shall be checked for leaks at each increment as specified in NAVSEA 0901-LP-480-0002, Chapter 9480.

TABLE I. Surface ships.

System	Pressure (lb/in^2)	
	System nominal operating	System hydrostatic test
N_2	0-33	50
O_2	0-33	50
N_2	50	75
N_2	55	83
O_2	50	75
N_2	58	87
O_2	75	112
N_2	125	187
N_2	145	218
N_2	150	225
N_2	200	300
N_2	1250	1875
N_2	1800	2700
O_2	1800	2700
N_2	2000	3000
N_2	3000	4500
O_2	3000	4500
N_2	4500	6750
N_2	5000	7500

NOTES:

1. For pressure not listed above, the test pressure shall be 150 percent of the system nominal operating pressure (minimum test pressure is 50 lb/in^2) or 135 percent of the system design pressure, whichever is lesser.
2. Test pressure shall be applied in increments as specified in NAVSEA 0901-LP-480-0002, Chapter 9480.

TABLE II. Submarines.

System	Pressure (lb/in^2)	
	System nominal operating	System hydrostatic test
O_2	1	50
N_2	20	50
N_2	145	218
N_2	1800	2700
H_2	3000	4500
N_2	3000	4500
O_2	3000	4500
N_2	4500	6750

NOTES:

1. For a pressure not listed above, the test pressure shall be 150 percent of the system nominal operating pressure (minimum test pressure is 50 lb/in^2) or 135 percent of the system design pressure, whichever is the lesser.
2. Test pressure shall be applied in increments as specified in NAVSEA 0901-LP-480-0002, Chapter 9480.

5.6.2.4 The final system hydrostatic test pressure shall be held for 8 hours. During this time, the entire system, including each joint and valve bonnet, shall be inspected for leaks with a halide leak detector. Each joint and valve bonnet shall be inspected three times by a different inspector each time. The first inspection shall be made when the system hydrostatic test pressure has been attained; the second inspection shall be made approximately half way through the test period; the third inspection shall be made near the end of the test period. No leakage shall be allowed. For short sections of pipe, the time for the hydrostatic test may be reduced to 30 minutes with local engineering approval. Each joint and valve bonnet in the short section of pipe shall be inspected one time at the end of the 30 minute test period. To preclude removal of existing shipboard interferences, inaccessible joints may be verified by performing a 24 hour static pressure drop test. That portion of the system, excluding the bank flasks, containing the uninspected joints shall be pressurized with nitrogen to the applicable system nominal operating pressure (see table I or II). The maximum allowable static pressure drop during the 24 hour period shall be equivalent to 1 percent of the test pressure. If the maximum allowable static pressure drop is exceeded, all joints shall be checked for leakage using

a leak detection compound in accordance with MIL-L-25567 or equivalent. After leak repairs are accomplished, a hydrostatic test and system flush shall be repeated for the affected portions of the system as specified in 5.6.2 and 5.5.2 or 5.5.4 respectively.

5.6.2.5 If a joint failure occurs during the 8 hour hydrostatic test resulting in hot work to be required, the cleaning solvent shall be drained from the system, and that portion of the system requiring hot work repairs shall be purged with low pressure nitrogen.

5.6.2.6 The nitrogen exhaust gas shall be checked with a halide leak detector for traces of cleaning solvent. Purging shall be continued until no solvent is detectable before performing hot work. After repairs are accomplished, a hydrostatic test and system flush shall be repeated for the affected portions of the system as specified in 5.6.2 through 5.5.2 or 5.5.4 respectively.

5.6.2.7 If leaks are found only at valve bonnets, seal welds or other mechanical joints, the leak shall be repaired after completion of the hydrostatic test. After repairs to mechanical joints are completed and system components and component internals removed as specified in 5.6.1 are reinstalled, the system shall be pressurized with nitrogen to the applicable system nominal operating pressure (see table I or II).

5.6.2.8 The final system nominal operating pressure shall be held for 2 hours. Mechanical joints in the system shall be checked for leakage using a leak detection compound in accordance with MIL-L-25567 or equivalent. No leakage shall be allowed.

5.6.2.9 Each valve shall be tested for seat tightness, using nitrogen, to the applicable system nominal operating pressure (see table I or II). The test time shall be 5 minutes with zero allowable leakage. Pressure shall be applied in the direction tending to unseat globe and needle valves, in the check direction for check valves, and from both directions for ball valves.

5.6.2.10 Components repaired in the shop or replacement piping being installed between mechanical joints after system hydrostatic test shall be hydrostatically tested in the shop before reinstallation. The test shall be conducted for 5 minutes at the applicable system hydrostatic test pressure (see table I or II). Valve seat tightness test shall be accomplished in the shop for 5 minutes at the applicable system nominal operating pressure (see table I or II). No leakage shall be allowed. Components and piping shall be certified oxygen clean before being reinstalled into the system. After reinstallation of the component or pipe, that portion of the system which includes the replaced component or pipe shall be tested using the procedures specified in 5.6.2.7 and 5.6.2.8.

5.6.2.11 Unobstructed flow test shall be accomplished from the regulators to the diffusers as specified in 4.12.2.

5.6.3 Hydrogen gas system tests.

5.6.3.1 The hydrogen piping shall be disconnected from the oxygen generator and blanked. The auxiliary sea water piping connected to the diffuser shall be isolated.

5.6.3.2 The hydrogen piping shall be filled with water, and gradually pressurized to the applicable system hydrostatic test pressure (see table II). The system shall be checked for leaks at each increment specified in the table.

5.6.3.3 The final hydrostatic test pressure shall be maintained for 30 minutes. During this time the entire system shall be inspected, including each joint and valve bonnet, for leaks. No leakage shall be allowed.

5.6.3.4 If leakage or rupture occurs, that portion of the system requiring hot work repairs shall be isolated and drained. After repairs are accomplished, the test shall be repeated as specified in 5.6.3 for the affected portion of the system.

5.6.3.5 After completion of hydrostatic testing, the water shall be depressurized and drained from the hydrogen piping and the system shall have a final flush as specified in 5.5.3.

5.6.3.6 If leaks are found only at valve bonnets or other mechanical joints, the leaks shall be repaired, and the system shall be pressurized with nitrogen to the applicable system nominal operating pressure (see table II).

5.6.3.7 The final system nominal operating pressure shall be maintained for 2 hours. Mechanical joints shall be checked for leakage using a leak detection compound in accordance with MIL-L-25567, or equivalent. No leakage shall be allowed.

5.6.3.8 With the system pressurized as specified in 5.6.3.6, each hydrogen system valve shall be tested for seat tightness. The test time shall be not less than 5 minutes with zero allowable leakage. Pressure shall be applied in the direction tending to unseat globe and needle valves, in the check direction for each check valve, and from both directions for ball valves.

5.6.3.9 Components repaired in the shop or replacement piping being installed between mechanical joints after hydrostatic testing shall be hydrostatically tested in the shop before reinstallation. The test shall be conducted for 5 minutes at the applicable system hydrostatic testing pressure in accordance with table II. Valve seat tightness test shall be accomplished in the shop for 5 minutes at the applicable system nominal operating pressure in accordance with table II. No leakage shall be allowed. After reinstallation of the component or pipe, that portion of the system which includes the replaced component or pipe shall be tested as specified in 5.6.3.6 and 5.6.3.7.

5.6.3.10 The joint at the oxygen generator shall be tested for tightness using a leak detection compound in accordance with MIL-L-25567, or equivalent, during operation of the oxygen generator. No leakage shall be allowed.

5.6.3.11 Hydrogen system piping outboard of the hull valve shall be tested in accordance with the requirements of the applicable system diagram or in accordance with NAVSEA 0901-LP-480-0002, Chapter 9480 for sea connected systems.

5.6.4 Final oxygen and nitrogen gas system tests. That portion of the system which includes the reinstalled flask and union joint connection shall be tested for tightness. The system shall be pressurized with nitrogen to the applicable system nominal operating pressure (see table I or II) and tested as specified in 5.6.2.8.

5.6.4.1 The union joints at the oxygen generator shall be tested for tightness during oxygen generator operation. The joints shall be checked for leakage using a leak detection compound in accordance with MIL-L-25567, or equivalent. No leakage shall be allowed.

5.6.5 Alternate oxygen and nitrogen piping (7-day pressure drop) test. NAVSEA approval shall be required prior to conducting this alternate test.

5.6.5.1 The system, including the flask, may be tested with a mixture of nitrogen and oil free refrigerant type 12 in accordance with BB-F-1421 vice the 8-hour hydrostatic test as specified in 5.6.2.4. Prior to the 7-day drop test, the system shall be hydrostatically tested as specified in 5.6.2 except the pressure shall be held for a minimum of 15 minutes to allow the entire system to be checked with a halide leak detector.

5.6.5.2 The maximum amount of refrigerant type 12 to be used shall be calculated from the following equation:

$$W = \frac{P_p \times V_s \times (MW)}{RT}$$

where: T = Ambient temperature at time of test ($^\circ R = 460 + ^\circ F$).

P_p = Partial pressure of refrigerant type 12 at "T" (see table III).

V_s = Volume of system (ft^3).

MW = Molecular weight of refrigerant type 12 (MW = 120 lb/lb mole).

R = Gas constant 10.73 $\frac{(lb/in^2)\ (ft^3).}{(lb - mole)\ (^\circ R)}$

W = Weight of refrigerant type 12 required (pounds).

TABLE III. Partial pressure refrigerant type 12 versus temperature.

Temperature (°F)	Partial pressure (lb/in²)	Temperature (°F)	Partial pressure (lb/in²)
30	43.148	60	72.433
32	44.760	62	74.807
34	46.417	64	77.239
36	48.120	66	79.729
38	49.870	68	82.279
40	51.667	70	84.888
42	53.513	72	87.559
44	55.407	74	90.292
46	57.352	76	93.087
48	59.347	78	95.946
50	61.394	80	98.870
52	63.494	82	101.860
54	65.646	84	104.920
56	67.853	86	108.040
58	70.115	88	111.230
60	72.433	90	114.490

5.6.5.3 A precision thermometer shall be installed on the top of each flask in the system with putty. One thermometer will be placed at each ballast tank for ambient temperature readings. Pressure regulators shall either be removed or isolated prior to this test.

5.6.5.4 The system will be charged with the proper amount of refrigerant type 12 as specified in 5.6.5.2 and pressurized with nitrogen to the system nominal operating pressure. Joints shall be examined for tightness with a halide leak detector. Pressure and temperature readings will be recorded at this time. Further readings will be taken at midnight for 7 consecutive days. Final pressure readings shall be corrected to the initial temperature condition. The pressure variation at the end of 7 days shall not exceed 5 lb/in².

5.6.5.5 Untested portions of the system (that is, downstream of the pressure regulator isolation valve) shall be opened to the tested portion of the system and the complete system shall be charged to the system nominal operating pressure and checked for leaks. Allowable pressure variations shall not exceed 1 percent of the design working pressure in 24 hours.

5.6.5.6 If leak repair introduces foreign matter into the system, the affected portions shall be recleaned and retested for tightness.

5.6.5.7 After satisfactory completion of the tightness test, the system shall be bled to atmospheric pressure and evacuated to a minimum of 25 inches Hg vacuum. The exhaust gas shall be checked with a halide leak detector for traces of refrigerant type 12. The check shall be continued until no trace of refrigerant type 12 is detectable.

5.6.5.8 The system shall be charged with nitrogen at 100 to 125 lb/in^2. Samples of nitrogen under pressure shall be taken after a period of 1 hour and analyzed by the laboratory for refrigerant type 12 content. The samples shall be analyzed by gas chromatographic or equivalent procedures. The refrigerant type 12 content shall not exceed 10 p/m (by volume) at standard conditions. If this limit is exceeded, the system shall be purged with nitrogen until acceptable samples are obtained.

5.6.5.9 Tightness, valve seat leakage and unobstructed flow tests shall be accomplished as specified in 5.6.2.

5.7 Maintenance of flasks for oxygen and nitrogen gas systems.

5.7.1 Flask inspection schedule. At a period not to exceed 12 years from previous flask inspection, oxygen system and nitrogen system flasks shall be removed from ship and recertified as specified in 5.7.3, 5.7.4 and 5.7.5.

5.7.2 Earlier inspection. For earlier inspection periods, NAVSEA guidance regarding the inspection, testing and refurbishment requirements for oxygen and nitrogen flasks shall be obtained.

5.7.3 Shop cleaning and inspection of flasks for oxygen and nitrogen gas systems.

5.7.3.1 Flask end plugs shall be removed from oxygen and nitrogen flasks. Flask and plug threads shall be dressed and examined. Flasks with neck threads exhibiting galling to the extent that thread damage occurs and which have a neck outside diameter (od) of 4.625 inches or more may be rebored and rethreaded for an oversized 3-inch plug. Flasks which have a neck od of less than 4.625 inches and have thread damage shall be scrapped. Plugs with damaged threads shall be replaced. End plugs for oxygen flasks shall be nickel-copper (Ni-Cu) in accordance with QQ-N-281, class A alloy.

5.7.3.1.1 The flask interior shall be inspected for evidence of corrosion, pitting, oil, dirt, paint and so forth. Flasks for oxygen or nitrogen service shall show no evidence of paint on the interior surface.

5.7.3.2 The inspected flask shall be classified in accordance with the following criteria:

(a) Excellent: No evidence of paint, oil, dirt, corrosion and so forth on the internal surface.
(b) Good: Not more than 10 percent of the interior surface has evidence of oil, dirt, corrosion and so forth.
(c) Fair: Ten to 20 percent of the interior surface has evidence of oil, dirt, corrosion and so forth.
(d) Poor: More than 20 percent of the interior surface has evidence of oil, dirt, corrosion and so forth.

5.7.3.3 Flask classed as fair or poor as specified in 5.7.3.2 shall be blasted with grit or similar material, or by spinning in a lathe with loose grit inside the flask. A good or excellent interior surface shall be obtained.

5.7.3.3.1 For flasks classified as painted, flask markings shall be examined to determine intended service of flask.

Service A = air
Service B = oxygen, oil free nitrogen

Service A flasks shall be replaced with service B flask. If service B, exhibited internal paint shall be stripped by grit blasting or by chemical means. Chemical cleaning shall be in accordance with NAVSEA S9551-AM-PRO-010.

5.7.3.4 The interior and exterior surfaces of all classes of flasks shall be visually inspected. The outside surface of the flask shall be marked to indicate the location of pits, cuts, burns, defects and so forth.

5.7.3.5 Pits, gouges, burns, arc strikes and other surface defects shall be treated in accordance with NAVSEA 0901-LP-490-0003, Chapter 9490.

5.7.3.6 Immediately after a final inspection of the interior surface of the flask for corrosion, the following sequence of events shall occur as specified in 5.7.3.6.1 through 5.7.3.6.3.

5.7.3.6.1 Grit and residue shall be removed by dumping and vacuum cleaning.

5.7.3.6.2 The flask plugs shall be reinstalled into the flask in accordance with NAVSEA 0901-LP-490-0003, Chapter 9490.

5.7.3.6.3 The flask shall be charged with nitrogen to a pressure of 10 to 15 lb/in^2. Pressure shall be maintained until testing begins.

5.7.4 Shop testing of flasks for oxygen and nitrogen gas systems.

5.7.4.1 The flask shall be cleaned and inspected as specified in 5.7.3 before starting this test.

5.7.4.2 The flask shall be filled with solvent while venting the nitrogen through the drain plug. If the flask does not have a drain plug, the flask shall be evacuated to a minimum of 25 inches of Hg vacuum and the vacuum broken with the solvent. The flask shall be completely filled with the solvent.

5.7.4.3 The flask shall be hydrostatically tested in accordance with NAVSEA 0901-LP-490-0003, Chapter 9490.

5.7.4.4 The flask shall be removed from the test stand and pressurized to the design working pressure of the flask (either 3000 or 5000 lb/in^2). Joints shall be inspected for leakage with the halide leak detector. No leakage shall be allowed.

5.7.4.5 Seal weld repair does not necessitate another expansion test in the water jacket. Flasks undergoing seal weld repair shall be solvent free. After repairs are complete, the flask shall be refilled with the solvent and retested as specified in 5.7.4.4.

5.7.4.6 After the flask has successfully passed the preceeding test, the pressure shall be reduced to zero. A sample of the solvent shall be collected. The laboratory shall analyze the sample for hydrocarbon content or residue as specified in 4.2. The maximum allowable contamination limit is 5 p/m. The sample shall be inspected for particulate contamination as specified in 4.2.3.1. If the hydrocarbon content (or residue) limit is exceeded, or if visible particles are present, the flask shall be flushed until acceptable samples are obtained.

5.7.4.7 When the flask is certified oxygen clean by the laboratory, the solvent shall be completely removed by draining and alternating cycles of pressurizing to 100 lb/in^2 with nitrogen and then depressurizing through the bleed off valves allowing the solvent to flow out. A vacuum pump may be used in the final stages of solvent removal. Heat (200°F maximum) may be applied to the external surfaces of the flask to facilitate removal of the cleaning solvent.

5.7.4.8 The exhaust shall be checked for traces of the cleaning solvent with a halide leak detector. Evacuating and purging shall be continued until no trace of the solvent is detectable.

5.7.4.9 The flask shall be charged with nitrogen. Samples of the nitrogen under pressure shall be taken after a period of 1 hour at 100 to 125 lb/in^2 and analyzed by the laboratory for solvent contamination. The amount of solvent in the nitrogen sample shall be not greater than 10 p/m (by volume) at standard conditions. If more than 10 p/m of solvent is found, flask shall be purged with nitrogen until it meets the requirements.

5.7.4.10 Nitrogen pressure shall be maintained at 10 to 15 lb/in^2 until the flask is reinstalled into the system and charged with gas. If the pressure should drop below 10 lb/in^2 before charging, the responsible authority shall be notified immediately. The responsible authority shall investigate circumstances associated with the drop in nitrogen pressure to ensure that no contamination could have entered the flask which would require repeating the cleanliness flush.

5.7.4.11 After the flask has been cleaned and certified, any further work on the flask shall be accomplished under oxygen clean conditions.

5.7.5 Flask exterior inspection. Oxygen flask external surfaces shall be inspected, cleaned and preserved as specified for nitrogen and other gas flasks in accordance with NAVSEA S9086-SX-STM-000, Chapter 550.

5.8 Tribasic sodium phosphate (TSP) cleaning procedures.

5.8.1 Component cleaning. Components shall be soaked and agitated in cleaning solution as specified in 4.2.2.1 for 10 minutes. A sample of the solution shall be cooled and analyzed by the laboratory for hydrocarbon content or

residue as specified in 4.2.2. The maximum allowable limit shall be 5 p/m at standard conditions. If the hydrocarbon (or residue) limit is exceeded, components shall be cleaned with fresh TSP solution until acceptable samples are obtained.

5.8.1.1 Cleaned components shall be rinsed with hot water maintained at 160 to 190°F. Rinse with successive portions until the rinse water is neutral when tested with phenolphthalein pH indicator solution and no visible particles are detected when examined as specified in 4.2.3.1.

5.8.1.2 Components shall be dried with nitrogen or in an oven dryer until dry.

5.8.2 System cleaning. NAVSEA approval shall be required prior to cleaning the oxygen and nitrogen gas piping systems with TSP solution. Cleaning solution as specified in 4.2.2.1 shall be circulated through the system for at least 30 minutes. Personnel shall avoid coming in contact with hot, unlagged piping during system cleaning. To prevent solid TSP from separating, the solution shall not be allowed to cool below 160°F or remain uncirculated in a system. TSP solution shall not be used for cleaning dead end piping. If the flushing circuit is through parallel paths, the flow paths shall be isolated as necessary to ensure that each path is flushed with the full flow for not less than 5 minutes, followed by a 30-minute flush of the entire system without full flow required in each leg. Drain the system and repeat the flush until solution appears visibly clear. Samples of the cleaning solution shall then be collected from all sampling locations. Samples shall be cooled and analyzed by the laboratory for hydrocarbon content or residue as specified in 4.2.2. The maximum allowable limit shall be 5 p/m at standard conditions. If the hydrocarbon (or residue) limit is exceeded, fresh TSP solution shall be circulated until acceptable samples are obtained.

5.8.2.1 When the piping is certified clean by the laboratory, the cleaning solution shall be removed. Immediately following removal of the cleaning solution, the system shall be flushed with hot water maintained at 160 to 190°F. Flushing shall continue until samples of rinse water from all sampling locations are neutral when tested with phenolphthalein pH indicator solution and no visible particles are detected when examined as specified in 4.2.3.1.

5.8.2.2 When acceptable rinse water samples are obtained, the system shall be drained and purged with nitrogen until the dewpoint of the discharging gas is minus 40°F, or less, at standard conditions. Heat (not greater than 200°F) may be applied to external surfaces of the piping to facilitate water removal.

5.9 Ships service demineralized water piping system flush.

5.9.1 The demineralized water piping shall be flushed to remove loose scale, rust, grit, filings and other foreign substances.

5.9.2 The piping from the ships service demineralizer to the oxygen generator, including the demineralized water storage tank, shall be flushed for 15 minutes with hot (150°F) grade A water.

5.9.3 A sample of the flush water shall be inspected for particulate contamination as specified in 4.2.3.1 and hydrocarbon contamination in accordance with article 231 of NAVSEA 0389-LP-015-2000.

5.9.4 Following the flush, the water shall be drained from the system and a visual inspection for hydrocarbon contamination shall be conducted at the oxygen generator union connection, of accessible surfaces in the demineralized water storage tank and of distillate supply piping running from the evaporator to the ships service demineralizer using ultraviolet light, bright white light, swipes, and so forth.

5.9.5 If visible traces of hydrocarbons are found, the piping shall be cleaned as specified in 5.5.2 or 5.8.2.

5.10 Oxygen-nitrogen plant cleaning.

5.10.1 The approved solvents for cleaning oxygen-nitrogen plants are R-113 conforming to MIL-C-81302 or R-11 of cleaning solvent quality acquired commercially as DuPont FREON MF, Allied Chemical Genesolv A or equivalent. In the condition received, ordinary refrigerant R-11 is not suitable for cleaning the oxygen-nitrogen plant. If it is used, ordinary refrigerant R-11 shall be distilled and purified to cleaning solvent quality as specified in 4.2.1.2.

5.10.2 The cleaning method consists basically of dividing the plants producer, storage and pump-vaporizer process piping into a number of separate piping circuits by using the equipment's isolation valves and temporary jumper hoses and pipe closures solvent is circulated through each piping circuit to be cleaned. The fill-and-soak method may be used for vessels such as distillation columns and storage tanks.

5.10.3 If solvent R-11 is used, it shall be introduced under pressure into a closed system so that solvent vaporization is suppressed. In either the fill and soak or the circulation method of cleaning, introduction of the solvent under 9 lb/in^2 pressure correspondingly raises the boiling point to 100°F. Introduction under 15 lb/in^2 pressure raises the boiling point to 112°F.

5.10.4 Consult the NAVSEA and the ship's planning yard if necessary to identify previously used cleaning procedures or to develop a specific procedure for the make/model equipment to be cleaned.

5.10.5 The oxygen-nitrogen plant shall be certified oxygen clean and free of cleaning solvent as specified in 5.5.2.5 through 5.5.2.7.

5.11 Disposal of waste material used in cleaning. Cleaning solvents such as R-113 and R-11 shall be returned to their original containers after use. The containers shall be marked dirty solvent and retained for proper disposal. Used or contaminated R-113 or R-11 solvent may be reclaimed for use as specified in 4.2.1.2. Hot flush water containing flux residues may be discharged overboard or to a sewer system. TSP shall be neutralized and discharged in accordance with local regulations.

5.12 Shipboard oxygen clean facilities and appropriate equipment.

5.12.1 Facilities requirements.

5.12.1.1 Shipboard oxygen clean room and clean area. A shipboard oxygen clean room or clean area shall be employed for cleaning, assembling, testing, bagging, packaging, and examination or disassembly of oxygen clean equipment. Before utilizing the clean room or clean area, the interior surfaces shall be cleaned to the maximum extent practicable by vacuuming and wiping free of all loose contamination. Work bench surfaces shall be wiped clean of all visible contaminants using lint-free cloth or sponge and cleaning solvent.

5.12.1.2 Shipboard oxygen clean room. The shipboard oxygen clean room shall consist of a complete enclosure in which windows and doors are tight fitting. The degree of tightness of windows and doors shall be adequate to prevent the inadvertent entry of contamination. The air supplied to the room shall be clean air. Mechanical filters for ventilation shall be capable of supplying clean air as a minimum. The ventilation air supply shall be adequate to maintain a positive pressure so that the air flow will always be outward from the clean room. Walls may be constructed of standard structural materials in accordance with MIL-HDBK-407. Walls shall be painted to minimize dirt pickup and to facilitate cleaning. Walls constructed of corrosion-resistant metals are not required to be painted. Personnel entering these areas shall wear clean coveralls or smocks without pockets, buttons, or similar items. In those cases where dirt may be brought in from the outside, preventive measures such as clean anterooms and shoe covers shall be employed. Air supply filters shall be maintained in a clean condition. Clean room work benches shall be provided with stainless steel or laminated plastic work surfaces. Benches and furniture shall be in accordance with MIL-HDBK-407.

5.12.1.3 Shipboard oxygen clean area. In those cases where it is not considered practical to provide a clean room, the same type of operations may be performed in areas temporarily set up for a particular job. These are called clean areas. Depending on the time and work involved for a particular operation, a clean area shall be one of the following:

(a) Clean space located or set up adjacent to areas which are non-contaminant producing.
(b) Clean tent or partitioned and covered area with a clean air ventilation supply adequate to maintain a positive pressure so that the air flow will always be outward from the enclosed area. The clean tent shall be established by taping clean, unused, polyethylene plastic sheets conforming to MIL-B-22191, type I, on the deck overhead, and vertical areas for a distance of 3 to 4 feet around the area concerned. The outside surfaces of exposed materials within the confined area shall be cleaned to remove dust, oil, dirt and other foreign material. Air movement within the confined area shall be held to a minimum.
(c) Clean glove box or isolation box with a clean atmosphere. The glove box is a temporary enclosure surrounding the work area and sealed from the outside atmosphere. Work is accomplished through plastic gloves sealed to the box walls.
(d) A sleeve, with a clean, dry, nitrogen supply or equally clean, dry, air supply.

5.12.1.3.1 The primary difference between the clean room and the clean area is the length of time during which clean conditions are required.

5.12.1.4 Welding or brazing. When welding or brazing of parts is performed in a clean area, precautions shall be taken to control splatter and to remove welding and brazing smoke from the area before redesignation as a clean area. Welding or brazing shall not be performed in a clean room.

5.12.1.5 Clean anteroom. Consideration shall be given to establishing anterooms if clean rooms are located in dirt-producing areas. The anteroom should provide a space for the changing and stowing of clothing and the examination of tools and equipment prior to entry into the clean room, and provide personnel access to the clean room. The anteroom shall consist of an area that is free of shop dirt-producing operations. Washing, toilet facilities, and storage facilities for maintenance of equipment should be provided in the immediate area, where desirable.

5.12.2 Tools, handling equipment, and clothing.

5.12.2.1 Tools and handling equipment. Tools, which are used in a shipboard oxygen clean room or a clean area, shall be cleaned to the same degree as required for the material to be cleaned. In general, cleaned surfaces may be handled with clean lint-free synthetic cloth or polyethylene gloves. Handling equipment in contact with internal surfaces shall be in good working condition. Verification of tool cleanliness may be accomplished by checking for fluoresence with a long wave ultraviolet light (3600-3900 angstrom units). Conduct a further check for oils and contaminants not detectable with ultraviolet light, by examining tools with bright white light for liquid residue, particles and fibers, and by wiping surfaces with filter paper and examining the filter paper for oil stains and contaminants. If no fluorescence or visible contamination is discernable, the tool is free of hydrocarbons. Rewash the tool with a cleaning solvent if fluorescence or visible contaminants are evident.

5.12.2.2 Temporary plugs or caps. Temporary plugs or external caps shall be used to prevent entry of contamination into oxygen clean component parts, equipment, and systems during and after repair and maintenance work. All plugs and caps shall have the same degree of cleanliness as the pipe or assembly to be sealed. Plugs shall be mechanically expandable, insert type with the plug fabricated from nonshedable rubber conforming to ZZ-R-710. The use of wood or plastic plugs is not permitted. Caps shall be fabricated from noncorrodible, nonshedable metal such as aluminum or corrosion-resistant steel. Caps shall be secured and sealed by bolting or by taping. Tape, plastics, or wood, shall not be used as the capping material. Wood, however, may be used over the metallic cap for purposes of bolting. An appropriate labeling device shall be affixed to the component, equipment, or system identifying it as oxygen clean (see 5.14.3.1). Components or equipment which have been cleaned and tested shall be thoroughly dried prior to plugging or capping.

5.12.2.3 Records. A formal written record of accountability shall be maintained for tools equipment, and temporary plugs or seals which are small enough to fit inside openings in systems or components and which are used in fabrication and assembly operations, unless internal surfaces can be visually observed by a quality assurance office representative and are certified to be satisfactorily clean prior to closure of the system or component involved. A physical boundary

shall be established to implement accountability when accountability is required. Care shall be taken when establishing the physical boundary such that it precludes the inadvertent introduction of foreign materials, tools and so forth, which have not been accounted for. Extraneous tools, equipment, and material shall be removed from the proximity of an opening in a system or component. Small articles which could be dropped or lost in a component or system during work shall be attached to the user or to a fixed piece of equipment by a wire or nylon cord lanyard. Special attention shall be given to the clothing worn while working on clean systems or the components in which there are openings. Precautions shall be taken to eliminate the possibility of accidental loss of articles such as buttons, badges, jewelry, pencils, pens, coins, spectacles, contact lenses, dentures, hearing aids, mask filters, and similar articles. Badges, where required to be worn, shall be securely fastened to the clothing.

5.12.2.4 Clothing. Personnel working continuously in a shipboard oxygen clean room or clean area shall be clothed in the following manner:

(a) Clean coveralls or smocks, without pockets, buttons, exposed zippers, keys, and similar articles shall be worn. In those cases where dirt such as mud or shop dirt could be brought in from the outside, shoe covers shall be used. Clean pipe or clean components shall be handled with clean lint-free gloves, such as latex or polyethylene.
(b) Clothing shall not be worn open, or worn outside of the clean room or clean area. Observers and visitors shall also wear clean clothes.
(c) Special precautions shall be taken in cases of opened components; for example, remove pencils, pens, etc.

5.12.3 Storage.

5.12.3.1 Location. Materials and components which have been certified oxygen clean shall be stored in a clean storage area set aside exclusively for the storage of certified oxygen clean materials and components. The storage area shall be located indoors. Not only shall it protect the stored material from exposure to dirt and oil, but it shall also protect them from extremes of temperature and humidity, below 40°F, and above 100°F, and over 90 percent relative humidity. Certified oxygen clean materials shall be stored so as to prevent damage to their protective plastic covers. The certification sticker or tag shall be attached so as to be visible for inspection and audit.

5.12.3.2 Shelf time. While in storage, all certified oxygen clean materials shall be recleaned and recertified at least every 5 years.

5.12.3.3 If the certification of certified oxygen clean material has expired, the certification sticker or tag is missing, or the protective plastic cover is damaged, the material may remain in storage in that condition but it shall be marked as "contaminated" as specified in 5.14.3.2 and recleaned and recertified prior to shipment or use.

5.13 Personnel qualification and training.

5.13.1 Piping systems and components to be certified oxygen clean shall be cleaned, assembled, tested, packaged and examined by qualified personnel.

5.13.1.1 Fleet personnel qualification. Fleet personnel qualification shall be obtained by completing a course of instruction and passing a written examination. A course of instruction shall be given by a NAVSEA authorized naval facility or shipbuilding contractor. Course material shall include topics listed in 5.13.2.

5.13.1.2 Personnel requalification. Personnel requalification shall be obtained every 2 years by repeating the applicable qualification procedure specified in 5.13.1.1.

5.13.1.3 Instructors. Fleet instructors performing personnel qualification shall be qualified and approved as instructors in certified oxygen clean by an authorized representative of NAVSEA or the agency concerned. Type commanders are authorized to designate as instructors, personnel who have completed an oxygen system and components cleanliness training course as specified in 5.13.1.1.

5.13.2 Training. The course of instruction shall include, as a minimum, education in the following topics:

(a) Purpose of certification of materials and historical events justifying the certification, covering:

(1) Reactions and dangers of contaminants.
(2) Major incidents due to lack of oxygen cleanliness. Indicate how certification and approved procedures may have prevented the incidents.
(3) Interference with equipment and system performance due to lack of oxygen cleanliness.
(4) Purpose of certification is to prevent dangerous incidents and degradation of performance.

(b) High pressure systems and safety precautions for dangerous gases, covering:

(1) Description of various systems - nitrogen, hydrogen and oxygen and the potential energy stored within them.
(2) Examples concerning system strength, assembly procedures and operating procedures.
(3) Review of safety precautions in NAVSEA S9086-SX-STM-000, Chapter 550, and those specified herein.

(c) Approved cleaning procedures for various systems and components, including:

(1) Those specified herein and present excerpts.
(2) Discussion of industry standards and procedures.

(d) Construction and maintenance of clean rooms and clean areas, including:

(1) Facility requirements specified in this standard.

(e) Personnel attire in clean rooms and clean areas, including:

(1) Clothing requirements as specified herein.

(f) Software preparation, usage and procedures for certified oxygen clean material, including:

(1) Use and importance of stickers and tags for certification and rejection, example: lost sticker unnecessarily creates costly rework.

(g) Operation of test equipment including ultra-violet lamps, halide torch, leak-detecting equipment, infrared spectrophotometers and gas chromatograph.

5.14 Certification.

5.14.1 Inspection.

5.14.1.1 Materials. The procedure during which materials are certified oxygen clean shall be witnessed for compliance by a quality assurance office representative during cleaning, assembly, testing, and packaging. After packaging for storage or shipment has been completed, and after the materials have met the requirements of this standard, the representative witnessing the procedure shall attach a certified oxygen clean sticker or tag to the material as specified in 5.14.3.1.

5.14.1.2 Shipboard oxygen clean facilities.

5.14.1.2.1 Shipboard oxygen clean rooms. Shipboard oxygen clean rooms shall be examined by a quality assurance office representative prior to use and while in use. Environmental conditions and room cleanliness shall be noted. Deficiencies shall be corrected to bring the room up to requirements of this standard before any work on material for certified oxygen clean can be performed. A shipboard oxygen clean room shall be certified oxygen clean if it meets the requirements of this standard.

5.14.1.2.2 Shipboard oxygen clean areas. Prior to use, shipboard oxygen clean areas shall be examined by quality assurance office representative for compliance with this standard. While a clean area is in use, a quality assurance office representative shall observe continued compliance with this standard.

5.14.1.2.3 Storage area and stored materials. Storage areas for certified oxygen clean materials while in use shall be examined monthly by a quality assurance office representative. Packaged or bagged certified oxygen clean material shall be examined annually for evidence of damage or contamination. Environmental conditions and those of the stored materials shall be noted. Materials deemed "contaminated" under this standard shall be marked in accordance with 5.14.3.2.

5.14.2 Audit. Annual audits shall be made by a quality assurance office representative, an authorized representative of NAVSEA or the agency concerned for compliance with this standard. Non-compliance results of the audit shall be reported to NAVSEA, Submarine Logistic Division.

5.14.3 Forms.

5.14.3.1 Acceptance. In order to identify materials and components which have been certified oxygen clean, a light green sticker or tag indicating certification shall be affixed to the bag containing the item so that it will not come in contact with the certified oxygen clean item. The quality assurance office representative shall write in the necessary information on the sticker or tag before attaching it to or on the bag. Figures 1 and 2 are typical acceptance sticker and tag designs.

5.14.3.2 Rejection. In order to identify materials and components, once certified oxygen clean, which have become contaminated and which are no longer certified oxygen clean in accordance with the provisions of this standard, a green and red sticker or tag indicating this contamination condition shall be affixed to the item by the quality assurance office representative. The quality assurance office representative shall write in the necessary information on the sticker or tag before attaching it to the item. Figures 3 and 4 are typical rejection sticker and tag designs.

5.15 Packaging methods for storage or shipment of oxygen clean components.

5.15.1 Immediately after cleaning, certification, assembly and testing, the components shall be bagged (unit packed) as specified in 4.2.4.

5.15.2 Intermediate packing shall be in accordance with MIL-C-52211.

5.15.3 Exterior packing shall be in accordance with MIL-C-52211.

5.16 Marking.

5.16.1 Each intermediate package shall be marked with a warning label that reads as follows:

"WARNING - THIS PART HAS BEEN
CERTIFIED OXYGEN CLEANED FOR
OXYGEN SERVICE IN ACCORDANCE
WITH MIL-STD-1330. DO NOT
OPEN UNTIL READY FOR USE."

5.16.2 Each exterior package shall be marked in accordance with MIL-STD-129.

Preparing activity:
Navy - SH
(Project 4730-N571)

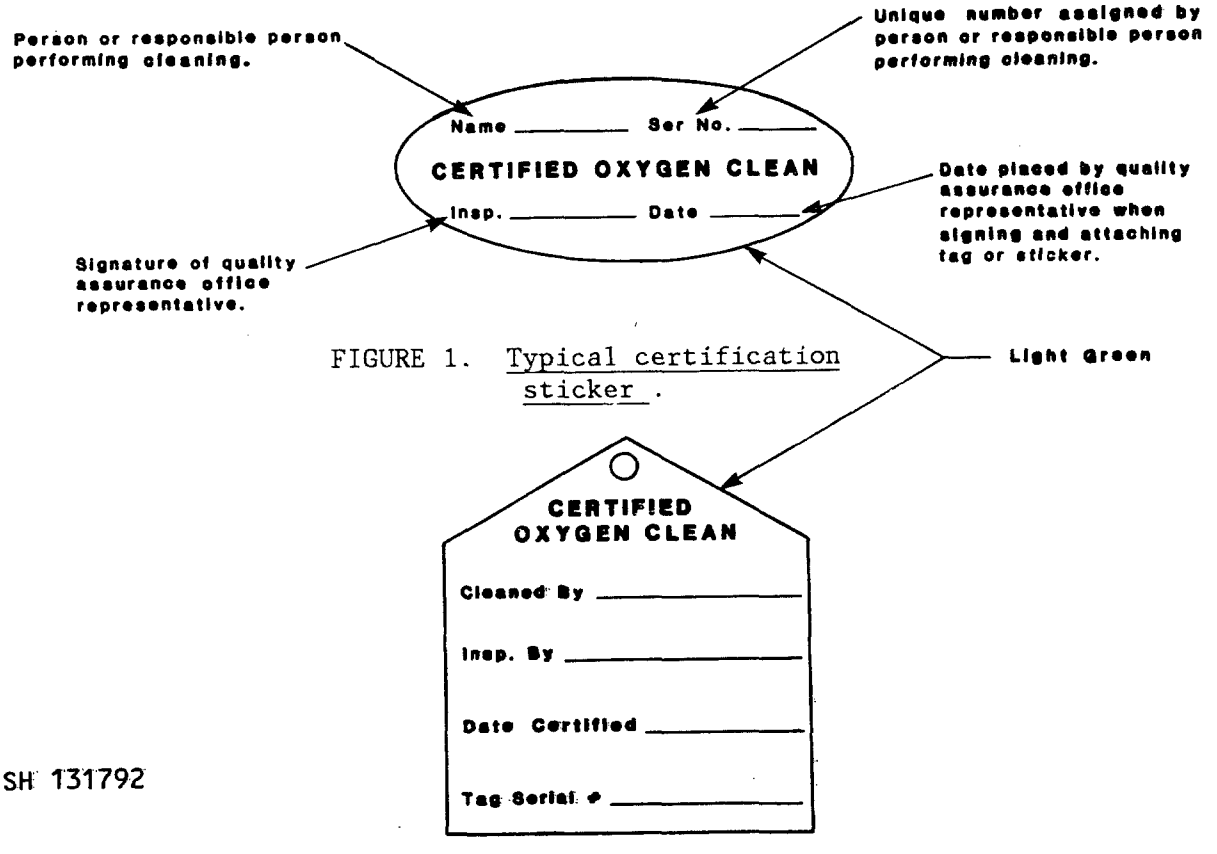

FIGURE 1. Typical certification sticker .

FIGURE 2. Typical certification tag.

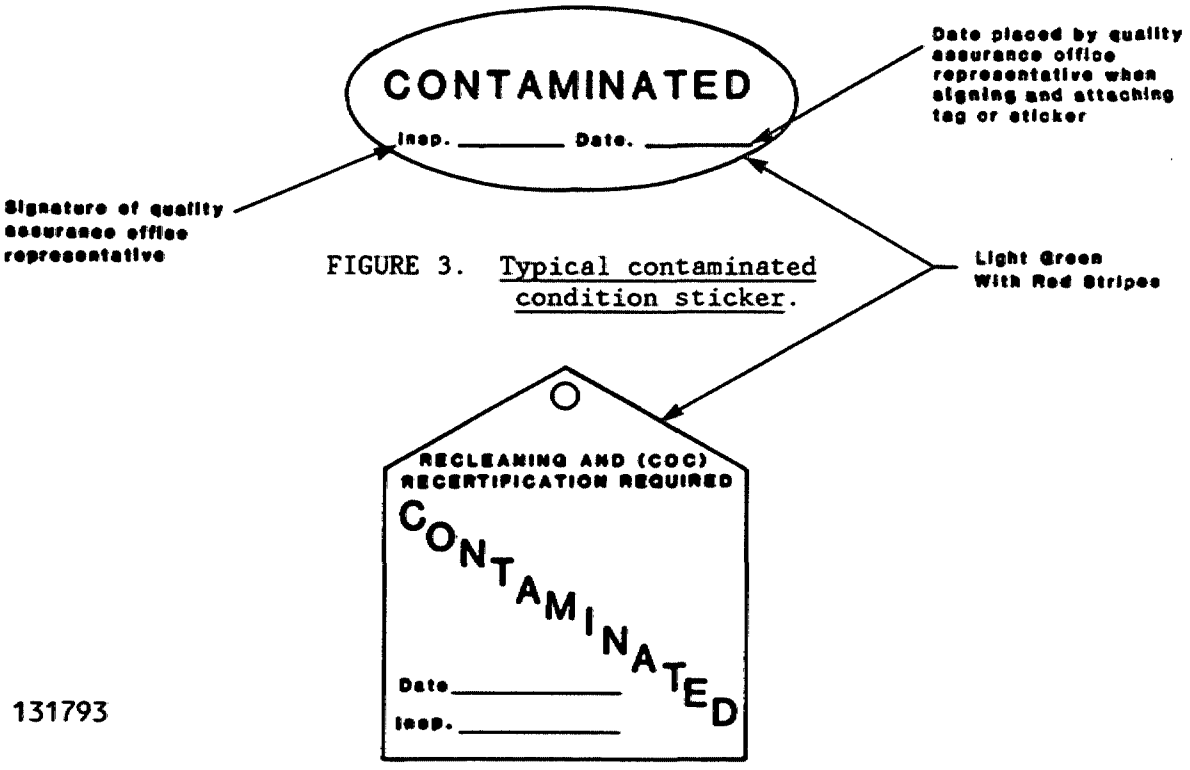

FIGURE 3. Typical contaminated condition sticker.

FIGURE 4. Typical contaminated condition tag.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-1330C(SH)	Cleaning And Testing Of Shipboard Oxygen, Nitrogen And Hydrogen Gas Piping Systems

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

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

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.