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DEPARTMENT OF DEFENSE STANDARD PRACTICE

PRECISION CLEANING AND TESTING OF SHIPBOARD OXYGEN, HELIUM, HELIUM-OXYGEN, NITROGEN, AND HYDROGEN SYSTEMS

AMSC N/A

FSC 4730

FOREWORD

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

2. This standard is for use by naval activities and private firms performing services as prime or sub-contractors for Naval Sea Systems Command.

3. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

CONTENTS

CONTENTS - Continued

CONTENTS - Continued

CONTENTS - Continued

CONTENTS - Continued

CONTENTS - Continued

TABLES PAGE

APPENDICES

1. SCOPE

1.1 Scope. This standard provides the requirements for precision cleaning and testing of oxygen or oxygen-enriched systems and components; oxygen generating plants including nitrogen, hydrogen, and demineralized water support systems and components; and helium, helium-oxygen, and hydrogen life support systems and components. Each activity will implement the applicable requirements of this document through a locally prepared and approved procedure. Activities subject to additional quality assurance requirements such as NAVSEA SS800-AG-MAN-010/P-9290 or NAVSEA SS521-AA-MAN-010 will obtain procedure approval from the applicable certifying activity.

1.2 Applicability. This standard is applicable to all surface ships, submarines, and supporting shore base facilities which contain any of the following:

1.2.1 Oxygen or oxygen-enriched systems and components, including gaseous and liquid oxygen generating equipment. The cleanliness boundary includes all material wetted by any fluid containing greater than 25 percent by volume oxygen during normal operations. An exception is the following diver life support equipment: diving helmets, masks, umbilicals, and items otherwise exempt by NAVSEA which are cleaned in accordance with MIL-STD-1622, critical applications. For information, compressed air systems directly supporting oxygen generating equipment are cleaned in accordance with MIL-STD-1622, critical applications.

1.2.2 Hydrogen, nitrogen, and demineralized water systems and components that support gaseous or liquid oxygen generating equipment.

1.2.2.1 The cleanliness boundary for hydrogen systems supporting oxygen generating equipment encompasses all wetted material from, and including, the point of interface or interface connection with an oxygen or oxygen-enriched system or component to the first check valve or normally shut isolation valve. Remaining portions of hydrogen systems should be cleaned using best commercial practice to remove loose scale, dust, grit, filings, oil, and grease.

1.2.2.2 The cleanliness boundary for submarine nitrogen systems supporting oxygen generating equipment encompasses all wetted material from, and including, the point of interface or interface connection with an oxygen or oxygen-enriched system or component upstream to either:

a. The nitrogen supply flasks, including all piping and components associated with charging when such supply is dedicated to oxygen generating equipment. Nitrogen piping to the ship demineralized water storage tank is cleaned in accordance with MIL-STD-1622, general applications.

b. The last check valve or normally shut isolation valve that separates the nitrogen supply flasks from the oxygen generator when such supply is not dedicated to oxygen generating equipment. Remaining portions of the nitrogen system are cleaned in accordance with MIL-STD-1622, general applications.

1.2.2.3 The cleanliness boundary for surface ship nitrogen systems includes any portion of the system that can be used to pressurize or purge the oxygen system, oxygen system components, oxygen-nitrogen producer, and storage equipment. Remaining portions of the nitrogen systems are cleaned in accordance with MIL-STD-1622, general applications.

1.2.2.4 The cleanliness boundary for demineralized water systems supporting oxygen generating equipment encompasses all wetted material from, and including, the point of interface or interface connection with an oxygen or oxygen-enriched system or component to the ship’s demineralizer.

1.2.3 Helium, helium-oxygen, and hydrogen systems and components that provide life support. The cleanliness boundary encompasses all wetted material providing life support functions except the following: diving helmets, masks, umbilicals and items otherwise exempted by NAVSEA which are cleaned in accordance with MIL-STD-1622, critical applications.

1.2.4 Equipment which comes in contact with or is used to transfer any fluid from its source to a system or component within any of the boundaries defined in 1.2.1, 1.2.2, and 1.2.3 when such interface is intended to maintain the cleanliness requirements specified herein.

1.2.5 Open ended applications constructed of material that is configured and operated at a pressure that represents a fire hazard in the presence of an oxygen or oxygen-enriched atmosphere when determined in accordance with the guidelines of ASTM G63 and ASTM G94. For open-ended piping or configurations constructed of material and operated in an oxygen or oxygen-enriched atmosphere at a pressure that does not propagate a flame when determined in accordance with the guidelines of ASTM G63 and ASTM G94, clean in accordance with MIL-STD-1622 for diver applications; otherwise use best commercial practice to remove loose scale, dust, grit, filings, oil, and grease. For information, copper, copper-nickel, bronze, brass, and monel will not propagate a flame in an oxygen or oxygen-enriched atmosphere at pressures up to 7500 pounds per square inch (lb/in^2).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

O-S-642	-	Sodium Phosphate, Tribasic, Anhydrous; Dodecahydrate; and Monohydrate; Technical
TT-I-735	-	Isopropyl Alcohol
ZZ-G-710	-	Gasket Material, Rubber 35 Durometer Hardness

COMMERCIAL ITEM DESCRIPTIONS

A-A-3174	-	Plastic Sheet, Polyolefin
A-A-58020	-	Drums, Shipping, Steel with Polyethylene Insert
A-A-59155	-	Nitrogen, High Purity, Special Purpose

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-D-16791	-	Detergents, General Purpose (Liquid, Nonionic)
MIL-PRF-22191	-	Barrier Materials, Transparent, Flexible, Heat-Sealable
MIL-F-22606	-	Flask, Compressed Gas, and End Plugs for Air, Oxygen, and Nitrogen
MIL-PRF-24139	-	Grease, Multipurpose, Water Resistant
MIL-DTL-24671	-	Cloth, Lint-Free, Flushing and Cleaning
MIL-DTL-24800	-	Cleaning Compound - Aqueous - Oxygen Systems Components
MIL-PRF-25567	-	Leak Detection Compound, Oxygen Systems
MIL-PRF-27401	-	Propellant Pressurizing Agent, Nitrogen

MIL-PRF-27407	-	Propellant Pressurizing Agent, Helium
MIL-PRF-27415	-	Propellant Pressurizing Agent, Argon
MIL-PRF-27617	-	Grease, Aircraft and Instrument, Fuel and Oxidizer Resistant

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1622	-	Cleaning of Shipboard Compressed Air Systems

DEPARTMENT OF DEFENSE HANDBOOKS

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

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

SS521-AA-MAN-010	-	U.S. Navy Diving and Manned Hyperbaric Systems Safety Certification Manual
SS800-AG-MAN-010/ P-9290	-	System Certification Procedures and Criteria Manual for Deep Submergence Systems
ST700-F1-PRO-010	-	Instrument and Gage Cleaning for MIL-STD-1330 Applications; Procedures Manual
TL855-AA-STD-010	-	Naval Shipyard Quality Program Manual
S6430-AE-TED-010	-	Piping Devices, Flexible Hose Assemblies
0900-LP-001-7000	-	Fabrication and Inspection of Brazed Piping Systems
0902-LP-018-2010	-	Deep Diving General Overhaul Specifications for SSBN/SSN Submarines
0924-LP-062-0010	-	Submarine Safety (Subsafe) Requirements Manual
0987-LP-022-3010	-	Pressure Instruments in Oxygen Gas Systems (Other Than Gas Generating Plants) In-Place and On-Site Calibration of
S9074-AR-GIB-010/ 278	-	Welding and Casting Standard
S9086-CH-STM-010/ CH-074 V1	-	Welding and Allied Processes
S9086-H7-STM-010/ CH-262	-	Lubricating Oils, Greases, Specialty Lubricants and Lubrication Systems

S9086-RK-STM-010/CH-505 - NSTM, Piping Systems

S9086-SY-STM-010/CH-551 - NSTM, Compressed Air Plants and Systems

S9086-SX-STM-010/CH-550 - NSTM, Industrial Gases; Generating, Handling and Storage

S9086-WK-STM-010/CH-670 - NSTM, Stowage, Handling and Disposal of Hazardous General Use Consumables

(Copies of these documents are available online at http://nll.ahf.nmci.navy.mil or from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z358.1 - Emergency Eyewash and Shower Equipment

(Copies of this document are available online at http://webstore.ansi.org/ or from the American National Standards Institute, 25 W. 43rd St, 4th Floor, New York, NY 10036.)

ASTM INTERNATIONAL (ASTM)

ASTM D1193 - Standard Specification for Reagent Water (DoD adopted)

ASTM D2109 Standard Test Methods for Nonvolatile Matter in Halogenated Organic Solvents and Their Admixtures (DoD adopted)

ASTM D3921 - Standard Test Method for Oil and Grease and Petroleum Hydrocarbons in Water (DoD adopted)

ASTM D4839 - Standard Test Method for Total Carbon and Organic Carbon in Water by Ultraviolet, or Persulfate Oxidation, or Both, and Infrared Detection

ASTM E70 - Standard Test Method for pH of Aqueous Solutions With the Glass Electrode (DoD adopted)

ASTM F311 - Standard Practice for Processing Aerospace Liquid Samples for Particulate Contamination Analysis Using Membrane Filters

ASTM F331 - Standard Test Method for Nonvolatile Residue of Solvent Extract from Aerospace Components (Using Flash Evaporator)

ASTM G63 - Standard Guide for Evaluating Nonmetallic Materials for Oxygen Service

ASTM G94 - Standard Guide for Evaluating Metals for Oxygen Service

(Copies of these documents are available online at www.astm.org or from ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959.)

COMPRESSED GAS ASSOCIATION (CGA)

CGA C-1 - Methods for Hydrostatic Testing of Compressed Gas Cylinders

CGA C-6.1 - Standards for Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders

CGA C-6.2 - Guidelines for Visual Inspection and Requalification of Fiber Reinforced High Pressure Cylinders

CGA G-10.1 - Commodity Specification for Nitrogen

(Copies of these documents are available online at www.cganet.com or from the Compressed Gas Association, Inc., 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923.)

INSTITUTE OF ENVIRONMENTAL SCIENCES AND TECHNOLOGY (IEST)

IEST-STD-CC1246 - Product Cleanliness Levels and Contamination Control Program

(Copies of this document are available online at www.iest.org or from the Institute of Environmental Sciences and Technology, 5005 Newport Drive, Suite 506, Rolling Meadows, IL 60008-3841.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 14644-1 - Cleanrooms and Associated Controlled Environments - Classification of Air Cleanliness

ISO 14644-2 - Cleanrooms and Associated Controlled Environments - Specifications for Testing and Monitoring to Prove Continued Compliance with ISO 14644-1

(Copies of these documents are available online at www.iso.org or from the International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211 Geneve 20, Switzerland.)

SAE INTERNATIONAL

SAE-AS8660 - Silicone Compound, NATO Code Number S-736 (DoD adopted)

(Copies of this document are available online at www.sae.org or from the SAE World Headquarters, 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096-0001.)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Method 9060A - Total Organic Carbon

(Copies of this document are available online at www.epa.gov or from the U.S. Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington DC 20460.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Aqueous cleaning solution. An aqueous cleaning solution is a water based cleaner whose constituents are soluble inorganic compounds such as silicates or phosphates or soluble organic compounds such as non-ionic surfactant or combinations thereof. Examples of aqueous cleaning solutions include commercial detergents which generally contain both soluble inorganic and organic compounds and Navy oxygen cleaner (NOC) which contains only soluble inorganic compounds.

3.2 Blue line. When a cut for a pipe or fitting nears the inner wall, the outer surface turns blue which is referred to as cutting to the blue line. The blue line results from oxidation caused by the reduced ability of the thinned pipe or fitting to dissipate heat generated by the power tool cutting the surface.

3.3 Clean. Clean refers to the absence of scale, particulate, oil, and grease contaminants at a level below that which adversely affects the operation or reliability of the component or system. The process of cleaning should not affect the form, fit, or function of the item being cleaned.

3.4 Cleaning solvent. A cleaning solvent is any material that exhibits the capability to dissolve other substances through chemical action and, for the purposes of this document, is 100 percent volatile. Examples include halogenated solvents such as HCFC-141b which is non-flammable and hydrocarbon solvents such as isopropyl alcohol (IPA) which is very flammable.

3.5 Cleanliness level. A cleanliness level is an established maximum allowable distribution of contamination of a given size and quantity in a specified area or volume.

3.6 Clean lint-free cloth. A clean lint-free cloth in accordance with MIL-DTL-24671, or equal, is used for local cleaning or wiping surfaces to evaluate loss of cleanliness. The cloth should be free of chemicals which could pose a compatibility, flammability, or toxicity hazard considering the specific application.

3.7 Cleanroom. A cleanroom is a permanent area where a high degree of cleanliness is continuously achieved by employing varying degrees of control and monitoring of environmental items such as ventilation, filtration, temperature, humidity, pressure, personnel, clothing, and room maintenance. Refer to 5.1 for cleanroom requirements.

3.8 Components. Components refer to items such as valves, fittings, gauges, regulators, and repair parts in the systems.

3.9 Contractor. A contractor is any person not employed by the U.S. Navy performing services on-board ships or at shore base facilities on components or systems defined by 1.2.

3.10 Controlled area. A controlled area is an area where a high degree of cleanliness is temporarily achieved and maintained by the use of temporary boundaries, air filtration, and the enforcement of strict controls on personnel access, operations, and area maintenance. Controlled areas are most often used for in-place maintenance and repair of shipboard systems. Refer to 5.1 for controlled area requirements.

3.11 Critical applications. Critical applications are systems or components requiring more detailed cleanliness and packaging requirements than generally specified because of unique operating parameters and environments. In the past, some saturated diving systems have been classified as critical applications because of the increased toxicity hazard associated with high partial pressure environments. Unless directed by NAVSEA or the Type Commander, critical requirements may not be used.

3.12 Dew point. Dew point is the measure of dryness or wetness of a gas. It is defined as the temperature at which gas becomes saturated with water vapor causing condensation when cooled at constant pressure. Dew point temperature is measured at atmospheric pressure.

3.13 Final cleaner. A final cleaner is an aqueous cleaning solution or a cleaning solvent used for final flushing of piping systems or final precision cleaning of components and parts.

3.14 Halogenated solvent. A halogenated solvent is any solvent whose chemical structure contains bromine, chlorine, fluorine, or iodine. Most halogenated solvents are non-flammable and many are very toxic. All NAVSEA approved halogenated solvents contain fluorine, some also contain chlorine, and none contain bromine or iodine.

3.15 Helium. Helium refers to gaseous helium as specified in 4.7.2.

3.16 Maximum operating pressure. The maximum operating pressure is the highest pressure that can exist in a system or subsystem under normal (non-casualty) operating conditions. This pressure is determined by such influences as pressure regulating valve set pressure, maximum pressure at the system source such as compressed gas bank pressure or sea pressure, and pump or compressor shut-off pressure for closed systems. For constant pressure systems, such as regulated compressed gas systems, the term Nominal Operating Pressure has been used to designate the steady state operating condition. Where this type of pressure rating is applied, for the purpose of the requirements stated herein, it may be substituted as the maximum operating pressure.

3.17 Membrane filter. A membrane filter refers to an absolute rated filter where the filter retains all particles whose smallest dimension is equal to or greater than the specified rating.

3.18 Nitrogen. Nitrogen refers to gaseous nitrogen as specified in 4.7.3.

3.19 Objective quality evidence. Objective quality evidence is any statement of fact, either quantitative or qualitative, pertaining to the quality of a product or service based on observations, measurements, or tests which can be verified. Evidence will be expressed in terms of specific quality requirements or characteristics. These characteristics are identified in drawings, specifications, and other documents which describe the item, process, or procedure.

3.20 Organic. Organic refers to any chemical compound containing carbon. For the purposes of this document, the organic compounds of interest are hydrocarbon compounds containing carbon and hydrogen, and fluorocarbon compounds containing carbon and fluorine. Hydrocarbon materials such as lubricating oils are very flammable in oxygen, while fluorocarbon materials such as MIL-PRF-27617 grease demonstrate good compatibility with oxygen.

3.21 Oxygen clean. Oxygen clean is the verifiable absence of particulate, fiber, oil, grease, and other contaminants determined through the use of qualitative and quantitative cleanliness measurement techniques. An oxygen, helium, helium-oxygen, nitrogen, nitrogen-oxygen, or hydrogen piping system or component successfully cleaned in accordance with this standard is considered oxygen clean.

3.22 Oxygen enriched. Oxygen enriched refers to any fluid containing greater than 25 percent oxygen by volume in accordance with ASTM G63 and ASTM G94.

3.23 Precision cleaning. Precision cleaning is the act of removing unwanted contaminants to better than visibly clean. Precision cleaning is accomplished using a controlled and verifiable process with cleaning agents that satisfy the applicable cleanliness requirements.

3.24 Pre-cleaner. A pre-cleaner is any aqueous cleaning solution or cleaning solvent used to clean parts to visually clean. Examples include Navy oxygen cleaner (NOC), dissolved tribasic sodium phosphate (TSP), isopropyl alcohol, and non-ionic detergent (NID) mixed with water or NOC or TSP.

3.25 Sample. Sample is a representative amount of cleaning solvent, cleaning solution, rinse water, or pressurized gas collected in clean containers at selected locations obtained to verify the performance of the cleaning process.

3.26 Surfactant. A surfactant is a surface wetting agent which reduces interfacial tension between a liquid and a solid.

3.27 Validation. Validation is the demonstration of the ability to perform a technique or process with verifiable results at a regular interval.

3.28 Vendor. A vendor is any person not employed by the U.S. Navy that performs services as specified in this standard at a facility not owned or operated by the government.

3.29 Water. Water refers to water as specified in 4.2.

3.30 Wetted surface. A wetted surface is any surface that comes in direct contact with the system fluid.

4. GENERAL REQUIREMENTS

4.1 Oxygen safety precautions. Personnel involved with cleaning and testing systems defined in 1.2 shall be qualified as specified in 5.14. They shall also be familiar with the applicable safety precautions for cleaning and testing fluids as specified herein before conducting any work. The removal of organic and particulate contamination from oxygen and oxygen enriched systems is absolutely necessary to prevent a fire hazard. Failure to thoroughly clean oxygen systems has resulted in catastrophic fires. Additionally, failure to use approved cleaners has resulted in the introduction of flammable and toxic contaminants that have resulted in personnel injury. While working with oxygen clean systems the safety precautions in accordance with NAVSEA S9086-SX-STM-010/CH-550 shall be observed.

4.2 Water.

4.2.1 Applicability. Three grades of water, A, B, and C, in descending order of purity, are associated with preparing and diluting cleaning solutions, flushing, rinsing, and testing, and are defined in Table I. Water purity requirements specified throughout this standard are minimum requirements and do not preclude the use of water of greater purity.

TABLE I. Grades of water.

Item	Grade		
	A 1/	B 1/	C 2/
Chloride ion, maximum, ppm	0.1	1.0	35
Conductivity, maximum, micromhos/cm 3/	2.5	20	550
Resistivity, minimum, ohms-cm 3/	400K	50K	1.8K
pH range 4/	6.0 to 8.0	-	-
Visual clarity	No turbidity, oil, or sediment		

NOTES:
1/ Demineralized water meeting the requirements of ASTM D1193, Type II, satisfies Grade A or B requirements.
2/ Potable water and municipal water generally meet Grade C requirements.
3/ Measure either conductivity or resistivity; resistivity is the inverse of conductivity.
4/ When the conductivity of Grade A water is 0.25 micromhos/cm or less, pH measurements are not required.

4.2.2 Disposal. Disposal of water shall be in accordance with local, state, and federal regulations.

4.2.3 Compatibility. Appendix A gives the compatibility of hot water with various materials. Where incompatibility exists, process changes such as rinsing with cooler water, shorter rinse durations, or immediate drying of wet surfaces may need to be considered. Where specific information is lacking, perform compatibility testing as specified in A.3.1 of Appendix A.

4.3 Aqueous cleaning solutions.

4.3.1 Navy oxygen cleaner (NOC).

4.3.1.1 Applicability. NOC is an aqueous alkaline cleaning solution approved for use as a pre-cleaner or final cleaner for all compatible piping and components other than liquid oxygen generating plants. It may be used for liquid oxygen generating plant piping and components provided the aqueous cleaning process specified herein can be successfully accomplished. NOC shall be in accordance with MIL-DTL-24800.

4.3.1.2 Safety precautions. Follow the safety precautions recommended in the vendor's material safety data sheet (MSDS) and the following precautions recommended by the Navy Environmental Health Center (NEHC).

a. Skin contact with NOC will result in irritation and chemical burns. Wear impervious protection clothing constructed of neoprene or other material of equivalent resistance to penetration so as to prevent skin contact. Use elbow-length gloves (with cuffs) as minimum protection any time open containers of the cleaning agent are handled. Wash potentially exposed skin areas with soap and water at breaks, and at the conclusion of the operation. Do not use organic solvents for this purpose. Thoroughly clean protective garments at the conclusion of the operation and store for reuse. Remove clothing which becomes contaminated as soon as possible and thoroughly clean before reuse. Seek prompt medical assistance should a rash, chemical burn, or other adverse effect be experienced which may be related to working with NOC. Do not store or consume food and tobacco in areas where they could be contaminated with NOC.

b. Eye contact with NOC could result in chemical burns. Wear chemical safety goggles for all operations where eye contact with NOC could occur. Additionally, use a full-length face shield for any operation where splashing of the material could occur. In the event of eye contact, personnel should flush their eyes thoroughly with fresh water for not less than 15 minutes, then seek prompt medical attention. An eye wash system conforming to the design requirements of the American National Standards Institute (ANSI) Z358.1 shall be in the immediate vicinity of all operations. Eye wash systems shall provide not less than 15 minutes of water for emergency flushing.

c. Over exposure to mists or vapors from NOC may result in sneezing, coughing, respiratory system irritation, and possibly chemical burns and subsequent edema in the upper airways. Based on off-gas testing at temperatures up to 180 degrees Fahrenheit (°F), such a possibility is unlikely, considering the magnitude and frequency of use. In the event any adverse health effects are experienced, cease operations involving NOC and consult the cognizant medical department representative for additional guidance.

4.3.1.3 Disposal. Disposal of NOC shall be in accordance with local, state, and federal regulations. If neutralizing NOC, dilute at least 4:1 with water before adding acid to prevent forming a precipitate.

4.3.1.4 Compatibility. Appendix A gives the compatibility of NOC with various materials. Where specific information is lacking, perform compatibility testing as specified in A.3.1 of Appendix A. NOC used to clean aluminum or anodized aluminum shall be diluted 50 percent with water as specified in 4.3.1.6.

4.3.1.5 Inspection prior to use. The following inspections shall be performed prior to using NOC.

a. A shake test as specified in 5.13.2.2 and a visual inspection as specified in 5.13.3.2 shall be performed. NOC which fails either inspection due to the presence of oil shall be rejected and returned to the vendor. NOC which fails the visual inspection due to the presence of particulate or fiber shall be either filtered with a 5 micrometer nominal or finer filter to remove the suspended particulate or fiber or rejected and returned to the vendor.

b. Activities verifying cleanliness using the non-volatile residue (NVR) by filtration procedure of Appendix B shall sample one container or drum of each NOC lot or batch to determine the background NVR. NOC from different lots or batches may be sampled from storage tanks, such as flushing rigs, to determine the background NVR. For NOC fresh from a container, drum, or tank which has not been used, the baseline NVR shall be no greater than 10 milligrams per liter (mg/L). NOC with greater than 10 mg/L NVR shall be rejected and returned to the vendor or filtered with a 5 micrometer or finer filter and verified less than 10 mg/L NVR prior to use.

c. Government purchases of NOC are origin inspected, origin accepted with a Certificate of Analysis for each lot maintained by the Defense Logistics Agency. Vendors purchasing NOC should request a Certificate of Analysis with each delivery. Any NOC returned to a vendor because of a quality deficiency shall be noted (see 6.3).

4.3.1.6 Dilution. NOC shall be diluted as follows:

a. Concentration: NOC can be diluted with water up to 50 percent. NOC shall be diluted 50 percent with Grade A or B water when cleaning aluminum or anodized aluminum.

b. Water quality: The preferred quality of water is 5 micrometer nominal or finer filtered Grade A water. For long term use in cleaning equipment, such as an ultrasonic cleaning tank, parts washer, or flushing rig, Grade B water may be used with a 1 micrometer nominal or finer filter installed. For short term use, such as a few hours, Grade B water may be used with no filter.

c. Order for mixing: In order to yield a more stable solution which will extend the life of the cleaner, water should be added to NOC rather than adding NOC to water.

4.3.1.7 Use of NOC in previously used equipment. For cleaning equipment previously used with other than NOC, the following actions should be taken to minimize and evaluate for the possibility of the NOC reacting with the residue left behind.

a. Fill the cleaning equipment with NOC diluted 25 to 50 percent with Grade B water.

b. Operate the cleaning equipment covered for 4 hours at 140 to 160 °F.

c. Visually inspect the NOC for foam and precipitate. Visually inspect the equipment for milky white deposits. Some white deposits at the fluid-air boundary are acceptable.

d. If precipitate is visible in the NOC, the NOC foams, or milky white deposits are visible on the equipment in areas continuously wetted with NOC, discard the NOC solution, remove the deposits as specified in 4.3.1.7(e), and repeat the process.

e. Deposits can be removed by soaking in hot water, or soaking and scrubbing with commercial white vinegar or a warm (up to 110 °F) 10 to 16 percent citric acid solution followed by a water rinse. A 10 to 16 percent citric acid solution can be prepared by adding 12 to 20 ounces of powdered citric acid (CAS No. 77-92-9) to one gallon of water.

4.3.1.8 Use for extended periods. Extended use of NOC should be in covered equipment to minimize evaporation. NOC can be recycled using filtration, and continuously used or reused, provided the following conditions are satisfied:

a. A shake test as specified in 5.13.2.2 reveals no excessive foam.

b. A visual inspection as specified in 5.13.3.2 reveals no particulate, fiber, or oil.

c. A hydrocarbon or NVR inspection as specified in 5.13.2 reveals less than 5 parts per million (ppm) above baseline.

d. An alkalinity test as specified in 5.13.5 indicates a satisfactory result. As the alkalinity of NOC is depleted in use, the volume of NOC required to obtain the blue end-point specified in 5.13.5 increases. When the alkalinity test measures 35 to 40 milliliters (mL) of NOC, the NOC is at risk of developing an insoluble precipitate. The NOC should either be replaced, or a portion of the low alkalinity NOC removed and replaced with fresh NOC to restore alkalinity. If evaporation concentrates the NOC causing the alkalinity test to measure less than 10 mL of NOC, the NOC should be diluted with water as specified in 4.3.1.6 to restore the alkalinity to a nominal measured range of 15 to 30 mL of NOC. Do not attempt to adjust the alkalinity of 50 to 100 percent concentrated NOC by adding acid; an immediate gel or precipitate will develop. Alkalinity of NOC in use or stored in cleaning equipment should be checked weekly until the alkalinity test measures about 30 mL of NOC. Then, more frequent analysis should be performed to ensure an insoluble precipitate does not form.

4.3.1.9 Filtration. For long term use in cleaning equipment such as large ultrasonic tanks or parts washers, a filter sized at about 1-micrometer nominal should be installed. For use in a flushing rig, a 5-micrometer nominal or finer filter shall be installed, and it is recommended that a filter sized at about 1-micrometer nominal be installed. A 5-micrometer filter prevents introducing significant contamination back into the system. A 1-micrometer filter allows recycling and extending the use of NOC. It is also recommended that for flushing applications, a strainer be installed upstream of the filter to remove large debris that can prematurely clog the filter. Filters used for the first time shall be checked for extractable organic material by recirculating with clean NOC at 140 to 160 °F for not less than 1 hour and then verifying organic cleanliness as specified in 5.13.2. Checking for extractable organic material of filters is not required for filters from the same vendor and of the same material that previously tested satisfactorily. A suitable filter material is thermally bonded, pleated polypropylene containing no plasticizer or adhesive. The major advantage of disposable polypropylene filter cartridges is ease of use. Cleaning stainless steel reusable filters can be difficult and time consuming. The large soil holding capacity of disposable filter cartridges can often balance the cost of using smaller soil holding capacity stainless steel filters requiring frequent cleaning. Filter housings should be configured with a vent on the top of the housing to allow removing oil that has separated from the NOC. Verify with the manufacturer that the temperature, pressure, and flow ratings of any filters are adequate for the intended application. Disposal of used filters or separated oil shall be in accordance with local, state, and federal regulations.

4.3.1.10 Stowage. NOC should be stored in covered containers to minimize evaporative losses. Stowage of heated NOC for several days should only be in corrosion resistant metal, Teflon, or Teflon lined glass containers. Long term stowage of heated NOC in plastic (other than Teflon), rubber, or glass containers will result in cleaner degradation. Unheated NOC may be stowed in plastic or plastic lined containers provided the container has been checked for extractable organic material. This is accomplished by filling the container with NOC for not less than 10 days and verifying organic cleanliness as specified in 5.13.2. Checking for extractable organic material of containers is not required for containers from the same vendor and of the same material that previously tested satisfactorily. Experience indicates that NOC can be successfully stored in aged uncolored or clear high density polyethylene (HDPE) or polypropylene plastic containers. NOC can also be stored in steel containers having an unplasticized low density polyethylene (LDPE) liner which is not adhesively bonded to the steel container similar to A-A-58020. Stowage of NOC in colored plastic containers may contaminate the cleaner and adversely affect the NVR analysis results. NOC allowed to dry on glass will result in a hard insoluble residue. Wide mouth glass sample bottles with external safety coatings and Teflon lined caps are acceptable, as are sampling containers manufactured from Teflon, Teflon lined glass, Teflon lined plastic, or stainless steel. Bulk shipboard stowage of NOC shall be in accordance with NAVSEA S9086-WK-STM-010/CH-670 for alkalies.

4.3.2 Tribasic sodium phosphate (TSP).

4.3.2.1 Applicability. TSP is a solid crystalline material mixed with water to prepare an aqueous alkaline cleaning solution approved for use as a pre-cleaner or final cleaner for all compatible piping and components other than liquid oxygen generating plants. It may be used for liquid oxygen generating plant piping and components provided the aqueous cleaning process specified herein can be successfully accomplished. TSP shall be in accordance with O-S-642, Type I or II, or equal. Type II is recommended because it is less susceptible to precipitation.

4.3.2.2 Safety precautions. Follow the safety precautions recommended in the vendor's material safety data sheet and the following:

a. TSP is a solid, crystalline material which has a caustic action on skin, eyes, and mucous membranes. Repeated or prolonged contact with the solid material or its solution shall be avoided.

b. Skin contact with TSP will result in irritation of the skin, including redness and burning of the skin, and other skin damage. Wear impervious protection clothing (gloves, aprons or coveralls, boots) constructed of neoprene or other material of equivalent resistance to penetration so as to prevent skin contact. If skin contact occurs, exposed areas shall be washed with large amounts of fresh water. Remove clothing which becomes contaminated as soon as possible and launder before reuse. If skin is damaged, seek immediate medical attention. If skin is not damaged and symptoms persist, seek medical attention. If irritating dust or solution mist is present, approved respirators shall be worn to avoid inhalation.

c. Eye contact with TSP could result in permanent eye injury, including injury of the cornea causing blindness. Symptoms include stinging, tearing, redness, and swelling of eyes. Wear chemical safety goggles for all operations where eye contact with TSP could occur. Additionally, use a full-length face shield for any operation where splashing of the material could occur. In the event of eye contact, personnel should flush their eyes thoroughly with fresh water for not less than 15 minutes, then seek prompt medical attention. An eye wash system conforming to the design requirements of the ANSI Z358.1 shall be in the immediate vicinity of all operations. Eye wash systems shall provide not less than 15 minutes of water for emergency flushing.

d. In the event any adverse health effects are experienced, cease operations involving TSP and consult the cognizant medical department representative for additional guidance.

4.3.2.3 Disposal. Disposal of TSP shall be in accordance with local, state, and federal regulations.

4.3.2.4 Compatibility. Appendix A gives the compatibility of TSP with various materials. Where specific information is lacking, perform compatibility testing as specified in A.3.1 of Appendix A.

4.3.2.5 Solution preparation. Prepare the TSP cleaning solution by dissolving 2 pounds of Type I or 4.5 pounds of Type II TSP with 5 gallons of Grade B water at 160 to 180 °F. In order to prevent a violent reaction and to more completely mix the TSP, add the TSP to the water; do not add water to the TSP. The solution shall be circulated until the TSP is dissolved prior to exposing the solution to a system or component.

4.3.2.6 Stowage. If a TSP stowage tank is not large enough, do not mix a solution stronger than as specified in 4.3.2.5 and attempt to dilute it in the piping system. Failure to maintain the temperature of a solution stronger than as specified in 4.3.2.5 at 160 to 180 °F can result in the TSP precipitating and developing a harden mass. This hardened mass is difficult, if not impossible, to remove. The preferred stowage tank material is stainless steel. Bulk shipboard stowage of TSP shall be in accordance with NAVSEA S9086-WK-STM-010/CH-670 for alkalies.

4.3.3 Non-ionic detergent (NID).

4.3.3.1 Applicability. NID is a concentrated non-ionic hydrocarbon surfactant that is mixed with water, NOC, or TSP solutions to prepare an aqueous detergent cleaning solution acceptable for use as a pre-cleaner. NID shall be in accordance with MIL-D-16791, Type I, or commercial equivalent, such as Triton X-100.

4.3.3.2 Safety precautions. Follow the safety precautions recommended in the vendor's material safety data sheet (MSDS). In the event any adverse health effects are experienced, cease operations involving NID and consult the cognizant medical department representative for additional guidance.

4.3.3.3 Disposal. Disposal of NID shall be in accordance with local, state, and federal regulations.

4.3.3.4 Compatibility. Appendix A gives the compatibility of NID solutions with various materials. The compatibility of solutions of NID with NOC or TSP shall refer to the respective compatibility tables for NOC or TSP specified in Appendix A. If necessary, perform compatibility testing as specified in A.3.1 of Appendix A.

4.3.3.5 Solution preparation. Prepare NID solution by adding 0.1 to 0.5 ounces of NID to each gallon of water. Prepare NOC and NID solution by adding 0.1 to 0.5 ounces of NID to each gallon of NOC diluted 50 percent with water. Prepare TSP and NID solutions by adding 0.1 to 0.5 ounces of NID to each gallon of water containing 8 to 12 ounces of TSP. NID solutions shall be used at temperatures not greater than 140 °F. At temperatures greater than 140 °F, the solubility of NID will decrease leading to possible precipitation of NID.

4.4 Cleaning solvents.

4.4.1 NAVSEA approved halogenated solvents.

4.4.1.1 Applicability. A NAVSEA approved halogenated solvent, as specified in Appendix E, shall be used as a final cleaner for instruments as specified in 5.4, for liquid oxygen generating plants and plant piping as specified in 5.8, and for field wipe as specified in 5.10.1.1 and 5.12.4. Use of a NAVSEA approved halogenated solvent for any other application requires local engineering, environmental, and industrial hygiene approval.

4.4.1.2 Safety precautions. For any NAVSEA approved halogenated solvent, follow the safety precautions recommended in the vendor's material safety data sheet and the following:

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 a halogenated solvent is being transferred by hose or pipe from a remote location, 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 a halogenated solvent are taking place or occupied spaces where leaks may occur while systems containing halogenated solvents 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 concentration 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 caused by oxygen being washed from 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 during overhaul in a shipyard, hot work may be performed on board a ship while systems are being flushed (not pressure tested) with halogenated solvents if each operation is authorized by a gas free engineer. Personnel shall be instructed to leave the area immediately if anyone experiences any irritation of the eyes, nose, or throat. During specially authorized hot work, self-contained breathing devices for emergency escape are 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:

WARNING

HALOGENATED SOLVENT OPERATION; DO NOT ENTER UNOCCUPIED SPACE WITHOUT FIRST TESTING FOR SOLVENT; NO HOT WORK OR OPEN FLAMES 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 5.8.3.2).

f. Chemical safety goggles shall be worn where eye contact is possible. A full-length face shield shall be worn over chemical safety goggles for any operation where splashing of the solvent may be a problem. In the event of eye contact, personnel should flush their eyes thoroughly with fresh water for not less than 15 minutes, then seek prompt medical attention. An eye wash system conforming to the design requirements of the American National Standards Institute (ANSI) Z358.1 shall be in the immediate vicinity of all operations. Eye wash systems shall provide not less than 15 minutes of water for emergency flushing.

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 saturated with solvent should be removed at once.

h. The atmosphere in the space where the solvent is used shall be continuously monitored. An alarm shall be set on the instrument which will be activated when the solvent reaches its recommended exposure criteria. The concentration of the solvent shall not be allowed to exceed the recommended exposure criteria 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 self-contained breathing apparatus operated in a pressure-demand mode.

i. An industrial hygienist, gas-free engineer, gas-free person, or other designated individual shall verify that ventilation in the space is adequate to keep the concentration of the solvent below the recommended exposure criteria during anticipated operations, excluding accidents or spills. If necessary use portable blowers. Exhaust ventilation is preferable to blowing air into the space. Solvent vapors should be captured as close as possible to the point of generation and discharged outside of the area in a manner that precludes recirculation and exposure to other personnel.

j. In the event any adverse health effects are experienced, cease operations involving halogenated solvents and consult the cognizant medical department representative for additional guidance. Should someone be overcome in a space which lacks oxygen or because of the presence of a high solvent vapor concentration, the person should be removed immediately and given artificial respiration if necessary.

WARNING

SINCE HALOGENATED SOLVENTS MAY CAUSE CARDIAC SENSITIZATION, THE ATTENDING PHYSICIAN SHALL NOT ADMINISTER AN INJECTION OF EPINEPHRINE OR SIMILAR HEART STIMULANT AS CARDIAC ARRHYTHMIA, INCLUDING VENTRICULAR FIBRILLATION, MAY RESULT. THE PATIENT SHOULD BE GIVEN FRESH AIR IMMEDIATELY AND SHOULD NOT BE ALLOWED TO EXERT HIMSELF OR HERSELF.

k. When drying with nitrogen, solvent vapors and nitrogen shall be externally vented away from populated areas. If this cannot be accomplished, a gas-free engineer shall be consulted. It may be necessary to use an oxygen monitor to ensure there is not an excessive dilution of oxygen in the air.

l. Emergency rescue procedures shall be established and proficiency documented to ensure that personnel can be safely removed in the event of hazardous exposures.

m. Halogenated solvents used in contact with Diver Life Support Systems shall be completely drained and placed in an oven or heated to ensure all solvent is volatilized and removed before assembly, test, and operation. Air samples as specified in 5.9.3 are required to confirm removal of all solvent.

4.4.1.3 Disposal. Disposal of NAVSEA approved halogenated solvents shall be in accordance with local, state, and federal regulations. Used or contaminated halogenated solvent should be reclaimed for use by distillation or other appropriate method and inspected as specified in applicable specifications (see 6.3).

4.4.1.4 Compatibility. Appendix E gives the compatibility of NAVSEA approved halogenated solvents with various non-metallic materials. Where specific information with respect to compatibility is lacking, perform compatibility testing as specified in A.3.1 of Appendix A.

4.4.1.5 Use of NAVSEA approved halogenated solvents. Follow the instructions provided by the vendor and as directed herein.

4.4.1.6 Water previously used in systems. Many halogenated solvents will react with water forming corrosive acids. Systems previously known or believed to contain water or aqueous cleaning solutions shall be purged with nitrogen as specified in 4.7.3. An outlet dew point of minus 40 °F shall be obtained prior to introducing a halogenated solvent.

4.4.2 Isopropyl alcohol.

4.4.2.1 Applicability. Isopropyl alcohol (IPA) is an approved cleaning solvent for use only as a pre-cleaner for compatible materials. IPA shall not be used as a pre-cleaner for Teflon which will be wetted by an oxygen-enriched fluid. IPA should be in accordance with TT-I-735 or equal. IPA is soluble in water and commercial grades can have as much as 30 percent water.

4.4.2.2 Safety precautions. Follow the safety precautions recommended in the vendor's material safety data sheet and the following:

a. IPA is a volatile hydrocarbon solvent with a boiling point of about 180 °F. IPA is extremely flammable having a flash point of 56 °F. IPA vapors are toxic having a recommended 8-hour time weighted average exposure criteria of 400 ppm. Ingestion of IPA will cause burning of the gastrointestinal tract, nausea, vomiting, bleeding, central nervous system (CNS) depression, hemolysis, and pulmonary damage. Ingestion of as little as 10 mL may cause serious injury, while ingestion of 240 mL can be fatal.

b. An industrial hygienist, gas-free engineer, gas-free person, or other designated individual shall verify that ventilation in the space is adequate to keep the concentration of the solvent below the recommended exposure criteria during anticipated operations, excluding accidents or spills. Use caution when ventilating IPA vapors since the vapors are flammable. Explosion-proof equipment may be necessary.

c. IPA is absorbed by non-metallic material, such as Teflon, and unless carefully dried may off-gas flammable and toxic material. Commercial grades of IPA, including TT-I-735, will leave a residue that may be flammable in an oxygen enriched atmosphere.

d. In the event any adverse health effects are experienced, cease operations involving IPA and consult the cognizant medical department representative for additional guidance.

4.4.2.3 Disposal. Disposal of isopropyl alcohol shall be in accordance with local, state, and federal regulations.

4.4.2.4 Compatibility. Where specific information with respect to compatibility is lacking, perform compatibility testing as specified in A.3.1 of Appendix A.

4.5 Other cleaners.

4.5.1 Other pre-cleaners. Any compatible aqueous cleaning solution or cleaning solvent may be used as a pre-cleaner with local engineering and environmental approval. Directions for use, safety precautions, disposal, and compatibility are the responsibility of the approving activity. For all Naval activities, review by the cognizant medical department or industrial hygienist shall be obtained prior to locally approving the use of any aqueous cleaning solution or cleaning solvent other than those specified in 4.3 or 4.4.

4.5.2 Other final cleaners. No aqueous cleaning solutions other than TSP solutions, or MIL-DTL-24800 compositions shall be used as a final cleaner. Other than the NAVSEA approved halogenated solvents, approval shall be obtained prior to using any other cleaning solvent as a final cleaner (see 6.3). Activities interested in obtaining approval of other final cleaning solvents or processes shall obtain direction (see 6.3).

4.6 Incompressible test fluids.

4.6.1 Safety precautions. An incompressible fluid, either water or NAVSEA approved halogenated solvent, shall be used to hydrostatically test systems or components. Incompressible test fluids shall be used at room temperature. Over- pressure protection shall be used when testing with an incompressible fluid. Incompressible fluids can easily generate very high pressures if heated and not vented. Any use of a NAVSEA approved halogenated solvent shall be as specified in 4.4. Unless otherwise specified, testing with incompressible fluids shall be in accordance with NAVSEA S9086-RK-STM-010/CH-505.

4.6.2 Water. Grade B water shall be the preferred hydrostatic test fluid for any system or component that can be cleaned with an aqueous cleaning solution. For oxygen clean systems or components, Grade B water filtered to 10 micrometers nominal, or finer, shall be used to prevent contamination. Grade A water filtered to 10 micrometers nominal, or finer, shall be used to tightness test the demineralized water system.

4.6.3 Cleaning solvent. A NAVSEA approved halogenated solvent shall be the preferred hydrostatic test fluid for any system or component that is final cleaned with a cleaning solvent. For oxygen clean systems or components, a NAVSEA approved halogenated solvent filtered to 10 micrometers nominal, or finer, and having a hydrocarbon or NVR level less than 5 ppm, determined as specified in 5.13.2, shall be used to prevent contamination.

4.7 Compressible test fluids.

4.7.1 Safety precautions. Inert gases, such as argon, helium, and nitrogen although not toxic, will not support human respiration and can cause asphyxiation. Accumulation of these gases in small or closed spaces can reduce the oxygen concentration below the normal level of 20 to 22 percent. Ensure adequate ventilation is provided to maintain the oxygen levels within normal levels. If doubt exists, an oxygen monitor with alarm set at 19.5 percent shall be used to monitor the area (see 6.4). Any use of oxygen shall be as specified in 4.1. Unless otherwise specified, testing with a gas shall be in accordance with NAVSEA S9086-RK-STM-010/CH-505.

4.7.2 Helium. Helium shall be the preferred test gas for helium and helium-oxygen components and systems when performing tightness tests. Helium or nitrogen are the preferred purge gases for all applications. Helium shall be in accordance with MIL-PRF-27407, Type I, Grade B. Helium shall be filtered to 10 micrometers nominal or less. Helium may be used in place of nitrogen for tightness testing with local engineering approval. However, note that helium may leak past mechanical joints or seats so that systems that are tight with nitrogen may demonstrate leakage when tested with helium. If residual helium in a system will present a problem, it shall be purged with the appropriate gas as required.

4.7.3 Nitrogen. Nitrogen shall be the preferred drying gas for all applications and test gas for hydrogen, oxygen, and nitrogen systems and components when performing tightness tests. Nitrogen or helium are the preferred purge gases for all applications. Nitrogen shall meet, by vendor or laboratory statement of conformance, the requirements of A-A-59155, Grade A or B, or MIL-PRF-27401, Type I, Grade B or C, or CGA G-10.1, Grade L or M. Nitrogen shall be filtered to 10 micrometers nominal or less. If residual nitrogen in a system will present a problem, it shall be purged with the appropriate gas as required.

4.7.4 Oxygen. Oxygen shall only be used in a system or component specifically designed and cleaned for oxygen service. When effected joints can be continuously monitored for leakage, oxygen may be used for tightness testing with local engineering approval. No other use of oxygen for tightness testing shall be permitted.

4.7.5 Argon. When argon is specified to support welding, it is an acceptable purge gas. Argon shall meet, by vendor or laboratory statement of conformance, the requirements of MIL-PRF-27415, Type I, Grade A. Argon shall be filtered to 10 micrometers nominal or less. If residual argon in a system will present a problem, it shall be purged with the appropriate gas as required.

4.8 Cleaning silver-brazed piping. For systems with new silver-brazed joints, residual silver-brazing flux shall be prevented or removed by one of the following procedures:

a. Systems cleaned with a NAVSEA approved halogenated solvent can either be brazed using the low flux procedure in accordance with NAVSEA S9086-CH-STM-010/CH-074, Volume 1, or the joint can be locally cleaned to remove the brazing flux. Halogenated solvents are not effective in removing brazing flux and systems cleaned with halogenated solvents can not be soaked or flushed with water to remove residual flux due to difficulties in drying the system.

b. For systems that will be cleaned with a NOC or TSP aqueous oxygen cleaning process, residual brazing flux can be removed in accordance with NAVSEA 0900-LP-001-7000 prior to cleaning, or residual brazing flux can be removed with the aqueous oxygen cleaning process. In either case, the brazing flux shall be removed prior to the hydrostatic test. When using an aqueous oxygen cleaning process to remove brazing flux from copper tubing, NOC is preferred because it does not discolor copper like TSP.

c. For systems that will be cleaned with water such as the boundary defined by 1.2.2.4, remove residual brazing flux in accordance with NAVSEA 0900-LP-001-7000, and then clean as specified herein.

4.9 Lubricants. Lubricants shall be oxygen compatible in accordance with NAVSEA S9086-H7-STM-010/CH-262 (see 6.3). During reassembly, lubricants shall be used sparingly. Direct contact of a lubricant with an oxygen or oxygen enriched atmosphere should be avoided. Excessive quantities of lubricant can trap particulate and other contaminants developing a potential fire hazard. Avoid the use of fluorinated lubricants with aluminum and magnesium under conditions of large shear such as threaded connections. Ignition of fluorinated lubricants has occurred in these applications.

5. DETAILED REQUIREMENTS

5.1 Facility requirements. Unless otherwise specified, the cleaning of components and assembling, testing, and packaging of components cleaned as specified in this standard shall be performed in a cleanroom. A general exception is nitrogen-oxygen life support components wetted by not greater than 50 percent by volume oxygen and demineralized water system components which can be cleaned, assembled, tested, and packaged in a controlled area. Other operations, including removal, replacement, and repair of piping and components cleaned as specified in this standard, shall be performed in either a cleanroom or controlled area unless otherwise specified in Table IX. Cleanroom and controlled area requirements shall be as specified in Table II and 5.1.1 through 5.1.7.

TABLE II. Cleanroom and controlled area requirements.

Attribute	Requirement	Critical cleanroom [1/]	General cleanroom	Controlled area
Structure	5.1.1	Class A	Class B	Class C
Maintenance	5.1.2	Class A	Class B	Class C
Average air temperature	5.1.3	72±5 °F	72±10 °F	Uncontrolled
Average relative humidity	5.1.3	30 to 50%	70% maximum	Uncontrolled
Air filtration	5.1.4	Type A	Type B	Type B
Ventilation and air pressure	5.1.5	Class A	Class B	Class C
Personnel clothing	5.1.6	Class A	Class B	Class C
Tools and equipment	5.1.7	-	-	-

NOTE:
[1/] A cleanroom in accordance with ISO 14644-1 and 14644-2, Class 8, shall be used for critical applications. For all other applications, a general cleanroom shall be used.

5.1.1 Structure.

5.1.1.1 Class A. Class B requirements shall apply. Additionally, best commercial practices shall be employed in the use of materials, construction, filtration, clothing, personnel, and temperature, pressure, and humidity control to achieve an airborne particulate cleanliness level equivalent to ISO 14644-1 and 14644-2, Class 8, or better. Refer to MIL-HDBK-407 for additional guidance.

5.1.1.2 Class B.

a. A permanent enclosure comprised of a rigid frame with clearly defined walls, ceilings, and floor, all adequate to prevent the entry of contamination from the surrounding environment.

b. The surface of the walls, ceiling, and floor shall be fabricated or coated with material that minimizes attraction of dirt and is easily cleaned. Refer to MIL-HDBK-407 for additional guidance.

c. Where dirt may be brought into the clean area, preventative measures such as anterooms, shoe covers, or tack mats shall be employed. Anterooms should provide for changing and stowing of clothing, examination of tools and equipment, and personnel access to the clean area. Washing, toilet facilities, and storage facilities for maintenance of equipment should be provided in the immediate area where desirable.

d. Furnishings and equipment such as work benches, chairs, and racks shall be constructed and finished with materials that will not produce dust or particulate as a result of chipping, flaking, or rusting. Paint should be hard and non-flaking or non-chalking. Furnishings likely to be abraded or bumped should be constructed of either stainless steel or non-fracture type plastic. Refer to MIL-HDBK-407 for additional guidance.

e. Work that produces airborne dust, dirt, or particulate should not be performed in a cleanroom. Welding and brazing shall not be performed in a cleanroom.

5.1.1.3 Class C. Air borne debris or contamination resulting from work accomplished in the controlled area shall be eliminated before redesignation as a controlled area. Depending on the time and work involved for a particular operation, a controlled 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. The clean-tent shall be established by taping clean, unused, polyethylene plastic sheets in accordance with MIL-PRF-22191, Type I, or equal, 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 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.

5.1.2 Maintenance.

5.1.2.1 Class A. Class B requirements shall apply. Additionally, when specified, a particle count of the laminar flow benches and each clean area should be accomplished daily.

5.1.2.2 Class B.

a. Complete cleaning and wipe-down of equipment, tools, workbenches, counters, table tops, and fixtures with detergent such as NID specified in 4.3.3, or commercial equivalent, and vacuuming and mopping of the floor shall be accomplished at the end of each 8 hours of operation and prior to use if greater than 24-hours has passed since the cleanroom was last used.

b. Complete cleaning and wipe-down of the walls, floors, and ceiling with detergent such as NID specified in 4.3.3, or commercial equivalent, shall be accomplished monthly.

c. The average air temperature and average humidity in a cleanroom shall be measured daily.

d. Air filters shall be cleaned or replaced at regular intervals.

e. Oil, grease, residue, spilled chemicals, and any foreign material which develop in the area shall be cleaned immediately. Chips, particles, and dust generated during any operation shall be removed during the operation by vacuum.

f. No eating, drinking, smoking, or personnel grooming is allowed. Drinking fountains are permissible.

g. Only oxygen approved lubricants as specified in 4.9 shall be stored and used. Items incompatible with oxygen such as hydrocarbon oil and grease and wood shall not be stored or used.

5.1.2.3 Class C.

a. Complete cleaning and wipe-down of equipment, tools, work surfaces, and fixtures with detergent such as NID specified in 4.3.3, or commercial equivalent, and vacuuming and mopping of the floor, if applicable, shall be accomplished at the end of each 8 hours of operation and prior to use if greater than 24 hours has passed since the controlled area was established.

b. Air filters, if installed, shall be cleaned or replaced at regular intervals.

c. Oil, grease, residue, spilled chemicals, and any foreign material which develop in the controlled area shall be cleaned immediately. Chips, particles, and dust generated during any operation shall be removed during the operation by vacuum.

d. No eating, drinking, smoking, or personnel grooming is allowed. Drinking fountains are permissible.

e. Only oxygen approved lubricants as specified in 4.9 shall be stored and used. Items incompatible with oxygen such as hydrocarbon oil and grease and wood shall not be stored or used.

5.1.3 Temperature and humidity. The temperature and humidity ranges indicated are recommendations only. Exceeding the recommended ranges may result in personnel discomfort, build-up of static charges if the humidity drops below 30 percent, or rusting of equipment and the enclosure if the humidity exceeds 50 percent. More stringent requirements may apply if other work, such as calibration, is being performed.

5.1.4 Air filtration.

5.1.4.1 Type A. The best commercial practice employing items such as high efficiency particulate air (HEPA) filters shall be used to achieve and maintain the airborne particulate cleanliness level as specified in Table II, footnote 1/.

5.1.4.2 Type B. Outside and recirculated air shall be filtered to remove dust particles. Filter nominal rating shall be less than 10 micrometers.

5.1.5 Ventilation and air pressure.

5.1.5.1 Class A. The cleanest room should have a positive pressure of not less than 0.05 inches of water above the ambient pressure. A differential pressure of not less than 0.01 inches of water should exist between any enclosure within the cleanroom and any adjacent area of lesser clean requirements.

5.1.5.2 Class B. The ventilation air supply shall maintain a slight positive pressure so that the air flow will always be outward from the clean area.

5.1.5.3 Class C. Ventilation shall be employed as necessary to prevent the entry of contaminants from surrounding areas and to keep the concentration of any solvent in use not greater than its recommended exposure criteria. Fully contained uninhabited areas such as glove bags shall employ ventilation as necessary to prevent the introduction of contaminants.

5.1.6 Personnel clothing.

5.1.6.1 Class A. Strict control of personnel and their clothing is required to achieve and maintain a critical cleanroom. At a minimum, Class B requirements shall apply. Additional items such as full coveralls with hoods and booties, anti-static gloves, lint-free paper, and limitations on personnel with skin ailments and colds are generally employed. Refer to MIL-HDBK-407 for guidance in establishing the requisite additional personnel and clothing requirements.

5.1.6.2 Class B.

a. Clean undamaged coveralls or smocks, without buttons, exposed zippers, keys, and similar articles shall be worn by all personnel including visitors and observers. Clothing should not be worn open or worn outside of the cleanroom or controlled area.

b. Where dirt could be brought in from the outside, shoe covers shall be worn.

c. Clean items shall only be handled with clean gloves such as latex, vinyl, or polyethylene which are free of lint and powder. Gloves in contact with cleaning solvents or solutions shall be chemically resistant for personnel safety and to prevent spread of contamination to oxygen clean surfaces. Oxygen clean surfaces touched with bare hands shall be considered contaminated.

d. Special precautions shall be taken in the case of opened piping and components to prevent the introduction of loose articles such as buttons, jewelry, pens, coins, glasses, contact lenses, and hearing aids. Badges, where required to be worn, shall be securely fastened to the clothing.

5.1.6.3 Class C.

a. Clean undamaged clothing with firmly affixed buttons and zippers shall be worn by all personnel including visitors and observers.

b. Tack mats or shoe covers shall be used if dirt could be brought in from the surrounding area.

c. Clean items shall only be handled with clean gloves such as latex, vinyl, or polyethylene which are free of lint and powder. Gloves in contact with cleaning solvents or solutions shall be chemically resistant for personnel safety and to prevent the spread of contamination to oxygen clean surfaces. Oxygen clean surfaces touched with bare hands shall be considered contaminated.

d. Special precautions shall be taken in the case of opened piping and components to prevent the introduction of loose articles such as buttons, jewelry, pens, coins, glasses, contact lenses, and hearing aids. Badges, where required to be worn, shall be securely fastened to the clothing.

5.1.7 Tools and equipment. Tools and equipment brought into a cleanroom or controlled area shall be free of visible soil and particulate. Tools and equipment used in direct contact with oxygen clean surfaces shall be cleaned in accordance with this standard. Where the configuration of the tool or equipment prevents cleaning in accordance with this standard such as micrometers and dial indicators, all exposed surfaces shall be wiped clean with an approved final cleaning solvent or solution and inspected as specified in 5.13.1 for visual cleanliness.

5.2 Aqueous component cleaning process.

5.2.1 Applicability. This aqueous component cleaning process is applicable to items that can be fully immersed in the ultrasonic tank or parts washer specified in 5.2.3. Large components such as flasks shall be cleaned as specified in 5.3 (see 6.3).

5.2.2 Objective. The objective of the aqueous component cleaning process is to remove all visible soil and particulate during the pre-clean and rinse step as specified in 5.2.4 before proceeding to a final clean, verification, and rinse step as specified in 5.2.5. The objective of the final clean, verification, and rinse step is to apply an oxygen and life support safe cleaning agent to remove thin soil films and particulate that may remain after the pre-clean step and to verify the required cleanliness. An effective pre-clean step increases the probability of a successful final clean and verification step reducing overall process cost and time.

5.2.3 Material and equipment.

a. A supply of rinse water and associated equipment such as sinks, spray nozzles, and ultrasonic tanks.

b. A supply of compatible pre-cleaner as specified in 4.3, 4.4, or 4.5 and associated equipment such as brushes, sinks, spray nozzles, and ultrasonic tanks.

c. A supply of NOC or TSP final cleaner as specified in 4.3 in an ultrasonic tank or a parts washer as specified in 5.2.3(f).

d. A supply of nitrogen if used for drying.

e. An oxygen clean facility as specified in 5.1.

f. An ultrasonic cleaning tank of sufficient size to allow complete immersion of the component being cleaned. The tank shall be heated to 160 °F for NOC or 180 °F for TSP. Tanks using NOC should have a recirculating pump system and filter as specified in 4.3.1.9. The tank shall have a generator frequency of at least 25 kHz and a generator power per radiated surface of at least 3 watts/in^2. The power per radiated surface area can be determined by dividing the total generator power by the surface area of tank bottom or side where the generator transducers are located. For example, a tank of dimensions 12 inches by 12 inches by 11 inches deep with a 600 watt transducer mounted on the bottom has a power of 4.2 watts/in^2, or

A parts washer of sufficient size to completely contain the component being cleaned. The parts washer shall completely immerse the component in the cleaning agent and shall direct cleaning agent across or through the component at a fluid velocity of not less than 3 feet per second (ft/sec). The parts washer shall be heated to 160 °F for NOC or 180 °F for TSP. Parts washers using NOC should have a recirculating pump and filter selected as specified in 4.3.1.9.

g. Equipment to dry oxygen clean parts.

h. Equipment to perform the applicable analyses as specified in 5.13. This includes clean 1-liter containers as specified in Appendix B or C to obtain the required samples.

i. Packaging material as specified in 5.16.

5.2.4 Pre-clean and rinse. Pre-cleaning should be accomplished in a well ventilated area outside of the cleanroom as follows:

a. Each component shall be pre-cleaned using a compatible pre-cleaner and then rinsed with water until all visible soil, particulate, and cleaning agent is removed. Components shall be disassembled to achieve maximum cleanliness. Components which are visibly clean may eliminate the pre-clean step and proceed directly to the final clean, verification, and rinse step as specified in 5.2.5.

b. Rinsing of corrosion resistant metals such as stainless steel, nickel-copper (monel), and copper-nickel may use Grade C water provided temperatures are less than 140 °F. At higher temperatures, or where municipal water supplies leave undesirable deposits, Grade B water shall be used.

c. When using multiple pre-cleaners, rinse between each different pre-cleaner application to prevent any harmful reaction which may occur when different cleaning agents are combined.

d. When removing difficult soils such as heavy waterproof greases, silicone greases, and fluorinated greases, most pre-cleaners will have limited effectiveness if used without agitation in a soak or ultrasonic tank. Hand scrubbing is often the best alternative.

e. Components shall be dried if the delay between completion of pre-cleaning and start of final cleaning could result in the formation of rust or other oxides. Otherwise, no specific drying step is required prior to final cleaning.

5.2.5 Final clean, verification, and rinse. Final cleaning, verification, and rinsing shall be accomplished as follows:

a. Fully immerse components in an ultrasonic tank or parts washer filled with NOC at 140 to 160 °F or TSP at 160 to 180 °F.

b. Energize the ultrasonic tank or parts washer for 5 to 15 minutes. For components such as O-rings and valve seats, limit exposure to a maximum of 10 minutes.

c. Obtain a 500 to 600 mL sample of the used NOC or TSP in a 1-liter container and verify organic cleanliness as specified in 5.13.2. If any analysis fails, replace the final cleaner and repeat the final clean, verification, and rinse process. Do not wait for the results of 5.13.2 before proceeding to rinsing as specified in 5.2.5(d). When cleaning large quantities of parts on a regular basis or when cleaning with an automated process, statistical process control can be implemented (see 6.3). Statistical process control could entail, for instance, sampling every fourth batch. If the fourth batch fails, the previous three batches also fail and require recleaning.

d. Remove the component(s) from the ultrasonic tank or parts washer and immediately rinse with Grade B water in an ultrasonic tank, batch tank, or flowing water. The rinse water shall be not less than 110 °F for NOC and 120 °F for TSP. Continue rinsing until the effluent rinse water pH measured as specified in 5.13.4.2 is 8.0 or less, but rinse for not less than 30 seconds. The preferred rinse process consists of two rinses using an ultrasonic or batch tank as the first rinse followed by a batch tank or flowing water as the second rinse.

e. Obtain a sample of not less than 200 mL of the effluent rinse water and verify particulate cleanliness as specified in 5.13.3. If the particulate analysis of 5.13.3 fails, replace the rinse water if applicable and repeat the final rinse step.

5.2.6 Dry, reassemble, and package. Drying, reassembling, and packaging shall be accomplished in an oxygen clean facility as follows:

a. Components shall be dried until no moisture is visible using any method that does not result in loss of cleanliness. Ovens, vacuum ovens, dryers, heat guns, and dry filtered nitrogen have been successfully used. The method chosen for drying shall be verified oxygen clean during the validation process as specified in 5.15. Appropriate precautions shall be taken to prevent damaging components, gaskets, and seals from excessive heat. For components with inaccessible areas, drying to plus 20 °F dew point is acceptable.

b. During reassembly, use oxygen compatible lubricants as specified in 4.9 sparingly.

c. Components shall be packaged as specified in 5.16.

5.3 Flask cleaning and inspection.

5.3.1 Applicability. Flask cleaning and inspection is applicable to flasks in the boundaries defined in 1.2.

5.3.2 Material and equipment.

a. A supply of rinse water and associated equipment for rinsing flasks.

b. A supply of NOC or TSP final cleaner as specified in 4.3.

c. A supply of helium or nitrogen.

d. Equipment as required to perform visual inspection and clean the flask.

e. Equipment to perform the applicable analyses as specified in 5.13. This includes clean 1-liter containers to obtain the required samples.

f. Equipment as required to remove paint from flask surfaces.

g. A dew point indicator equal to the Ondyne Series 1400 Dewpoint Indicator or the MCM Dewluxe Model hygrometer capable of detecting a dew point of minus 40 °F (128 ppm H_2O).

5.3.3 Clean, verification, and rinse. Cleaning, verification, and rinsing should be accomplished in a controlled area with the flasks positioned vertically to facilitate drainage as follows:

a. Flasks final cleaned with a fill and recirculate process as specified in 5.3.3.(b) or 5.3.3.(c) shall be pre-cleaned as specified in 5.2.4 using a compatible pre-cleaner and then rinsed with water until all visible oil, grease, ink, dye, and cleaning agent is removed. Flasks final cleaned with a spray process as specified in 5.3.3.(b) or 5.3.3.(c), or flasks with no visual evidence of oil, grease, ink, or dye may eliminate the pre-clean step and proceed directly to final clean.

b. If final cleaning flask interior surfaces with NOC, apply NOC at not less than 120 °F for a time sufficient to ensure all wetted surfaces are in contact with the cleaner for not less than 10 minutes if using a spray process or at 150 to 170 °F for not less than 30 minutes if using a fill and recirculate process. Use of sprayers with high flow and low pressure or low flow and high pressure are recommended.

c. If final cleaning flask interior surfaces with TSP, apply TSP at 160 to 180 °F for a time sufficient to ensure all wetted surfaces are in contact with the cleaner for not less than 10 minutes if using a spray process or not less than 30 minutes if using a fill and recirculate process. Use of sprayers with high flow and low pressure or low flow and high pressure are recommended. When using TSP, the flask shall be preheated by circulating hot Grade B water through the flask. In order to prevent precipitation of TSP, the TSP shall not be allowed to cool or remain uncirculated prior to rinsing as specified in 5.3.3(e).

d. Obtain a 500 to 600 mL sample of the used NOC or TSP in a 1-liter container and verify organic cleanliness as specified in 5.13.2. If any analysis fails, replace the cleaner and repeat the clean, verification, and rinse process. Do not wait for the results of 5.13.2 before proceeding to rinsing as specified in 5.3.3(e).

e. After flushing with NOC or TSP, immediately rinse the flask with Grade B water. For corrosion resistant flasks, Grade C water may be used followed by a Grade B water rinse. The water temperature shall be adequate to remove the cleaning agent. Continue rinsing until the effluent rinse water pH measured as specified in 5.13.4.2 is not greater than 8.0. Do not dry the flask between cleaning and rinsing.

f. Recirculate or spray Grade B water through the flask for not less than 5 minutes. The water temperature does not need to be elevated. Obtain a sample of the rinse effluent and verify particulate cleanliness as specified in 5.13.3. If the particulate analysis of 5.13.3 fails, repeat the rinse step.

5.3.4 Drying. Drying after exposure of a flask to water or moist gas, such as ambient air, shall be accomplished as follows:

a. Dry the flask as quickly as possible with nitrogen until a minus 20 °F dew point is reached. Nitrogen preheaters, strip heaters, or vacuum pumps have been successfully used. Appropriate precautions shall be taken to prevent damaging the flask or support piping and equipment from excessive heat.

b. While maintaining cleanliness as specified in 5.10, perform a visual inspection on the internal flask surfaces as specified in 5.13.1.2 and 5.13.1.3. Flask surfaces with evidence of oil, grease, ink, dye, particulate, or fibers shall be recleaned. Flask surfaces with evidence of corrosion shall be blasted or tumbled as specified in 5.3.5.3.

c. While maintaining cleanliness as specified in 5.10, install end fittings and seal weld, if required, in accordance with the applicable specification. Steel flasks shall be evacuated to 20 inches or less of mercury or purged with nitrogen to remove moist air, and then pressurized to 5 to 15 lb/in^2 with nitrogen.

5.3.5 In-service interior inspection. When interior inspections of in-service flasks are required for recertification, the interior surfaces shall be inspected for evidence of corrosion, loose scale, particulate, grit, filings, paint, oil, and grease as specified in 5.13.1.2 and 5.13.1.3. Interior surfaces shall also be inspected and the outside surface of the flask marked to indicate the location of pits, cuts, burns, defects, and so forth. Pits, gouges, burns, arc strikes, and other surface defects shall be treated in accordance with NAVSEA S9086-SY-STM-010/CH-551, CGA C-6.1, or CGA C-6.2. Steel flasks shall be evacuated to 20 inches or less of mercury or purged with nitrogen to remove moist air, and then pressurized to 5 to 15 lb/in^2 with nitrogen immediately after the internal inspection if satisfactory, or corrective action of 5.3.5.1 to 5.3.5.4 if unsatisfactory. Based on the interior inspection, flasks shall be classified in accordance with the following criteria:

a. Satisfactory: Not more than 10 percent of the internal surface has evidence of corrosion or particulate, and no evidence of loose scale, filings, paint, oil, or grease on the internal surface.

b. Unsatisfactory: More than 10 percent of the internal surface has evidence of corrosion or particulate, or any evidence of loose scale, filings, paint, oil, or grease on the internal surface.

5.3.5.1 Flasks classified as unsatisfactory because of oil and grease shall be cleaned as specified in 5.3.3.

5.3.5.2 Flasks classified as unsatisfactory because of particulate or grit shall be flushed as specified in 5.3.3(f) or vacuumed until a satisfactory interior surface as specified in 5.3.5(a) is obtained.

5.3.5.3 Steel flask surfaces classified as unsatisfactory because of corrosion and loose scale shall either be blasted in accordance with MIL-F-22606 or tumbled in accordance with CGA C-6.1 and then flushed as specified in 5.3.3(f) or vacuumed to remove particulate until a satisfactory interior surface as specified in 5.3.5(a) is obtained. Aluminum flask surfaces classified as unsatisfactory because of corrosion and loose scale shall be tumbled in accordance with CGA C-6.1 and then flushed as specified in 5.3.3(f) or vacuumed to remove particulate until a satisfactory interior surface as specified in 5.3.5(a) is obtained.

5.3.5.4 Flasks classified as unsatisfactory because of internal paint shall be blasted or chemically cleaned until a satisfactory interior surface as specified in 5.3.5(a) is obtained. Flasks that have had interior paint removed by chemical methods shall be off-gas tested as specified in 5.9.3 to ensure removal of all chemical. Additionally, MIL-F-22606 flasks with evidence of internal paint shall be examined to determine the intended service of the flask. Flasks identified as Service A, which are intended for air systems, shall be replaced with Service B flasks which are intended for oxygen service.

5.4 Cleaning and calibration of instruments and gauges. The requirements for cleaning instruments and gauges, including flowmeters and dead-end pressure switches and transducers, within the boundaries defined in 1.2 shall be in accordance with NAVSEA ST700-F1-PRO-010 (see 6.3) using a NAVSEA approved halogenated solvent. Instruments and gauges should be calibrated in place by a comparative calibration procedure in accordance with NAVSEA 0987-LP-022-3010.

5.5 Aqueous system cleaning process.

5.5.1 Applicability. The aqueous system cleaning process is applicable to all compatible systems other than liquid oxygen generating plants. It may be used for liquid oxygen generating plant piping provided the aqueous system cleaning process can be successfully accomplished. Flushing of ships service demineralized water system piping shall be as specified in 5.7.

5.5.2 Material and equipment.

a. A supply of NOC or TSP as specified in 4.3 in a flushing rig as specified in 5.5.2(d).

b. A supply of rinse water in a flushing rig as specified in 5.5.2(d).

c. A supply of nitrogen.

d. A flushing rig consisting of tanks, pumps, piping, measuring devices for pressure, temperature, and flow, hoses, filters, and strainers. All items shall be compatible with the cleaner and attain the pressure, temperature, flow rates, and filtering required by this standard. Non-metallic material, other than seats, seals, and Teflon, wetted by the cleaning solution shall be verified free of extractable organic material as specified in 4.3.1.9.

e. Equipment to perform the applicable analyses as specified in 5.13. This includes clean 1-liter containers to obtain the required samples.

f. A dew point indicator equal to the Ondyne Series 1400 Dewpoint Indicator or the MCM Dewluxe Model hygrometer capable of detecting a dew point of minus 40 °F (128 ppm H_2O).

5.5.3 System preparation.

5.5.3.1 If shipboard conditions prevent flushing or testing a system as a single unit, the system may be divided into sections and flushed accordingly. System sections may be flushed as required to accommodate items such as interference problems and ship’s schedule. Precautions shall be taken to ensure that portions of the system which have been certified oxygen clean are not flushed with contaminated cleaning agent. Local engineering shall review the flushing paths or line-ups to ensure the system has been flushed and sampled.

5.5.3.2 The following items shall be accomplished to prepare a system for flushing:

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

b. Valves, valve internals, pressure regulators, filter elements, or other mechanically jointed components that will interfere with the flow of the cleaning agent should be removed and flush plugs, spools, jumpers, and blanks shall be installed. Where jumpers are used, their inside diameter should be not less than the piping they are bypassing. Seal welded regulators may be left in place if the high pressure chambers are disassembled and the nozzles removed.

c. Items having incompatible material that can be damaged during flushing shall be removed.

d. Components such as instruments which are not free draining shall be removed or isolated if appropriately configured. Cleanliness of certified oxygen clean instruments shall be maintained as specified in 5.10.

e. Flow restrictors, if installed in the supply nipple upstream of the oxygen regulators, shall also be removed.

f. Flushing rig, including temporary piping, components, and flush plugs required for system flushing, shall be pressure tested and cleaned to remove loose scale, dust, grit, filings, oil, and grease.

5.5.3.3 All removed items shall be cleaned as specified in 5.2. Where it is necessary to flush with valve cartridges installed, after the flush, each cartridge shall be removed and cleaned as specified in 5.2.

5.5.3.4 Large in-line volumes that will not support minimum flushing velocities should be individually cleaned and bypassed during the final flush if possible. The concern is that NOC and TSP final cleaners remove soil by displacement. In areas of low flow, suspended oil can separate from NOC or TSP and collect. If the volume cannot be bypassed, cannot be inspected and locally cleaned as specified in 5.12.4, and will collect separated oil perform the following: isolate the volume into the smallest flushing loop possible, obtain local engineering approval (see 6.3) to pre-clean by flushing with a low foaming detergent pre-cleaner that will emulsify oil contamination, and then perform the preflush as specified in 5.5.6 prior to the final NOC or TSP flush. The pre-cleaner is used to remove oil and grease contamination, and then NOC or TSP is used to remove any pre-cleaner residue and certify cleanliness. For volumes that cannot be bypassed, but can either be locally cleaned as specified in 5.12.4 or the configuration of the volume will not collect separated oil during the final flush, such as an in-line vertically oriented flask, a separate pre-clean flush is not required.

5.5.4 Electrolytic oxygen gas generators. For systems with electrolytic oxygen generators, perform a potassium hydroxide (KOH) contamination inspection as specified in 5.6.

5.5.5 Leak-check. The flush boundary shall be leak-checked with nitrogen or Grade B water to the anticipated flush pressure. This will eliminate the time consuming clean-up of spilled or leaked cleaner. Where an oxygen clean system interfaces with a flush boundary, using nitrogen for the leak check is recommended. Any nitrogen leakage into the oxygen clean system will not cause loss of cleanliness.

5.5.6 Preflush. For new systems or systems with extensive modifications, a preflush as follows is recommended:

a. Perform a forward and backward preflush at a minimum of 3 ft/sec using Grade B water. The preflush water temperature may be elevated to not greater than 180 °F. The higher temperatures will increase the effectiveness of the preflush and preheat the system minimizing the pipe line cleaning time.

b. Outlets should be opened one at a time to help clean valve bodies and other probable pocketing areas. The flush should continue until there is no visible evidence of debris.

5.5.7 Hydrostatic test. Hydrostatic testing as specified in 5.9 should normally be accomplished after the preflush, if applicable, and before the final flush.

5.5.8 Final flush or pipe line cleaning. The final flush or pipe line cleaning shall be accomplished as follows:

a. Flush the system with NOC at 150 to 170 °F or TSP at 160 to 180 °F at the flow rate as specified in 5.5.8(b). The temperature of the NOC at the outlet of the system being cleaned shall be maintained at not less than 140 °F. If TSP is used, the system shall be preheated by flushing once-through with hot Grade B water until the desired temperature is attained. In order to prevent precipitation of the TSP, the TSP shall not be allowed to cool or remain uncirculated prior to rinsing as specified in 5.5.9. If NOC is used, it may be recirculated in the system cold and heated in place. The flush starts when the outlet temperature reaches 140 °F.

b. The fluid velocity shall be not less than 3 ft/sec. The flow rate in gallons per minute (GPM) equivalent to 3 ft/sec can be determined by multiplying the square of the pipe or tube inside diameter in inches by 7.4, as follows:

$$\text{GPM at 3 ft/sec} = (\text{ID-inches})^2(7.4)$$

c. The requirements for a back flush and the flush durations for various applications are as specified in 5.5.8(a) and Table III.

d. At the completion of the flush, obtain a 500 to 600 mL sample of the flushing medium in a 1-liter container from each outlet prior to the filter. Sampling prior to the back flush is required only if new cleaning agent will be used for the back flush. If the same charge of cleaner is used for both directions of the flush, only sampling at the end of the flush is required.

e. For NOC, visually inspect the sample for oil and particulate. If oil or particulate is present, continue flushing until no oil or excessive (3 or more particles) particulate is present. Continued flushing will allow the filter to remove the visible contaminants. If no oil or excessive particulate is present, verify organic cleanliness as specified in 5.13.2.

f. For TSP, verify organic cleanliness as specified in 5.13.2.

g. If any analysis fails, replace the cleaning solution and repeat the final system flush. Do not wait for the results of 5.13.2 before proceeding to rinsing as specified in 5.5.9.

TABLE III. Applicability matrix for flush duration and back flush. [1]

Configuration	Flush duration	Back flush
System contains socket welds, fittings, or components with expansions or contractions	Not less than 60 minutes	Not less than an additional 60 minutes
System contains only bends and elbows and no socket welds, fittings, or components with expansions or contractions	Not less than 30 minutes	Not required
Any configuration with all sections of piping fabricated from pre-cleaned piping and components	Not less than 30 minutes	Not less than an additional 30 minutes

NOTE:

[1] Regardless of the configuration, the back flush can be deleted if all of the following conditions are met:

(a) It is authorized by local engineering.

(b) All pipe sections have been pre-cleaned.

(c) All valve bodies, filter housings, and other large component housings shall have been cleaned to oxygen cleanliness requirements.

(d) Prior to the flush, all cartridges, filter elements, regulators, and other components shall be removed and flush plugs or bypass lines installed. After the flush, all cavities shall be visually inspected as specified in 5.13.1. Any evidence of contamination shall be removed by either local cleaning with NOC or TSP or additional flushing. The results of the visual inspection shall be recorded.

(e) For oxygen enriched systems only, the system piping and components shall be fabricated from material that will not propagate a flame at maximum operating pressure when determined in accordance ASTM G94. For information, brass, bronze, copper, copper-nickel, nickel-aluminum-bronze, and nickel-copper (monel) will not propagate a flame in an oxygen or oxygen enriched atmosphere at pressures up to 7500 lb/in^2.

5.5.9 Rinsing and particulate flushing. Rinsing and particulate flushing shall be accomplished as follows:

a. Remove the majority of NOC with nitrogen and collect for future use, or proceed to 5.5.9(b). When using nitrogen, do not allow NOC to dry before proceeding to 5.5.9(b).

b. Remove cleaning solution by rinsing the system once-through with Grade B water at a velocity of not less than 3 ft/sec. Return filters that were used during the flush step should be removed, replaced, or bypassed prior to rinsing to prevent contamination trapped by the filter from being introduced into the system. The water temperature shall be not less than 110 °F for NOC and 160 °F for TSP. Systems flushed with large in-line volumes, such as moisture separators, where the flushing velocity is less than 3 ft/sec shall be back flushed with rinse water to ensure all cleaning agent is removed.

c. Obtain a sample of the rinse effluent and measure the pH as specified in 5.13.4.2. When the effluent pH is not greater than 8.0, outlets shall be opened one at a time to help clean valve bodies and other probable pocketing areas. The rinse water shall then be recirculated until the pH of the effluent at each branch, vent, or drain is not greater than 8.0.

d. At the completion of rinsing, obtain a sample of the rinse effluent from each branch and verify particulate cleanliness as specified in 5.13.3. If any of the samples do not pass the required inspection, recirculate Grade B water through the system at a velocity of not less than 3 ft/sec for not less than 30 minutes. The water temperature does not need to be elevated. Filters should be installed to trap particulate. Continue flushing until a sample of the effluent from each branch passes the particulate cleanliness as specified in 5.13.3.

e. Any residual NOC or TSP in the cavities should be removed prior to drying. Remove flush plugs and inspect for residual NOC or TSP. Remove all visible traces of NOC or TSP by wearing cleanroom gloves and wiping each cavity and flush plug with a clean lint- free cloth wetted with Grade B water at a temperature of 100 to 120 °F. The flush plugs should be reinstalled prior to drying with nitrogen.

5.5.10 Drying and reinstalling components. Drying and reinstallation of components shall be accomplished as follows:

a. Remove rinse water and dry the system with nitrogen until a minus 40 °F dew point is reached. For systems which operate at elevated humidity, such as electrolytic oxygen generator systems, or in the absence of an elevated dryness requirement, a dew point of plus 20 °F is acceptable. Nitrogen preheaters, strip heaters, or vacuum pumps have been successfully used. Appropriate precautions shall be taken to prevent damaging piping and equipment.

b. The recommended drying method is using nitrogen at low flow rates. This allows the gas to evaporate the moisture. Higher flow rates are suitable for removing visible moisture. If it is suspected that pockets of water exist at low points in the system, a high-volume blow-down can be employed. The pressure should be not greater than 100 lb/in^2 or maximum operating pressure, whichever is less.

c. While maintaining cleanliness as specified in 5.10, all items shall be removed which were installed in 5.5.3.2. A visual inspection of each cavity shall be performed as specified in 5.13.1. Additionally, where applicable, open and visually inspect all large volumes as specified in 5.13.1. If the visual inspection fails, locally clean as specified in 5.12.4. While maintaining cleanliness as specified in 5.10, components cleaned as specified in 5.2 shall be installed:

d. The system shall be reassembled and pressurized with nitrogen or helium to maintain not less than 10 lb/in^2, or packaged as specified in 5.16 to maintain cleanliness. If the pressure should drop below 10 lb/in^2, the responsible authority shall investigate the circumstances associated with the pressure drop to ensure that no contamination could have entered the system which would require repeating the flush.

e. Test, charge with system fluid, and return to operational conditions.

5.6 Potassium hydroxide (KOH) inspection.

5.6.1 Applicability. This inspection applies only if the system has an electrolytic oxygen gas generator that uses KOH. The oxygen system shall be visually inspected for KOH contamination at mechanical joints before the system is flushed as specified in 5.5.5 through 5.5.9. KOH is a whitish solid that may occur as a scale on the inside of pipes and components.

5.6.2 Inspection. The inspection for KOH contamination shall be accomplished as follows:

a. The oxygen generator union connection shall be considered the first mechanical joint downstream of the moisture separator. 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. If contamination is found, perform the inspection as specified in 5.6.2(b).

b. If KOH is found in the oxygen generator union connection as identified in 5.6.2(a), downstream piping to the isolation valves in the distribution header shall be visually inspected. If no KOH is found in this section, no further inspection is required and the KOH shall be removed as specified in 5.6.3. If KOH is found in this section, the remainder of the system shall be visually inspected as specified in 5.6.2(c).

c. If KOH is found in the distribution header as identified in 5.6.2(b), the remainder of the system shall be visually inspected. The KOH shall be removed as specified in 5.6.3.

5.6.3 KOH removal. KOH shall be removed by flushing with Grade B water at a temperature of 120 to 140 °F. Flush until the conductivity of the effluent is within 2 micromhos of the influent, or the pH measured as specified in 5.13.4.2 is 8.0 or less. Dry as specified in 5.5.10.

5.7 Flushing of ships service demineralized water piping systems.

5.7.1 Applicability. This process applies to ships service demineralized water piping systems as defined in 1.2.2.4.

5.7.2 Material and equipment. The following material and equipment are required:

a. A supply of Grade A water.

b. A flushing rig for flushing piping systems as specified herein. It shall consist of pumps, piping, measuring devices for pressure, temperature, and flow, and hoses. Items shall attain the pressure, temperature, and flow rates required by this standard.

c. Equipment to perform the applicable analyses as specified in 5.13.

5.7.3 Flush. Flushing shall be accomplished as follows:

a. The demineralized water piping shall be flushed for 15 minutes with Grade A water at not less than 150 °F to remove loose scale, rust, grit, filings, oil, grease, and other foreign substances. Lower temperatures may be used to prevent damage to items such as PVC piping with local engineering approval.

b. A sample of the flush water shall be inspected for particulate cleanliness as specified in 5.13.3 and verified free of visual turbidity, oil, sediment, and resin beads. Resin beads or fines within the demineralizer are acceptable. If organic contamination is suspected, determine the level of contamination in accordance with ASTM D4839, EPA Method 9060A, or equal. Organic levels should not exceed 1 ppm.

5.7.4 Visual inspection. Following the flush, the system shall be inspected as follows:

a. Drain the water from the system and perform a visual inspection as specified in 5.13.1 except inspect only for visible traces of hydrocarbons. The inspection shall be performed 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.

b. If visible traces of hydrocarbons are found, the piping shall be cleaned as specified in 5.5.

5.8 Solvent system cleaning processes.

5.8.1 Applicability. The solvent system cleaning processes are given in Table IV.

TABLE IV. Solvent cleaning processes.

Application [1]	Requirement
Oxygen-nitrogen plants	5.8.2
Oxygen-nitrogen plant piping [2] [3]	5.8.3

NOTES:

[1] The boundaries are as defined in 1.2.

[2] The oxygen-nitrogen plant piping consists of all piping for handling liquid oxygen or nitrogen and the gas cross connect piping between plants. If moisture can be removed from the piping or item being cleaned, it may be cleaned as specified in 5.5 instead of 5.8.3.

[3] Distribution piping for the oxygen-nitrogen plant can be cleaned with cleaning solvent as specified in 5.8.3 provided that a flush is being performed concurrently.

5.8.2 Oxygen-nitrogen plants.

5.8.2.1 Material and equipment.

a. A supply of cleaning solvent as specified in 4.4.

b. The required cleaning equipment and process depends on the plant make, model, and configuration. Specific procedures and equipment are not specified in this standard. The equipment shall be compatible with the cleaning solvent.

5.8.2.2 Cleaning solvent. The cleaning solvent for cleaning oxygen-nitrogen plants shall be a NAVSEA approved halogenated solvent as specified in 4.4.

5.8.2.3 Cleaning method. The cleaning method consists basically of dividing the plant's 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. Each piping circuit is leak-checked prior to filling with solvent. Solvent is then circulated through each piping circuit to be cleaned. A fill-and-soak method may be used for large vessels such as distillation columns and storage tanks. Consult NAVSEA, the vendor, or the ship's planning yard if necessary to identify previously used cleaning procedures or to develop a specific procedure for the make and model of the oxygen-nitrogen plant to be cleaned.

5.8.2.4 Sample and removal of cleaning solvent from system. The oxygen-nitrogen plant shall be certified oxygen clean and free of cleaning solvent as specified in 5.8.3.4(b) and 5.8.3.4 (c). The gas cross connect piping shall be sampled for cleaning solvent content as specified in 5.8.3.4 (c).

5.8.3 Oxygen-nitrogen plant piping.

5.8.3.1 Material and equipment. The following material and equipment are required:

a. A supply of cleaning solvent as specified in 4.4.

b. A supply of nitrogen.

c. A vacuum pump pulling not less than 25 inches mercury (Hg) vacuum for removing the cleaning solvent. The pump design shall preclude pump lubricant from being drawn into the system being cleaned in the event of a pump failure or stoppage. The pump shall be compatible with the cleaning solvent.

d. Gauges, flowmeters, and thermometers as required which are compatible with the cleaning solvent.

e. Equipment to perform the applicable analyses as specified in 5.13.

5.8.3.2 Preliminary joint tightness test. A preliminary joint tightness test shall be performed on the system before introducing the cleaning solvent into the system piping. The preliminary joint tightness test shall be performed with nitrogen to a minimum of 75 lb/in^2 or the maximum system operating pressure if lower. Accessible mechanical joints, seal welds, and disturbed welded joints shall be tightness tested using the test duration and acceptance criteria as specified in 5.9 and Table VI.

5.8.3.3 Hydrostatic test. Hydrostatic testing as specified in 5.9 and Table V should normally be accomplished before the final flush.

5.8.3.4 Flush. Flushing shall be accomplished as follows:

a. The system piping shall be flushed at not less than 3 ft/sec with cleaning solvent for not less than 30 minutes. If the flushing circuit is through parallel paths, if necessary, the flow paths shall be isolated to ensure that each path is flushed with 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.

b. Obtain a sample of the cleaning solvent from all sampling locations and verify organic cleanliness as specified in 5.13.2 and verify particulate cleanliness as specified in 5.13.3. If any of the analyses fail, replace or reclaim the solvent and repeat the flush.

c. After acceptable samples are obtained, 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. The nitrogen exhaust shall be checked for traces of the cleaning solvent with a halide leak detector or equal. Evacuating and purging shall continue until no trace of the solvent is detectable.

d. The system shall be pressurized with nitrogen to a minimum of 75 lb/in^2 or the maximum system operating pressure if lower. Samples of nitrogen under pressure shall be taken after a period of not less than 1 hour and analyzed for solvent content. Samples shall be analyzed by gas chromatography or equivalent methods. The solvent content shall not exceed 10 ppm. If this limit is exceeded, the system shall be purged with nitrogen until acceptable samples are obtained.

5.8.3.5 Maintenance of pressure in system. The system shall be maintained with not less than 10 lb/in^2, or the maximum system operating pressure if lower, of nitrogen until the system is charged with oxygen or nitrogen. If the pressure should drop below 10 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 flush.

5.9 Testing.

5.9.1 Pressure testing. Piping and components defined by the boundaries of 1.2 shall be pressure tested (hydrostatic, joint tightness, seat tightness, and pressure drop) as specified in Tables V through VIII. Flexible hoses shall be tested in accordance with NAVSEA S6430-AE-TED-010. When contractually invoked, or otherwise specified by NAVSEA, the test requirements of NAVSEA SS800-AG-MAN-010/P-9290 or NAVSEA SS521-AA-MAN-010, or other NAVSEA approved procedure shall take precedence over Tables V through VIII.

TABLE V. Hydrostatic testing.

Attribute	Requirement
Applicability	New or major repaired pipe and components, including replacement of pressure containing piece parts, shall be hydrostatically (strength and porosity) tested. Major repairs include any work/rework where the pressure containing boundary is affected by welding, brazing, machining, or a fabrication process which could affect the structural adequacy of the pipe or component. The following items are exempt from hydrostatic testing: isolatable pressure measuring devices such as pressure gauges, transducers, and pressure switches, valve packing, pump packing, pump mechanical shaft seals, mechanical joint bolting, valve stems, and storage tanks in support of oxygen-nitrogen plants.
When accomplished	Hydrostatic testing is normally accomplished before component cleaning or final system flushing. It shall be accomplished prior to tightness or operational testing. Hydrostatic testing on an oxygen clean component or system is allowed provided the following are met or accomplished: Water: The test equipment shall satisfy 1.2.4, the water shall be as specified in 4.6.2, and the component or system shall be dried as specified respectively in 5.2.6 and 5.5.10. Solvent: Testing for cleanliness and solvent removal shall be as specified in 5.8.3.4(b) and 5.8.3.4 (c). If the samples indicate that the system has been contaminated, the contaminated portion of the system shall be reflushed as specified in 5.8.
Test fluid	The test fluid is as specified in 4.6.
Test pressure	The test pressure is 150 percent of system maximum operating pressure, but not less than 50 lb/in^2.
Test duration	Shop testing of components shall be for not less than 1 minute plus sufficient time for inspection. Testing conducted on piping or installed components shall be for not less that 15 minutes plus sufficient time for inspection.
Acceptance criteria	No leakage or permanent deformation.

TABLE V. Hydrostatic testing. Continued.

Attribute	Requirement
Special notes	1. Hydrostatic testing with a gas (helium or nitrogen) is allowed with local engineering approval. Hydrostatic testing with a gas is extremely dangerous. Appropriate safety precautions are the responsibility of the performing activity. 2. Hydrostatic testing of Department of Transportation (DOT) certified steel flasks shall be in accordance with CGA C-1. Hydrostatic testing of DOT certified aluminum flasks shall be in accordance with CGA C-1 and CGA C-6.1. Hydrostatic testing of DOT certified fiber reinforced aluminum flasks shall be in accordance with CGA C-1 and CGA C-6.2, except prior to measuring permanent expansion, the flask shall rest for not less than 60 seconds. Hydrostatic testing of MIL-F-22606 flasks shall be in accordance with NAVSEA 0902-LP-018-2010 and NAVSEA S9086-SY-STM-010/CH-551. Flasks tested with water shall be dried as specified in 5.3.4. 3. Hydrostatic test requirements may be replaced with added inspections in accordance with NAVSEA S9086-RK-STM-010/CH-505 for welded or brazed joints associated with piping system modifications or repairs with local engineering approval. Welded joints shall be cleaned as specified in this standard, or cleanliness shall be maintained as specified in 5.11. Brazed joints shall be cleaned as specified in 4.8.

TABLE VI. Joint tightness testing.

Attribute	Requirement
Applicability	New or repaired pipe and components, including flasks, shall be joint tightness tested. Repairs are any work/rework which could affect the pressure containing ability of the item such as welding, brazing, replacement of software, or disturbance of mechanical joints.
When accomplished	Joint tightness testing is normally accomplished after component or system cleaning and prior to operational testing.
Test fluid	The test fluid is as specified in 4.6 or 4.7.
Test pressure	The test pressure is 100 percent of system maximum operating pressure.
Test duration	Shop testing shall be for not less than 5 minutes. Testing conducted in the as-installed configuration shall be not less than 15 minutes soak time plus sufficient time for inspection.
Acceptance criteria	Testing with nitrogen or oxygen: No leakage is allowed while monitoring accessible joints for leakage using methods such as full immersion or using leak detection solution in accordance with MIL-PRF-25567, or equal. Leakage is identified by individual bubbles forming which are visible with the naked eye. Testing with helium: The maximum allowable leakage rate is 0.6 standard cubic centimeters per minute (sccm) past valve stem seals while monitoring accessible joints for leakage using methods such as full immersion or using leak detection solution in accordance with MIL-PRF-25567, or equal. Leakage is identified by the formation of individual bubbles visible under white light inspection. An electronic leak detector, such as USON, may be used at the beginning and end of the joint tightness test. Testing with water: No leakage is allowed.

TABLE VII. Seat tightness testing.

Attribute	Requirement
Applicability	New or repaired valves and regulators shall be seat tightness tested. Repairs are any work/rework which could affect the ability of the valve or regulator to remain seat tight such as machining of the seat area or replacement of the seat.
When accomplished	Seat tightness testing is normally accomplished after component cleaning or final system flushing and prior to operational testing.
Test fluid	The test fluid is as specified in 4.6 or 4.7.
Test pressure	The test pressure is 100 percent of system maximum operating pressure.
Test duration	Shop testing shall be for not less than 5 minutes. Testing conducted in the as-installed configuration shall be the time necessary for the minimum leakage to be detected at the point of observation or monitoring.
Acceptance criteria	Pressure shall be applied in the direction tending to unseat globe or needle valves, in the check direction for check valves, and in pressure holding direction for ball valves. Testing with nitrogen or water: Leakage shall be zero or as specified by the applicable military or manufacturer specification. Testing with helium: The maximum allowable leakage rate is 0.6 sccm or as specified by the applicable military or manufacturer specification.

TABLE VIII. Pressure drop testing.

Attribute	Requirement
Applicability	New systems defined by 1.2.1 and 1.2.3 with storage capacity designed for greater than 24 hours duration shall be pressure drop tested. Joints defined by 1.2.1 and 1.2.3 subsequently disturbed or installed and inaccessible for joint tightness testing as specified in Table VI shall be pressure drop tested. The test boundary shall be from and including the storage flasks downstream to the last isolation valve.
When accomplished	Pressure drop testing is normally accomplished after joint and seat tightness testing and prior to operational testing. Drop and joint tightness testing may be performed concurrently.
Test fluid	The test fluid is as specified in 4.7.
Test pressure	The test pressure is 100 percent of system maximum operating pressure.
Test duration	The test duration is not less than 24 hours.
Acceptance criteria	The temperature corrected pressure drop shall not exceed 1.0 percent of the test pressure.

5.9.2 Operational testing. Repairs, modification, or installation of new piping and components which affect the operation of the system or components require operational testing prior to manned use. Open-ended piping requires an operational test to prove unobstructed flow.

5.9.3 Gas sampling and analysis. For critical applications and Diver Life Support Systems, a gas sample is required if work was accomplished that could introduce gaseous contaminants into a component or system such as cleaning with a solvent. For components with large volumes, such as flasks, the sample may be taken prior to or after installation, however, sampling prior to installation is recommended to prevent rework. The gas sample shall be taken and analyzed as follows:

a. Isolate the pressurized component or portion of the system from the pressurized source. The recommended hold time is not less than 24 hours.

b. Obtain a gas sample from the component or system.

c. While obtaining the sample, prevent contamination of the gas sample with the ambient atmosphere and pressurize and vent the gas sample flask sufficiently to obtain a representative sample.

d. Analysis of the gas sample shall meet the requirements of NAVSEA SS800-AG-MAN-010/P-9290 or NAVSEA SS521-AA-MAN-010.

5.10 Removal and replacement of components in oxygen clean systems.

5.10.1 General requirements. To maintain cleanliness during repair or maintenance of an oxygen clean system, the following general requirements apply. Containment and purge requirements shall be as specified in Table IX and, as applicable, 5.10.2. For nitrogen-oxygen life support systems wetted by not greater than 50 percent by volume oxygen and demineralized water systems, maintain cleanliness during repair or maintenance in accordance with MIL-STD-1622, except paragraph 5.17 of this standard applies for "maintenance of cleanliness".

TABLE IX. Containment and purge requirements.

Conditions	Purge [1]	Controlled area [2]
Airborne contamination [3] is being produced such as a ship in an overhaul. A controlled area can be established which will prevent entry of contamination into an opened system.	No	Yes
Airborne contamination [3] is being produced such as a ship in an overhaul. A controlled area alone is not adequate to establish oxygen clean conditions.	Yes	Yes
Airborne contamination is not being produced such as a ship at sea or a clean chamber.	Yes	No
	No	Yes
Airborne contamination is not being produced such as a ship at sea or a clean chamber. Additionally, the item being removed falls into one of the following categories: [4] (a) A charging connection. (b) A test connection or instrument being removed for instrument calibration. (c) Routine replacement of flasks in accordance with detailed procedures. (d) Removal of fittings or components to connect a purge source to a system.	No	No

NOTES:

[1] Purges shall be established as specified in 5.10.2. A purge is always required, regardless of the conditions, if socket or seal welding in accordance with NAVSEA S9074-AR-GIB-010/278, or equal, is being performed and cleanliness is being maintained. Additionally, a purge is always required if the ambient environment may introduce an unwanted contaminant. Examples of unwanted ambient environmental contaminants include air contamination of a helium life support system or moisture contamination of a liquid oxygen system.

[2] A controlled area as specified in 5.1 shall be constructed around the component to be removed.

[3] Airborne contamination includes operation of gasoline or diesel fueled equipment, and evolutions such as grinding, painting, and brazing.

[4] On a case basis, local engineering can authorize no purge and no controlled area for items outside of these categories. Items such as flame propagation and damage to delicate components from particulate contamination shall be considered. ASTM G63 and ASTM G94 provide guidance for evaluating materials for oxygen service which can be used to assess the probability of flame propagation.

5.10.1.1 The component being removed and adjacent piping and equipment shall be externally cleaned with an aqueous cleaner or NAVSEA approved halogenated solvent[1] to remove loose scale, dust, dirt, and other foreign material. Ultraviolet and white light inspections as specified in 5.13.1.2 and 5.13.1.3 shall indicate no visible contamination.

[1] For critical applications, NAVSEA approved halogenated solvents may be used for external cleaning with local engineering approval.

5.10.1.2 That portion of the system to be entered shall be isolated with appropriate boundary isolation valves and depressurized. Discharge of any fluid shall be in accordance with the appropriate safety precautions of NAVSEA S9086-SX-STM-010/CH-550.

5.10.1.3 Personnel clothing, including cleanroom gloves as specified in 5.1.6, Class B, paragraph (c), or equal shall be worn whenever handling the wetted surface of oxygen clean components. Oxygen clean component wetted surfaces touched with bare hands shall be considered contaminated and shall be cleaned as specified in 5.2 to re-establish oxygen cleanliness.

5.10.1.4 Systems containing oxygen at levels greater than 22 percent or hydrogen at levels greater than 3 percent shall be purged with helium or nitrogen to eliminate fire or explosion hazards using one of the following procedures:

a. Where the configuration allows a purge path, the affected can be purged with helium or nitrogen until the effluent purge gas measures not greater than 22 percent oxygen or 3 percent hydrogen. The measurement shall be taken using suitable colormetric gas detector tubes such as those manufactured by Draeger Manufacturing Company or a portable analyzer or other equivalent means.

b. Where the configuration does not allow a purge path such as a flask, or gas sampling equipment to measure oxygen or hydrogen is not available, verify the affected area is depressurized, then pressurize to about 100 lb/in^2 with helium or nitrogen, and then depressurize the affected area. Repeat the cycle one additional time for oxygen or oxygen enriched systems for a total of two pressurization-depressurization cycles. For hydrogen systems, the pressurization-depressurization cycle shall be performed two additional times for a total of three times. Sampling to measure oxygen or hydrogen concentration is not required.

5.10.1.5 Only certified oxygen clean items, including replacement pipe, components, and tools, shall be installed or come in contact with the wetted surface of an oxygen clean system or component. Oxygen clean items removed for transportation shall be immediately packaged as specified in 5.16. If cleanliness is lost because of torn packaging, maintenance, or repair, the effected item shall be cleaned as specified in 5.2 to re-establish oxygen cleanliness.

5.10.1.6 Socket and seal welding in accordance with NAVSEA S9074-AR-GIB-010/278, or equal, are considered clean processes that do not result in loss of oxygen cleanliness provided that a purge as specified in 5.10.2 is maintained. Any other welding or brazing processes result in a loss of oxygen cleanliness that requires recleaning as specified in 5.5 or 5.8.

5.10.1.7 Establish the containment or purge requirements as specified in Table IX. When a system is opened to remove an item, perform a visual inspection as specified in 5.13.1. Any visible contamination of the wetted surfaces shall be locally cleaned as specified in 5.12.4. Complete the necessary maintenance and repair. Prior to closing the system, repeat the visual inspection as specified in 5.13.1 for visual contamination. Any evidence of visible contamination may be an indication that loss of cleanliness has occurred and additional inspections as specified in 5.12 shall be accomplished.

5.10.1.8 If there is an unscheduled delay whatsoever, such as the wrong material, an incorrect part, or contamination, 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 packaged as specified in 5.16.1.3. When the system is reopened, perform a visual inspection as specified in 5.13.1. Any evidence of visible contamination may be an indication that loss of cleanliness has occurred and additional inspections as specified in 5.12 may be required.

5.10.2 Purge. When the system is open, a slight positive purge of about 2 lb/in^2 helium or nitrogen shall be maintained within the system to prevent possible entry of airborne contamination.

5.11 Piping repairs.

5.11.1 Applicability. For repairs of piping, the following procedure may be employed to eliminate the need to hydrostatically test and clean the piping. Local engineering approval is required to employ this procedure.

5.11.2 System preparation. The area where cutting or grinding will occur and the adjacent piping or equipment shall be externally cleaned to remove loose scale, dust, dirt, oil, grease, and other foreign materials as specified in 5.10.1.1. That portion of the system where cutting or grinding will occur shall be depressurized and purged of dangerous gases (such as, oxygen, hydrogen) using helium or nitrogen. The affected portion of the system where cutting or grinding will occur shall be isolated by shutting the boundary isolation valve. A convenient bleed point within the affected boundary shall be allowed. After the affected portion has been depressurized, systems containing oxygen at levels greater than 22 percent or hydrogen at levels greater than 3 percent shall be purged with helium or nitrogen to eliminate fire or explosion hazards as specified in 5.10.1.4.

5.11.3 Maintenance of purge. During cutting or grinding and when the system is open to the atmosphere, maintain a slight positive helium or nitrogen purge of about 2 $\mathrm{lb/in^2}$ to prevent possible entry of airborne contamination or contamination from cutting or grinding.

5.11.4 Cutting or grinding of system. When cutting, cut to the blue line and carefully break the pipe or remove the fitting minimizing the entry of contaminants. When grinding, grind carefully to prevent the entry of contaminants. Exercise extreme caution when performing cuts in vertical pipe runs to prevent introducing contamination. A cut in a horizontal pipe run should precede any vertical cut. Increase purge pressure as necessary during cutting or grinding to prevent the entry of contaminants.

5.11.5 Cleaning. While maintaining the purge, locally clean the pipe internally and externally where the cutting or grinding occurred as specified in 5.12.4. If there are any significant delays during fit up and welding, the system shall be packaged as specified in 5.16.1.3. The purge shall be maintained during joint fitup. Depending on the welded joint design, the purge pressure established to maintain cleanliness may need to be reduced or the purge stopped to allow satisfactory completion of the weld. In this case, once the cleanliness boundary is secured, such as when the weld joint is tacked to positively prevent separation, and verified by a Certified Oxygen Clean Worker qualified in accordance with 5.14, the welder can adjust the purge as necessary provided this does not otherwise conflict with the requirements of NAVSEA S9074-AR-GIB-010/278. Work shall be planned to minimize the time the system is open to the atmosphere or temporarily packaged. If cleanliness is maintained properly and no contamination is detected, flushing of the piping system is not required. If contamination is detected, the extent and source of the contamination shall be determined and the system shall be cleaned as required to remove the contamination as specified herein.

5.11.6 Inspection and testing. Hydrostatic testing is not required if the operating test option authorized in NSTM S9086-RK-STM-010/CH-505 is used. The operating test option of NSTM S9086-RK-STM-010/CH-505 specifies that the weld root shall be inspected by liquid penetrant (PT). The option to inspect the weld root with 5X visual per NAVSEA S9074-AR-GIB-010/278 is deleted. After welding, perform a joint tightness test as specified in 5.9.

5.12 Loss of system cleanliness.

5.12.1 Definition. Contamination of a system which has previously been cleaned as specified by this standard due to other than normal system use is considered a loss of system cleanliness. Examples include loss of a purge, system degradation causing pieces of material to deposit in the system, and inadvertent exposure of a cleaned surface to an uncontrolled atmosphere.

5.12.2 Method for determination of extent of contamination. Whenever loss or suspected loss of cleanliness occurs, the extent of the contamination shall be determined by performing a visual inspection as specified in 5.13.1. The boundary of the contamination is determined based on the inspection results. The following would be considered as unacceptable requiring corrective action as specified in 5.12.3. This list is for guidance only and does not include all items that may be encountered requiring corrective action.

a. Any fluorescence under ultraviolet light or observable coatings attributed to other than approved lubricants. The procedure specified in 5.13.6 for detecting hydrocarbon contamination by swipe is useful in differentiating an approved lubricant from a hydrocarbon contaminant.

b. Clearly defined pieces such as elastomers likely caused by system degradation.

c. Visible particles attributed to several causes such as exposure to an uncontrolled atmosphere, inadequately filtered purge gas, or corrosion of nearby components. If possible, particles should be collected and analyzed in order to determine the source.

5.12.3 Corrective action. Contaminated systems shall be evaluated by local engineering for the need to reclean. Consideration should be given to items such as the application, configuration, and potential hazards posed by the contamination. For instance, particulate is expected and considered acceptable in a closed loop life support system with scrubbers; however, any contamination in a high pressure oxygen system with aluminum piping or components poses a serious hazard. Particulate contamination or organic contamination identified as an approved lubricant should be removed by local cleaning as specified in 5.12.4. However, evidence of hydrocarbon contamination requires recleaning to the requirements of this standard. Loss of system cleanliness due to other than normal system use shall be noted (see 6.3) specifying corrective action.

5.12.4 Local cleaning. During performance of local cleaning, maintain system cleanliness as specified in 5.10. Clean cloths as specified in 3.6 shall be used for local cleaning. Wearing cleanroom gloves, wipe the contaminated surface with the clean cloth wetted with warm (100 to 120 °F) NOC or TSP solution as specified in 4.3 or, with local engineering approval, a NAVSEA approved halogenated solvent. After use of NOC or TSP solution, wipe the cleaned surface with a new clean cloth wetted with warm (100 to 120 °F) Grade B water to remove cleaner residue. This process shall be repeated until the parts pass the visual inspection as specified in 5.13.1. Dry the wetted surfaces with a new clean cloth. If necessary, use nitrogen to dry the surface.

5.13 Process verification methods.

5.13.1 Visual surface inspection methods.

5.13.1.1 Applicability. When specified, verification of surface cleanliness by visual inspection shall be performed using ultraviolet light as specified in 5.13.1.2, bright white light as specified in 5.13.1.3, and for surfaces with areas not less than 16 square inches (in^2) (100 cm^2), swipe as specified in 5.13.1.4. Visual inspection techniques as specified in 5.13.1.2 through 5.13.1.4 are limited only to determining the presence of organic or particulate contamination on a surface cleaned in accordance with this standard. Visual inspection techniques shall not be used in place of cleaning or to establish the absence of contamination on a surface not cleaned as specified in this standard.

5.13.1.2 Ultraviolet light method. The surface shall be inspected with an ultraviolet light having a wave length of 3600 to 3900 angstroms. The inspection shall be performed by a person with normal visual acuity, natural or corrected. Any evidence of fluorescence from oil, grease, ink, dye, particulate, or fibers on the surface being inspected shall be cause for rejection, unless otherwise specified. Note that most oils and greases do not fluoresce, while some non-metallic substrates may fluoresce leading to possible false negative or false positive results.

5.13.1.3 Bright white light method. The surface shall be inspected with a bright white light of at least 100 foot-candles. The inspection shall be performed by a person with normal visual acuity, natural or corrected. A general purpose two D-cell flashlight, in good condition, at a distance of no greater than 18 inches from the surface being inspected will illuminate the surface with an intensity of not less than 100 foot-candles. Any evidence of oil, grease, ink, dye, particulate, or fibers on the surface being inspected shall be cause for rejection, unless otherwise specified.

5.13.1.4 Swipe method. The surface shall be swiped with at least two movements with filter paper or a clean swipe cloth as specified in 3.6. Any evidence of oil, grease, ink, dye, particulate, or fibers shall be cause for rejection. Note that the swipe method is limited to surfaces with areas no less than 16 in^2 (100 cm^2).

5.13.2 Hydrocarbon and NVR analysis methods.

5.13.2.1 Applicability. All aqueous cleaning processes using NOC as a final cleaner shall check for the presence of excessive foam using the shake test specified in 5.13.2.2. Depending on the final cleaner, one of the analytical methods specified in Table X shall be used to quantitatively determine the concentration of hydrocarbons (oil and grease) or non-volatile residue (NVR) in the final cleaner. Exceptions are nitrogen-oxygen life support piping and components wetted by not greater than 50 percent by volume oxygen and final cleaned with NOC, and demineralized water system components final cleaned with NOC. For these items, the qualitative clarity inspection of NOC specified in 5.13.2.9 may be substituted for the quantitative inspection specified in Table X.

TABLE X. Hydrocarbon and NVR analysis methods.

Final cleaner	Analysis technique	Acceptance criteria [1]	Procedure
NOC [2]	NVR in NOC by filtration and gravimetric	5 ppm maximum above baseline	5.13.2.3
TSP or NOC [2]	Solvent extraction of aqueous cleaners; then analyze per 5.13.2.5 or 5.13.2.8	5 ppm maximum above baseline when analyzed per 5.13.2.5 or 5 ppm maximum total hydrocarbons when analyzed per 5.13.2.8	5.13.2.4
CFC-113 or HCFC-225	NVR in solvent extract by gravimetric	5 ppm maximum above baseline	5.13.2.5
All NAVSEA approved halogenated solvents	NVR in solvent by gravimetrics	5 ppm maximum above baseline	5.13.2.6
All NAVSEA approved halogenated solvents	Residue in solvent by Optically Stimulated Electron Emission	5 ppm maximum above baseline	5.13.2.7
CFC-113	Hydrocarbon oil and grease in solvent extract by infrared spectrophotometry	5 ppm maximum total hydrocarbons	5.13.2.8

NOTES:

[1] When measuring hydrocarbon or NVR contamination, negative results are possible. These results are acceptable and should be reported as less than 1 ppm.

[2] The preferred method of analyzing NOC is as specified in 5.13.2.3.

5.13.2.2 Shake test. A half-full capped sample container of not less than 250 mL shall be vigorously agitated for not less than 5 seconds, then allowed to stand undisturbed for 5 minutes. Any evidence of bubbles remaining on the surface shall be cause for rejection. The shake test is useful in detecting the presence of some soluble organic contaminants such as hydrocarbon surfactants in low foaming inorganic solutions such as NOC. As an example, NOC with only 5 milligrams per liter (mg/L) NID will develop a stable foam visible after 30 minutes. The presence of foam is often the result of carry-over from a pre-clean step. However, the shake test is used only to determine the presence of organic or particulate contamination. A shake test will not detect insoluble organic contaminants such as oil or grease, and, therefore, shall not be used to establish the absence of organic contaminants.

5.13.2.3 Non-volatile residue in NOC. The concentration of NVR in NOC shall be determined as specified in Appendix B.

5.13.2.4 Solvent extraction of aqueous cleaners. As specified in Appendix C, this method serially extracts a homogenized sample of TSP solution or NOC with three 30 mL or 160 mL volumes of CFC-113 or HCFC-225, as applicable, and subsequently dilutes the extract to either 100 mL or 500 mL. The extract is then analyzed as specified in 5.13.2.5 or 5.13.2.8.

5.13.2.5 Solvent extract non-volatile residue. Non-volatile residue (NVR) of solvent extract shall be determined in accordance with ASTM F331 (see 6.3). This method evaporates 500 mL of solvent to 20 to 30 mL using a rotary flash evaporator, evaporates the 20 to 30 mL residue with a 105 to 110 °C oven, cools the sample, and then weighs the remaining residue, recording the NVR in ppm. Because of the volume, expense, and effluent discharge associated with the solvent NVR analysis, activities should implement methods to collect and recycle evaporated solvent.

5.13.2.6 Solvent non-volatile residue. Non-volatile residue (NVR) of solvent shall be determined in accordance with NAVSEA ST700-F1-PRO-010, Appendix E, or ASTM D2109, method A (see 6.3). NAVSEA ST700-F1-PRO-010, Appendix E, was developed for instruments that have a smaller sample size of 100 mL.

5.13.2.7 Solvent optically stimulated electron emission. Residue in solvent shall be determined in accordance with Appendix D.

5.13.2.8 Solvent infrared spectrophotometry. Hydrocarbon oil and grease in trichlorotrifluoroethane (CFC-113) shall be determined in accordance with ASTM D3921 (see 6.3).

5.13.2.9 White light visual clarity inspection. Samples shall be visually inspected for clarity. Inspections shall be performed by a person with normal visual acuity, natural or corrected, under bright white light of at least 100 foot-candles. A general purpose, two D-cell flashlight in good condition, at a distance of no greater than 18 inches directly above a surface will illuminate the surface with an intensity of not less than 100 foot-candles. Samples shall be inspected in a chemically compatible clear container, or clean white dish. Any visible turbidity from contaminants such as oil, grease, sediment, paint chips, bead blast, or resin beads shall be cause for rejection. Evidence of not greater than 3 particles is acceptable.

5.13.3 Particulate inspection methods.

5.13.3.1 Applicability. Unless otherwise specified, a white light visual particle inspection as specified in 5.13.3.2 shall be performed on a sample of the final rinse water or solvent. For critical applications, a particle count as specified in 5.13.3.3 shall be performed on a sample of the final rinse water or solvent.

5.13.3.2 White light visual particle inspection. Samples of final rinse water or solvent 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. A general purpose two D-cell flashlight, in good condition, at a distance of not greater than 18 inches directly above a surface will illuminate the surface with an intensity of not less than 100 foot-candles. Samples shall be inspected in a chemically compatible clear container or clean white dish. Any visible particles shall be cause for rejection. This visual inspection corresponds to a quantitative limit of no particles greater than 50 micrometers.

5.13.3.3 Particle count. Particle counts of final rinse water or solvent samples should meet IEST-STD-CC1246 cleanliness level 100 or 200 when determined in accordance with ASTM F311 (see 6.3). A particle count is determined by filtering a sample of rinse water or solvent through a 1.0 micrometer, or less, membrane filter. The size and quantity of particles on the filter is then determined using a microscope. The particle count should be reported in relation to a known volume (1 liter) or surface area [1 square foot (ft^2)] using the appropriate IEST-STD-CC1246 cleanliness level distribution. Note that the analysis should be performed in a clean environment to prevent contamination. One alternative to simplify the particle count is to look for a particle larger than the largest particle size allowed to have an unlimited quantity. As an example, if the largest particle size allowed to have an unlimited quantity is 50 micrometers, look only for particles greater than 50 micrometers. A complete particle count would be required only if particles greater than 50 micrometers were observed.

5.13.4 pH analysis.

5.13.4.1 Applicability. When specified, the pH of rinse water shall be determined as specified in 5.13.4.2. The pH of NOC should be determined as specified in 5.13.4.3.

5.13.4.2 Rinse water pH. When specified, the pH of rinse water shall be determined using a pH probe, litmus paper, or phenolphthalein indicator solution. Three drops of phenolphthalein indicator solution in a 100 mL sample will appear colorless or a very slight pink when the pH is 8.0 or less.

5.13.4.3 NOC pH. To accurately measure the pH of NOC, measure pH as specified by MIL-DTL-24800, or measure in accordance with ASTM E70 and the following:

a. Select a pH probe with a low sodium ion error and Teflon junction that is rated for a pH range of 0 to 14. The Teflon junction will not clog as quickly as the commonly used ceramic junction. Use of thick glass pH probes rated at 0 to 12 will result in pH errors of up to 0.5 units. Alternatively, an ion selective field effect transistor (ISFET) probe can be used. The ISFET probe eliminates the pH sensitive glass tip easing clean up and extending life.

b. Check the calibration of the pH meter with pH 10 and pH 12 buffer solutions. The common practice of checking pH meter calibration with pH 7 and pH 10 buffer solutions will not yield accurate results.

c. After measuring the pH of NOC, clean the probe by soaking in a saturated solution of calcium hydroxide for about 1 hour. A saturated solution of calcium hydroxide can be prepared by mixing 0.2 gm calcium hydroxide with 100 mL of water. The presence of some precipitate indicates the solution is saturated.

5.13.5 NOC alkalinity. When specified, the alkalinity (hydroxide concentration) in NOC shall be evaluated as follows:

5.13.5.1 Equipment.

a. A balance accurate to 0.01 grams with a zero drift less than 0.01 grams, and a capacity sufficient to prepare reagent solutions as specified in 5.13.5.3. Suitable balances are available through laboratory supply houses such as Thomas Scientific.

b. Beakers or erlenmeyer flasks of 100 to 250 mL capacity, plastic or glass; or equal.

c. Graduated cylinder of 50 to 100 mL capacity, plastic or glass; or equal.

d. Eye dropper or pipette, plastic or glass; or equal.

e. Syringe or buret, 35 to 50 mL capacity, with 1 mL graduation intervals, preferably plastic; or equal.

5.13.5.2 Reagents.

a. Potassium acid phthalate or potassium biphthalate (KHP), CAS No. 877-24-7, primary standard or acidimetric standard, crystals, ACS reagent grade or better, available from chemical supply houses such as Sigma Chemical Co. (800) 325-3010. Do not use powdered KHP; powdered KHP will not completely dissolve.

b. Thymolphthalein, pH indicator, CAS No. 125-20-2, powder, available from chemical supply houses such as Sigma Chemical Co. (800) 325-3010.

c. Grade B water.

d. Isopropyl alcohol as specified in 4.4.2.

5.13.5.3 Reagent preparation.

a. Prepare a 4 percent wt/vol KHP solution by adding 100.0±1.0 mL of Grade B water to each 4.0±0.1 grams of KHP (see 5.13.5.2(a)). The KHP may not dissolve in the water immediately. After adding the water to the flask gently swirl or stir the contents for about 1 minute being careful not to deposit solid KHP on the sides of the container. Let the container stand for 10 minutes and swirl or stir the flask for an additional minute. The KHP solution has a 3-month shelf life when stored in a tightly sealed glass container.

b. Prepare a 0.2 percent wt/vol thymolphthalein pH indicator solution by adding 50.0±1.0 mL of isopropyl alcohol (see 5.13.5.2(d)) to each 0.1±0.01 grams of thymolphthalein (see 5.13.5.2 (b)). The solution may have to sit for up to 4 hours to allow the thymolphthalein to completely dissolve. The pH indicator should be clear, water white with no precipitate. The pH indicator has a 1-month shelf life when stored in a tightly sealed brown glass or plastic container.

5.13.5.4 Procedure.

a. Transfer 50.0±1.0 mL of the 4.0 percent KHP solution (see 5.13.5.3(a)) to the beaker or erlenmeyer flask.

b. Add five drops of the 0.2 percent thymolphthalein pH indicator solution (see 5.13.5.3(b)) to the beaker or erlenmeyer flask. The KHP solution should be clear.

c. Fill the syringe or buret with NOC test solution. Record to the nearest 1 mL the level of the NOC in the syringe or buret.

d. Slowly add NOC to the KHP solution while swirling the beaker or erlenmeyer flask until a blue color endpoint persists for 15 seconds. Record to the nearest 1 mL the final level of the NOC in the syringe or buret.

5.13.5.5 Calculation. Determine the volume of NOC used by subtracting the final level (from 5.13.5.4(d)) of NOC solution in the syringe or buret from the initial level (from 5.13.5.4(c)) of NOC solution in the syringe or buret. Record this volume difference in milliliters. Report this number as the alkalinity - mL of NOC. When the alkalinity test measures 35 to 40 mL of NOC, the NOC should be discarded, or recharged as specified in 4.3.1.8.

5.13.6 Detection of hydrocarbon contamination by swipe. This procedure can be used to identify the presence of hydrocarbons in visible contamination. Some non-visible contamination such as a film of hydrocarbon lubricating oil may also be detected. It is intended to supplement the visual inspection methods of 5.13.1.2 to 5.13.1.4 during maintenance or loss of system cleanliness. The procedure does not measure the concentration of hydrocarbon contamination, and shall not be used to certify cleanliness of a system or component not previously cleaned and certified as specified in this standard. The procedure has a sensitivity of only 20 to 30 milligrams per square foot (mg/ft^2) hydrocarbons. Systems and components cleaned and certified as specified in this standard have hydrocarbon cleanliness levels of 3 mg/ft^2 or less.

5.13.6.1 Equipment.

a. Disposable pure Teflon membrane filters as specified in B.5(c) of Appendix B. Do not use bonded or laminated Teflon filters as these filters contain hydrocarbons that will interfere with the analysis.

b. A Fourier transform infrared (FTIR) spectrometer.

5.13.6.2 Swipe Procedure.

a. Using cleanroom gloves as specified in 5.1.6, swipe the area of interest by applying direct pressure to the center of the filter using only one finger and draw for a distance of about 1 to 2 inches. Unlike 5.13.1.4, the swipe area is intended to be very small. In order to detect contamination with the FTIR, it is very important to locate the contamination in the center of the filter in a very small area; preferably less than 10 millimeter diameter.

b. Transfer the filter to a non-contaminating container such as a clean polyethylene bag as specified in 5.16, or a clean glass or clear hard plastic container. Record the date and the swipe location, and transport to a laboratory for analysis.

5.13.6.3 FTIR Procedure.

a. Perform about 32 scans of the center swiped area of the filter with the FTIR in absorbance mode with Res 4 and full aperture between 2600 cm^{-1} and 3400 cm^{-1}.

b. Review the spectrum for absorbance peaks occurring at the CH stretch region near 2930 cm^{-1}. Absorbance peaks in this region that are 3 to 5 times higher than background are discernable significant peaks that indicate the presence of hydrocarbon contamination requiring corrective action.

5.14 Personnel qualification and training.

5.14.1 Applicability. Piping systems and components to be certified oxygen clean, shall be cleaned, assembled, tested (if cleanliness is being maintained), packaged, and, when required by Table XII, inspected or witnessed by qualified personnel. Government personnel shall be qualified as either Certified Oxygen Clean Instructors or Certified Oxygen Clean Workers. Qualification shall be obtained by completing the appropriate course of instruction specified in 5.14.2 and passing a written examination. Contractor personnel shall demonstrate equivalent training by completing the appropriate course of instruction specified in 5.14.2, or its equivalent, and passing an appropriate written examination. Vendor personnel should obtain equivalent training from authorized government facilities or commercial agencies such as ASTM subcommittee G-4 or CGA.

5.14.2 Course of instruction.

5.14.2.1 Certified Oxygen Clean Instructor. Personnel qualified as Certified Oxygen Clean Instructors shall successfully complete an oxygen clean instructor course. The location and content of the course shall be as authorized by NAVSEA. The course content shall include all requirements, directions, and provisions of this standard. Requalification of Certified Oxygen Clean Instructors shall be as specified in 5.14.3. Personnel qualified as Certified Oxygen Clean Instructors and whose job function provides continuous proficiency in the requirements of this standard should be designated Senior Certified Oxygen Clean Instructors by the local command or activity. Examples of job functions that provide continuous proficiency include cleanroom supervisors and personnel teaching oxygen clean instructor courses.

5.14.2.2 Certified Oxygen Clean Worker. Personnel qualified as Certified Oxygen Clean Workers shall successfully complete an oxygen clean worker course taught by a Certified Oxygen Clean Instructor. The location and content of the course shall be authorized by the local command or activity. The course content shall, at a minimum, include those requirements of this standard that pertain to the safe accomplishment of work performed at the local command or activity. Requalification of Certified Oxygen Clean Workers shall be as specified in 5.14.3.

5.14.3 Requalification. Personnel shall requalify every 3 years by completing an accelerated course of instruction that reviews at a minimum the requirements for oxygen and cleaning agent safety, maintenance of oxygen cleanliness, loss of oxygen cleanliness, packaging, certification, and any changes or revisions to this standard. The local command or activity may exempt Senior Certified Oxygen Clean Instructors from requalification. Requalification of Certified Oxygen Instructors shall be performed by a Senior Certified Oxygen Clean Instructor. Requalification of Certified Oxygen Clean Workers shall be performed by a Certified Oxygen Clean Instructor, or by completing a NAVSEA approved electronic-learning Oxygen Clean Worker Requalification Course.

5.15 Validation of the component cleaning process.

5.15.1 Periodicity. Validation of the aqueous component cleaning process shall be performed annually as specified in 5.15.2. This validates the entire process including the pre-clean, final clean, rinse, and dry steps. Each operator should perform the validation within a 3-year period. Records of the results of the validations shall be maintained for not less than 3 years. Failure to meet the validation requirements shall be immediately corrected, assessed for impact on previously delivered oxygen clean material, and recorded (see 6.3).

5.15.2 Procedure. Three monel or cres 304 or 316 coupons of dimensions 0.875 to 1.125 inches wide by 3.875 to 4.125 inches high by 0.0625 to 0.125 inches thick shall be cleaned as specified in 5.2. Each coupon shall be weighed on a scale capable of measuring 0.1 mg. All three coupons shall be contaminated with 75 to 100 mg of the same soil and weighed. The soils used shall be MIL-PRF-24139 hydrocarbon grease, SAE-AS8660 silicone grease, and MIL-PRF-27617 fluorinated grease, or equal. The contaminated coupons shall be cleaned as specified in 5.2. After cleaning, the final weight of each coupon shall indicate that not less than 99.9 percent of the soil was removed.

5.16 Packaging, identification, and storage.

5.16.1 Packaging.

5.16.1.1 Applicability. Certified oxygen clean components cleaned internally and externally shall be packaged as specified in 5.16.1.2. Certified oxygen clean items cleaned internally only, such as hoses or piping assemblies, shall be packaged as specified in 5.16.1.3.

5.16.1.2 Internally and externally cleaned components. Using film as specified in Table XI, packaging shall be accomplished as follows:

a. Sealing of openings. Items with openings leading to cleaned inner surfaces, should be sealed as specified in 5.16.1.3.

b. Intimate cushioning. Heavy items or items having threads, sharp points, or edges which could damage the barrier packaging shall be cushioned with film. Secure the cushioning film with tape whose adhesive shall not come in contact with the cleaned component.

c. Intimate packaging. After performing step (a) or (b), if applicable, place the component in a film bag and gently compress the bag to force out excess air. Heat seal the bag. For temporary closures, such as maintaining cleanliness of a component during transport, tape may be used to completely seal the bag opening provided the adhesive does not come in contact with the cleaned component.

d. Environmental packaging. After performing step (c), package the component using the same methods as specified in step (c).

5.16.1.3 Internally cleaned items. If feasible, plugs or external caps should be used. Film can be used when openings cannot be sealed with caps or plugs. Film should not be used for flasks because it may not provide an adequate moisture barrier. The requirements are as follows:

a. Plugs and external caps. Plugs and caps shall have the same or higher degree of cleanliness as the item being sealed. Threaded plugs shall be manufactured from brass, copper-nickel, or nickel-copper. Mechanically expandable, insert type plugs fabricated from nonshedable rubber in accordance with ZZ-G-710, or equal, are acceptable. The use of wood or plastic plugs is not permitted. Caps shall be fabricated from nonshedable plastic or corrosion-resistant metal such as stainless steel, monel, brass, or copper. Caps shall be secured and sealed by bolting or by taping. Tape or wood shall not be used as the capping material. Wood, however, may be used over the metallic cap for purposes of bolting.

b. Closure with film. Apply a double layer of film as specified in Table XI over openings. Secure each layer of film with a minimum of two tight wraps of tape. The tape shall not contact the open portions of the item. If the closure is for other than temporarily maintaining cleanliness, a third layer of packaging material shall be applied in the same manner or, preferably and if practical, completely wrap the item with packaging material as specified in 5.16.1.2.

TABLE XI. Film for packaging.

Material properties	Material [1]		
	Polyethylene	Nylon [2]	Teflon FEP [2]
Application	Intimate or environmental	Intimate	Intimate
Specification	MIL-PRF-22191 or equal [5]	Commercial	Commercial
Thickness (approximate)	6 mils	2 mils	2 to 5 mils
Strength	Low	High	Medium
Sloughing resistance	Low	High	Medium
Moisture permeability resistance	High	Low	High
Gas permeability resistance	High	Low	Low
Oxygen flammability [3]	Medium	Medium	Low
Static charge color coding [4]	Static: natural Anti-static: pink	Static: natural Anti-static: orange or yellow-green	Not color coded. Available in anti-static.

NOTES:

[1] Film cleanliness should be verified by visual inspection as specified in 5.13.1.2 and 5.13.1.3.

[2] Local engineering shall approve the use of these materials including the applicable source using MIL-HDBK-407 for guidance.

[3] Flammability is a concern if film is introduced into a system.

[4] It is recommended that all film be anti-static.

[5] Polyethylene in accordance with A-A-3174, Type I or II, Class 1, Grade A is equivalent to MIL-PRF-22191.

5.16.2 Identification.

5.16.2.1 Acceptance. In order to identify materials and components which have been certified oxygen clean, a sticker or tag indicating certification shall be completed. The sticker or tag shall be affixed to the capped or plugged item or package or placed between the intimate and environmental packaging containing the item so that it will not come in contact with the certified oxygen clean item. The sticker or tag shall, at a minimum, contain the information given on Figures 1 and 2. The shape of the tag is optional.

5.16.2.2 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, action shall be taken by the shop processing the material or quality assurance office representative to clearly indicate that the material requires recleaning.

5.16.3 Storage.

5.16.3.1 Location. Materials and components which have been certified oxygen clean shall be stored in a clean storage area. Certified oxygen clean materials shall be stored so as to prevent damage to their protective plastic covers. The storage area should protect the material from exposure to dirt and oil, and should also protect the material from temperature extremes of below 40 °F and above 100 °F. The certification sticker or tag shall be attached so as to be visible for inspection.

5.16.3.2 Inspection of packaging. Prior to use or transport, the packaging of all certified oxygen clean materials shall be inspected. If the outer package is torn or damaged, but the inside package is intact, replace the outer package. If the inside package is torn or damaged exposing the oxygen cleaned surface to the ambient atmosphere, the item shall be recleaned and recertified as specified herein. An exception is high valued items such as valves, regulators, and compressors of which local engineering approval to use 5.12 shall be obtained (see 6.3). For shipboard storage, the packaging of all certified oxygen clean material should be inspected every 3 years to ensure ready spares are available.

5.17 In-process inspections.

5.17.1 Inspection. When required by Table XII, an inspector or witness shall observe the applicable operation for compliance with this standard. The witness or inspectors shall be designated by the local activity.

5.17.2 Objective quality evidence (OQE). Objective quality evidence testifying to the satisfactory accomplishment of the following inspections required by this standard shall be recorded and maintained for not less than 3 years. An exception is that OQE is not required for inspections specified in 5.10 during maintenance of cleanliness when performed by Type Commander or Ships Force personnel on systems and equipment not certified by NAVSEA SS800-AG-MAN-010/P-9290, NAVSEA SS521-AA-MAN-010, or NAVSEA 0924-LP-062-0010.

a. Cleanroom maintenance inspections required by 5.1.2.
b. Results of testing specified by 5.9.
c. Results of inspections or analyses addressed in 5.13 when directed by this standard.
d. Signature or initial of witnesses or inspectors when directed by 5.17.1.

5.17.3 Audit or surveillance. Facilities performing oxygen cleaning may be subject to audits or surveillance made by higher level organizations such as an assurance office representative, an authorized representative of NAVSEA, or the agency concerned for compliance with this standard in accordance with NAVSEA TL855-AA-STD-010. Audit or surveillance results shall be recorded (see 6.3).

TABLE XII. In-process operation inspections.

Procedure	Operation	Operation performed by	Inspector or witness
5.1.2	Facility maintenance	Not applicable	Not required
5.2 and 5.16	Cleaning and packaging of components in a cleanroom	Not applicable	Not required
5.2 and 5.16	Cleaning and packaging of components in a controlled area	Not applicable	Required [1/] [2/]
5.3	Cleaning of flasks	Not applicable	Not required
5.3	Inspection of flasks	Not applicable	Required [1/]
5.4	Instrument cleaning	Not applicable	Not required
5.5 through 5.8	Cleaning of piping systems	Not applicable	Not required
5.9.1 and 5.9.2	Pressure and operational testing	Not applicable	Not required
5.9.3	Gas analysis	A facility which is recognized and accepted by NAVSEA	Not required
5.10	Maintenance of cleanliness	Not applicable	Required [1/] [2/]
5.11	Piping repairs between flasks	Not applicable	Not required
5.12	Loss of system cleanliness	Not applicable	Required [1/] [2/]
5.13.1	Visual inspection of surface for cleanliness	Personnel who performed the cleaning or an independent group not associated with the cleaning	Not required
5.13.2.2	Shake test	Personnel who performed the cleaning or an independent group not associated with the cleaning	Not required
5.13.2.3 through 5.13.2.8	NVR and hydrocarbon inspection	Personnel who performed the cleaning	Required [2/]
		Independent group not associated with the cleaning	Not required
5.13.2.9 5.13.3.2	Visual inspection for clarity or particles	Personnel who performed the cleaning or an independent group not associated with the cleaning	Not required
5.13.3.3	Particle count	Personnel who performed the cleaning	Required [2/]
		Independent group not associated with the cleaning	Not required
5.13.4 and 5.13.5	pH and alkalinity analysis	Personnel who performed the cleaning or an independent group not associated with the cleaning	Not required

TABLE XII. In-process operation inspections. Continued.

Procedure	Operation	Operation performed by	Inspector or witness
5.13.6	Detection of hydrocarbons by swipe	Personnel who performed the cleaning or an independent group not associated with the cleaning	Not required
5.16	Packaging	Not applicable	Required if packaging is for maintaining system cleanliness. Not required for all other circumstances. [1]

NOTES:

[1] Inspectors or witnesses shall be qualified as specified in 5.14.

[2] Not required if approved by local engineering.

5.17.4 Accountability of small items. For most applications, measures to prevent entry of small items into openings are adequate; however, for applications such as oxygen-nitrogen plants, accountability of small items is also necessary. To prevent entry of small items into systems or components, attach the item to the user or to a fixed piece of equipment by a wire, lanyard, or equivalent method. When accountability is needed, a formal written record 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 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 so that it precludes the inadvertent introduction of foreign materials and tools. Extraneous tools, equipment, and material shall be removed from the proximity of an opening in a system or component.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard practice is for the precision cleaning and testing of naval surface ship, submarine and diving oxygen, oxygen enriched systems, and interfacing systems. The precision cleaning process specified herein is based on the processes and data reported in COMNAVSEA ltr's Ser 03Y2A/081 dtd 24 Mar 94, Ser 03Y2A/122 dtd 7 Apr 95, and Ser 03Y2A/275 dtd 11 Sept 95, and supplements thereof; and NASA Doc. No. WSTF-IR-95-0048 dated 30 Jan 95, and supplements thereof. The performance of the precision cleaning process specified herein directly affects the safe operation of naval surface ship, submarine and diving oxygen systems, oxygen enriched systems, and interfacing systems. Nonconformance can result in the introduction or failure to remove toxic and flammable contaminants that can cause catastrophic equipment failure and personnel injury and death.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the standard.

b. Identification of critical application systems or components as defined in 3.11, if applicable.

6.3 NAVSEA approval and direction.

6.3.1 Deviations from specified materials, procedures, and requirements and selection of specific alternative materials and procedures require NAVSEA approval or direction. Requests should include supporting documentation.

6.3.2 Several referenced documents within Appendix A of this standard are known to be officially withdrawn at the time of this revision's approval. Since these documents are still in common use within commercial practice and industry, the official status of these publications should not affect the intent of this specification. Additionally, three documents that have been officially withdrawn at the time of this revision's approval are still in common use within commercial practice and industry; and continued use is technically acceptable. FED-STD-209, Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones, has been cancelled and replaced by ISO-14644 (reference Section 5.1). However, FED-STD-209 Class 100,000 (or better) clean rooms for critical applications are technically acceptable alternatives to ISO-14644. MIL-STD-1246 has been cancelled and replaced by IEST-STD-CC1246 (reference Section 5.13). However, particle counts in accordance with MIL-STD-1246, Product Cleanliness Levels and Contamination Control Program, for critical applications are technically acceptable alternatives to IEST-STD-CC1246. ASTM D930, Standard Test Method of Total Immersion Corrosion Test of Water Soluble Aluminum Cleaners, has been cancelled without replacement (Reference Appendix A). For historical purposes, ASTM D930 was used to evaluate the corrosion resistance of all aqueous cleaners with aluminum.

6.4 Safety precautions. If an oxygen monitor with alarm is used as specified in 4.7.1, it should be in accordance with OPNAVINST 5100.19.

6.5 Subject term (key word) listing.

Halogenated solvent

Helium

Hydrogen

Isopropyl alcohol

Navy oxygen cleaner (NOC)

Oxygen

Oxygen clean

Trisodium phosphate

6.6 Change notations. The margins of this standard are marked with vertical lines to indicate modifications generated by this change. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

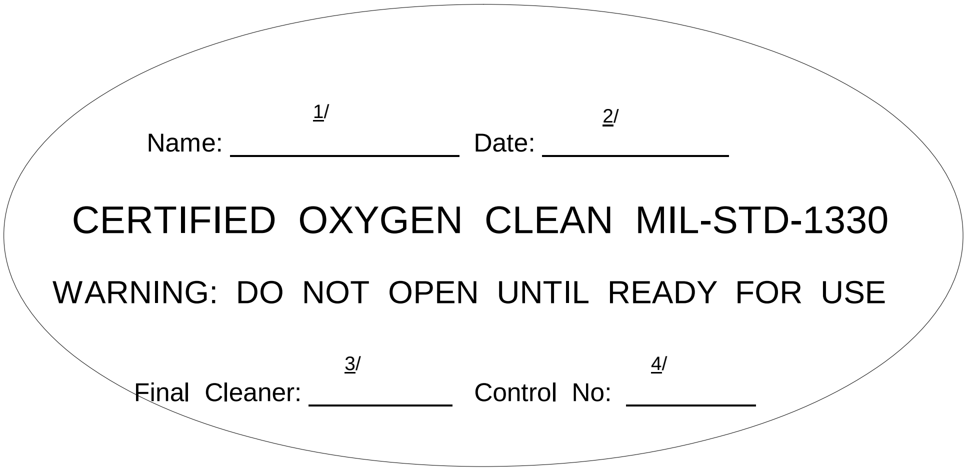
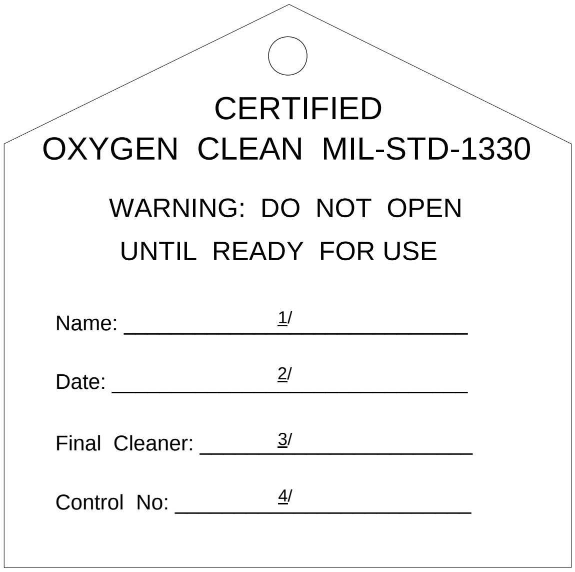


FIGURE 1. Typical certification sticker. 5/



CERTIFIED
OXYGEN CLEAN MIL-STD-1330

WARNING: DO NOT OPEN
UNTIL READY FOR USE

Name: ________ 1/ ________

Date: ________ 2/ ________

Final Cleaner: ____ 3/ ________

Control No: ______ 4/ ________

FIGURE 2. Typical certification tag. 5/

NOTES:

1/ Activity or organization that performed the cleaning.

2/ Date cleaning performed.

3/ Specify NOC, TSP, or specific NAVSEA approved halogenated solvent.

4/ Unique number traceable to the OQE as specified in 5.17.2.

5/ Stickers and tags shall have backgrounds that are green in color, but may be of any shape including square, rectangular, and circular, as well as those indicated.

MATERIAL COMPATIBILITY

A.1 SCOPE

A.1.1 Scope. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance. This appendix provides results of compatibility testing and direction for performing additional testing.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in sections A.3 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections A.3 of this standard, whether or not they are listed.

A.2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those cited in the solicitation or contract (see 6.2).

ASTM INTERNATIONAL (ASTM)

ASTM D471	-	Standard Test Method for Rubber Property - Effect of Liquids (DoD adopted)
ASTM D543	-	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents (DoD adopted)
ASTM D1280	-	Standard Test Method of Total Immersion Corrosion Test for Soak Tank Metal Cleaners
ASTM D1414	-	Standard Test Methods for Rubber O-Rings (DoD adopted)

(Copies of these documents are available online at www.astm.org or from ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959.)

A.3 PROCEDURE

A.3.1 Compatibility testing. Compatibility is determined by evaluating material properties such as weight, volume, tensile strength, elongation, or hardness and, for metals, inspecting the surface for discoloration and degradation after exposure to the fluid of interest. Guidelines for performing material compatibility testing are as specified in A.3.2 through A.3.4. These guidelines are conservative. Accordingly, local engineering review of compatibility testing performed or actual experience may result in different conclusions. Results of compatibility testing using these guidelines are provided in Tables A-I through A-III. If experience or testing indicates that a material is less compatible than as indicated in these tables, contact NAVSEA. If a material of interest is not listed in these tables, compatibility testing shall be accomplished using the following guidelines.

A.3.2 Metal. ASTM D930 or ASTM D1280 provide guidance for performing compatibility testing on metals. The allowable corrosion limits are as specified in MIL-DTL-24800.

A.3.3 Rubber. ASTM D471 or ASTM D1414 provide guidance for performing compatibility testing on rubbers. The criteria to determine the exposure limits are as specified in Table A-IV.

A.3.4 Plastic. ASTM D543 provides guidance for performing compatibility testing on plastics. The criteria to determine the exposure limits are as specified in Table A-V.

TABLE A-I. Metallic material compatibility.

METAL; specification	NOC 170 °F [1]	TSP 170 °F [1]	WATER 170 °F [1]	NID [1] [2]
ALUMINUM, Alloy 5052-0; WW-T-700 and WW-T-700/4	C	I	I	NH
ALUMINUM, Alloy 5456; ASTM B209, HT116	C	I	C/D	NH
ALUMINUM, Alloy 6061-T6; ASTM B221	C	I	C	NH
ALLOY STEEL, Alloy HY-100; MIL-S-16216	C	C	C	C
ALLOY STEEL, Alloy HY-100; MIL-S-23008	C	C	C/D	C
ALLOY STEEL, Alloy MIL-F-22606; ASTM A336 CL F-22	C	C	C/D	C
ALLOY STEEL, Alloy 4130, MIL-F-22606	C	C	C/D	C
BRAZING MATERIAL, BCuP-5; QQ-B-654	C	C	C	C
BRONZE; CDA922	C	C/D	C	C
CARBON STEEL, ABS Grade EH36; MIL-S-22698	C	C	C	C
COPPER, Alloy C12200-H80; MIL-T-24107	C	C/D	C	C
COPPER-NICKEL, Alloy C715-70/30; MIL-T-16420	C	C	C	C
COPPER-NICKEL, Alloy C715-70/30; MIL-C-15726	C	C	C/D	C
INCONEL, Alloy N06600; ASTM B167 CW	C	C	C/D	C
INCONEL, Alloy N06600; ASTM B167 HF	C	C	C	C
INCONEL, Alloy N06625; ASTM B446 CR	C	C	C	C
NAVAL BRASS, Alloy 464; ASTM B171	C/D	C/D	C	C
NICKEL-ALUMINUM-BRONZE, Alloy C95800; ASTM B148	C	C/D	C	C
NICKEL-ALUMINUM-BRONZE, Alloy C63000-HR50; ASTM B150	C	C/D	C/D	C
NICKEL-ALUMINUM-BRONZE, Alloy C64200-HR50; ASTM B150	C	C/D	C/D	C
NICKEL-COPPER; MIL-T-1368	C	C	C	C
NICKEL-COPPER; QQ-N-281 CL A	C	C	C	C
NICKEL-COPPER; QQ-N-286, Cold Aged	C	C	C	C
STAINLESS STEEL, Alloy 304; MIL-P-24691 and MIL-P-24691/3	C	C	C/D	C
STAINLESS STEEL, Alloy 304; QQ-S-763 Cold	C	C	C/D	C
STAINLESS STEEL, Alloy 316; QQ-S-763 Cold	C	C	C	C
TITANIUM, Pure; ASTM B337	C	C	C	C
TITANIUM, Ti-6Al-4V; ASTM B265 GR5	C	C	C	C

NOTES:

[1] See [1] on Table A-II or A-III.

[2] See [2] on Table A-II or A-III.

TABLE A-II. Rubber material compatibility.

RUBBER; specification	NOC 170 °F [1]	TSP 170 °F [1]	WATER 170 °F [1]	NID [1] [2]
ADIPRENE, Polyether urethane	1L	12L	12L	C
BUNA-N, Butadiene-nitrile; MIL-P-5510	C	C	C	C
BUNA-N, Butadiene-nitrile; MIL-P-5516, Class A	C	C	C	C
BUNA-N, Butadiene-nitrile; MIL-P-5516, Class B	C	C	C	C
BUNA-N, Butadiene-nitrile; MIL-P-25732 [3]	C	C	C	C
BUNA-N, Butadiene-nitrile; MIL-P-83461	C	12L	C	C
BUNA-S, Butadiene-styrene; MIL-S-21923	C	C	C	C
EP, Ethylene propylene; MIL-G-22050, 65 Durometer	12L	12L	12L	C
EP, Ethylene propylene; MIL-G-22050, 80 Durometer	12L	12L	12L	C
EP, Ethylene propylene; AIA NAS 1613, 70 Durometer	12L	C	C	C
EP, Ethylene propylene; AIA NAS 1613, 80 Durometer	C	C	C	C
EP, Ethylene propylene; MIL-R-83285, 60 Durometer	12L	C	C	C
EP, Ethylene propylene; MIL-R-83285, 80 Durometer	12L	C	C	C
HYPALON-40, Chlorosulfonate polyethylene; MIL-R-81828	C	12L	C	C
KEL-F, Polychlorotrifluorothylene; Commercial	1L	12L	12L	C
NEOPRENE, Chloroprene; MIL-R-6855	C	C	C	C
SILICONE, Vinyl-methyl-polysioxane; Commercial	12L	C	C	NH
THIOKOL FA, polysulfide; Commercial	C	12L	C	C
VITON, Vinylidene fluoride + hexafluoroproplyene; MIL-R-83248, 75 Durometer	12L	C	12L	C
VITON, Vinylidene fluoride + hexafluoroproplyene; MIL-R-83248, 90 Durometer	12L	12L	C	C

NOTES:

[1] "C" indicates that the material is compatible with the cleaning agent.
"I" indicates that the material is not compatible with the cleaning agent.
"1L" indicates that exposure of the material should be limited to 1 hour per cleaning.
"12L" indicates that exposure of the material should be limited to 12 hours per cleaning.
"C/D" indicates that the material is compatible with the cleaning agent, but the material surface was discolored during testing. Testing on a sample of the material may be necessary to determine if the discoloration is permissible.
"NT" indicates that the material was not tested.

[2] Compatibility of NID is based on test data and service history. "NH" indicates that there is no test data or history on the material compatibility.

[3] Compatibility of Buna-N in accordance with MIL-P-25732 is provided for historical purposes only. MIL-P-25732 is inactive for new design.

TABLE A-III. Plastic material compatibility.

PLASTIC; specification	NOC 170 °F [1]	TSP 170 °F [1]	WATER 170 °F [1]	NID [1] [2]
ABS, Acrylonitrile butadiene styrene; Commercial	C	C	C	NH
DELRIN, Acetal resin; ASTM D4181	C	C	C	C
EPOXY, Epoxy resin; Commercial, unfilled	I	I	I	C
HDPE, High density polyethylene; ASTM D1248	C	C	C	C
LEXAN, Polycarbonate resin; Commercial	C	C	C	C
LUCITE & PLEXIGLASS, Methyl-methacrylate; MIL-P-5425, finish A	I	1L	1L	C
NYLON, Polyamide resin; ASTM D4066, nylon 6,6	1L	1L	1L	1L
PAI, Polyamide-imide (Torlon 4203L); Commercial, injection molded	12L	12L	C	NH
PEI, Polyetherimide (Ultem 1000); Commercial, injection molded	1L	1L	C	C
Polyurethane; Commercial	12L	C	I	NH
PP, Polypropylene; ASTM D4101, unfilled	12L	C	C	C
PVC, Polyvinyl chloride; ASTM D1784, rigid	C	C	C	C
PVC, Polyvinyl chloride; ASTM D2287, nonrigid	12L	C	12L	C
SURLYN, Ionomer resin; Commercial, No. 9650	NT	I	I	C
SURLYN, Ionomer resin; Commercial, No. 9720	I	C	C	C
TEFLON FEP, Fluoethyl propylene; ASTM D2116	C	C	C	C
TEFLON TFE, Polytetrafluoro-ethylene; ASTM D1457	12L	12L	C	C
VESPEL-21, Polyamide resin + graphite; Commercial	1L	1L	NT	C

NOTES:

[1] "C" indicates that the material is compatible with the cleaning agent.
"I" indicates that the material is not compatible with the cleaning agent.
"1L" indicates that exposure of the material should be limited to 1 hour per cleaning.
"12L" indicates that exposure of the material should be limited to 12 hours per cleaning.
"C/D" indicates that the material is compatible with the cleaning agent, but the material surface was discolored during testing. Testing on a sample of the material may be necessary to determine if the discoloration is permissible.
"NT" indicates that the material was not tested.

[2] Compatibility of NID is based on test data and service history. "NH" indicates that there is no test data or history on the material compatibility.

TABLE A-IV. Rubber compatibility criteria.

Exposure limit	Tensile and elongation (% original)	Durometer hardness (change in units)	Volume (% change)
Compatible	≥ 85	≤ ±5	≥ 0 and ≤ +10
12 hours	≥ 75 and < 85	> ±5 and ≤ ±7	≥ -5 and < 0
1 hour	≥ 60 and < 75	> ±7 and ≤ ±9	≥ -10 and < -5 > +10 and ≤ +15
Incompatible	< 60	> ±9	< -10 > +15

TABLE A-V. Plastic compatibility criteria.

Exposure limit	Tensile (% original)	Weight (% change)
Compatible	≥ 95	≤ 1
12 hours	≥ 90 and < 95	> 1 and ≤ 2
1 hour	≥ 85 and < 90	> 2 and ≤ 3
Incompatible	< 85	> 3

ANALYSIS OF NON-VOLATILE RESIDUE IN NAVY OXYGEN CLEANER BY GRAVIMETRIC

B.1 SCOPE

B.1.1 Scope. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance. This appendix provides a procedure for determination of non-volatile residue (NVR) in the Navy oxygen cleaner (NOC) by gravimetric analysis. The residue could consist of any insoluble low vapor pressure material in the NOC including particulate, gels, and inorganic as well as organic residues which are retained by a Teflon membrane filter of pore diameter 0.45 micrometer.

B.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

B.3 PROCEDURE

B.3.1 Summary of test method. The NVR in NOC is determined by passing a given quantity of NOC through a 0.45-micrometer Teflon filter and measuring the increase in the weight of the filter. The NOC sample is either pushed through the filter by pressurizing a filtration reservoir containing the NOC sample with oil-free nitrogen, or the NOC sample is drawn through the filter by a vacuum. The filter collects the NVR residue contained in the NOC. The filter is subsequently washed with demineralized water, dried, and weighed. The increase in the weight of the filter is a measure of the NVR in the NOC. This is performed for new, before-use NOC to establish a baseline NVR, and is then compared to a post clean NOC sample to determine a final net after cleaning NVR.

B.4 Significance and use.

B.4.1 NOC is an aqueous inorganic alkaline solution that is filtered to 0.1 micrometers during manufacture resulting in a material specification of 1.0 mg/L for insoluble matter. NOC removes oil and grease by displacement with the resultant removed contaminants existing in NOC as a filterable suspension. This test method measures the amount of NVR contained in NOC. The test is used to verify the cleanliness of oxygen systems and components which have been cleaned by NOC.

B.4.2 This method will determine the amount of all types of NVR washed out of a system or component by NOC including organic material, particulate, and gels. The filtrate is dried at a temperature less than or equal to the NOC application temperature. Therefore, this procedure is not expected to result in any appreciable loss of semi-volatile contaminants.

B.4.3 This analysis is susceptible to interference from demineralized water contaminated with insoluble material, from a filtration column contaminated with dried NOC residue or ambient dust, and to homogenizer wear that could contaminate the NOC sample with particulate.

B.4.4 The quantitative cleanliness standard for systems cleaned as specified in this standard generally applies to organic (hydrocarbon) residues. However, this gravimetric method does not differentiate between organic and inorganic residue. Therefore, when reporting contamination based solely on the results of this analysis, a higher than actual value may be reported resulting in a built-in safety factor.

B.5 Apparatus.

a. A balance accurate to 0.1 mg with a zero drift less than 0.1 mg. A balance with an accuracy of 0.05 mg with a zero drift less than 0.05 mg is suggested. The balance shall be calibrated in accordance with the Navy Metrology and Calibration Program, or equivalent. Between calibrations, the accuracy of the balance should be verified using certified balance weights. Suitable balances, such as A&D Model ER-182A or OHAUS Model AP250D, are available through laboratory supply houses such as Thomas Scientific.

b. Balance weights of 1.0, 2.0, 5.0, and 10.0 mg, accurate to 0.02 mg (NIST Class S or ASTM Class 2) and made from non-magnetic material.

c. Disposable Teflon membrane filters of 0.45 or 0.50 micrometer pore size and 47 millimeter diameter supplied by Savillex Corp., 6133 Baker Rd, Minnetonka, MN 55345, (612) 935-4100, part number 1121; Millipore Corp., 80 Ashby Rd, Bedford, MA 01730, (617)275-9200, part number FHUP04700, or equal.

d. Stainless steel vacuum filtration column with not less than 250 mL capacity available from laboratory supply houses such as Fischer Chemical is preferred. Alternately, an inexpensive Teflon vacuum or pressure filtration reservoir of 250 mL capacity minimum is available from Savillex Corp., 6133 Baker Rd, Minnetonka, MN 55345, (612) 935-4100, consisting of cap with connection for ¼-inch tube, part number 501-4; upper segment, part number 504; lower segment, part number 504-47; and upper/lower segment connector, part number 502, or equal.

e. Laboratory homogenizer with 500-1000 watt motor power with a no-load speed control of 10,000 to 30,000 revolutions per minute (rpm), and a 20 millimeter diameter saw tooth generator capable of homogenizing a 1 liter sample into a 1-5 micrometer emulsion at about 7,500 rpm loaded speed. Suitable homogenizers and generators are available from Omni International Inc., 6530 Commerce Court, Gainesville, VA (800)776-4431, homogenizer part number GLH-115 and generator part number G20-195ST; or PRO Scientific, PO Box 448, Monroe, CT (203)452-9431, homogenizer part number 01-01250 and generator part number 02-20200. A holder or stand for the homogenizer is recommended.

f. A drying oven capable of maintaining a temperature of 55 °C (131 °F) to 60 °C (140 °F).

g. NOC sample/homogenizing bottles of 1-liter volume for collecting and homogenizing NOC effluent from oxygen systems or NOC effluent from oxygen components. Ensure the opening is large enough to allow insertion of the homogenizer generator (item (e)). Wide mouth glass sample bottles with external safety coatings and Teflon lined caps are acceptable, as are sampling containers manufactured from Teflon, Teflon lined glass, Teflon lined plastic, or stainless steel. Suitable containers are available from laboratory supply houses such as Thomas Scientific.

h. Graduated cylinders of 250 mL minimum volume with minimum graduations of 50 mL to measure 200 mL of homogenized NOC sample to be filtered. Cylinders should be glass or polypropylene.

i. A vacuum collector of 500 mL capacity to collect filtered NOC when using a vacuum to draw the NOC through the membrane filter, preferably made of plastic. The stopper used to seal the collector should be made of Teflon. The stopper requires a ¼-inch outside diameter hole for the tube from the filter support.

j. Beakers of 250 mL capacity to collect the filtered NOC, preferably plastic, when pressurizing the NOC sample.

k. Beakers of 250 mL capacity to measure 100 mL of demineralized water used to wash the membrane filter.

l. Erlenmeyer flasks of 1 liter capacity, plastic or glass, for rinsing the homogenizer. Ensure the opening is large enough to allow insertion of the homogenizer generator (item (e)).

m. Petri dishes, quantity 2, which are covered, glass and 50 millimeter minimum diameter for drying membrane filters in the oven.

n. Forceps with non-serrated tips to handle filters.

o. An eye dropper or pipette to transfer isopropyl alcohol to wet the membrane filter prior to filtration.

p. Teflon tape to prepare threaded connections on the filtration reservoir.

q. If using a vacuum to draw the NOC through the membrane filter, a vacuum source capable of drawing a vacuum equivalent to 10 inches Hg (5 lb/in^2 differential) and controllable at 2 inches Hg (1 lb/in^2) increments. Sources of vacuum include traditional electric vacuum pumps; gas vacuum ejector pumps available from Cole-Parmer, and inexpensive water aspirator/ejector vacuum pumps such as Nalgene Part No. 6140-0010.

r. If using pressure to push the NOC through the membrane filter, an oil-free air or nitrogen pressure source capable of providing 5 lb/in^2 and controllable at 1 lb/in^2 increments.

B.6 Reagents.

a. Navy oxygen cleaner (NOC) in accordance with MIL-DTL-24800.

b. Demineralized water in accordance with ASTM D1193 Type II or 1 micrometer nominal filtered Grade B as specified in 4.2.

c. Isopropyl alcohol, American Chemical Society (ACS) reagent grade, having an NVR of 5 ppm (0.005 percent) or less which is available from laboratory supply houses.

B.7 Samples.

a. A 500 to 600 mL sample of new-unused NOC shall be collected from each container or drum of each lot or batch to establish a baseline NVR.

b. A 500 to 600 mL NOC sample of the NOC effluent from the oxygen system or component being cleaned shall be collected for cleanliness verification.

c. Samples of homogenized NOC used for the gravimetric analysis will be 200 mL.

B.8 Preparation and maintenance of apparatus.

B.8.1 Apparatus used in the procedure, including the sample bottles, homogenizer, homogenizing container, graduated cylinder, filtration reservoir, and demineralized water beaker shall have been cleaned as specified in 5.2.

B.8.2 Threaded connections in the filtration reservoir and filter support shall be wrapped with Teflon tape to prevent leakage of the NOC sample.

B.8.3 After contact with NOC, all apparatus shall immediately be rinsed with demineralized water to remove residual NOC to prevent formation of inorganic deposits and to maintain cleanliness.

B.9 Procedure.

B.9.1 Select a membrane filter that has equilibrated to ambient conditions.

B.9.2 Using forceps, weigh the filter to the nearest 0.1 mg, preferably to the nearest 0.05 mg.

B.9.3 Transfer the membrane filter to the filter holder and attach the filter holder to the filtration reservoir as shown on Figure 3. DO NOT OVER TIGHTEN. Over tightening the threaded connections may cause permanent deformation allowing the NOC sample to leak.

B.9.4 Homogenize the 500 to 600 mL NOC sample for 3 minutes at a speed of about 7,500 revolutions per minute (rpm) (position 3 on an OMNI Model GLH homogenizer).

B.9.5 Using an eye-dropper or pipette, wet the filter with about 1 mL of isopropyl alcohol. Allow not less than 15 seconds for the isopropyl alcohol to fully wet the filter. This is observable as a change in filter color from opaque white when dry to translucent when wet.

B.9.6 Optional - Excessive isopropyl alcohol can react with NOC to form a white precipitate that may cause high NVR results. If this interference is suspected, the isopropyl alcohol can be removed from the filter by transferring 15 to 25 mL of demineralized water to the filter reservoir and filtering the demineralized water by vacuum or pressurizing the reservoir with oil-free air or nitrogen before proceeding to step B.9.7.

B.9.7 Transfer 200 mL of homogenized NOC to the filter reservoir.

B.9.8 Filter the homogenized NOC at less than 50 mL/min by vacuum or by pressurizing the reservoir with oil-free air or nitrogen. Very little pressure differential (less than 5 psid) will be required to obtain the desired filtration rate. DO NOT EXCEED A FILTRATION RATE OF 50 MILLILITERS PER MINUTE.

B.9.9 Transfer 100 to 110 mL of demineralized water to the filter reservoir to wash the filter and reservoir of residual NOC.

B.9.10 Filter the demineralized water at less than 50 mL/min by vacuum or by pressurizing the reservoir with oil-free air or nitrogen. Very little pressure differential (less than 5 psid) will be required to obtain the desired filtration rate. DO NOT EXCEED A FILTRATION RATE OF 50 MILLILITERS PER MINUTE.

B.9.11 Remove the filter, place in a petri dish, and dry with petri dish cover ajar in an oven at 131 to 140 °F (55 to 60 °C) for 20 to 30 minutes.

B.9.12 Remove the petri dish with filter from the oven, transfer the filter to an ambient temperature petri dish, and allow it to cool with the cover ajar for at least 2 minutes.

B.9.13 Weigh the filter to the nearest 0.1 mg; preferably to the nearest 0.05 mg.

B.10 Calculations.

B.10.1 Calculate the baseline (before use) NVR in NOC by subtracting the initial weight of the filter (step B.9.2) from the final weight of the filter (step B.9.13) after filtering new-unused NOC. Record the weight difference in mg. Multiply the weight difference by five, and record as baseline (before use) mg/L NVR in NOC.

B.10.1.1 Perform a baseline analysis for each lot or batch of NOC. The term lot or batch refers to the manufacturing lot or batch numbers identified on each container of NOC. Where multiple containers have the same lot or batch number, only one container needs to be sampled. For cleaning applications using multiple containers with different lot or batch numbers, either the average of the different baselines or the lowest of the different baselines shall be used when determining final NVR in NOC.

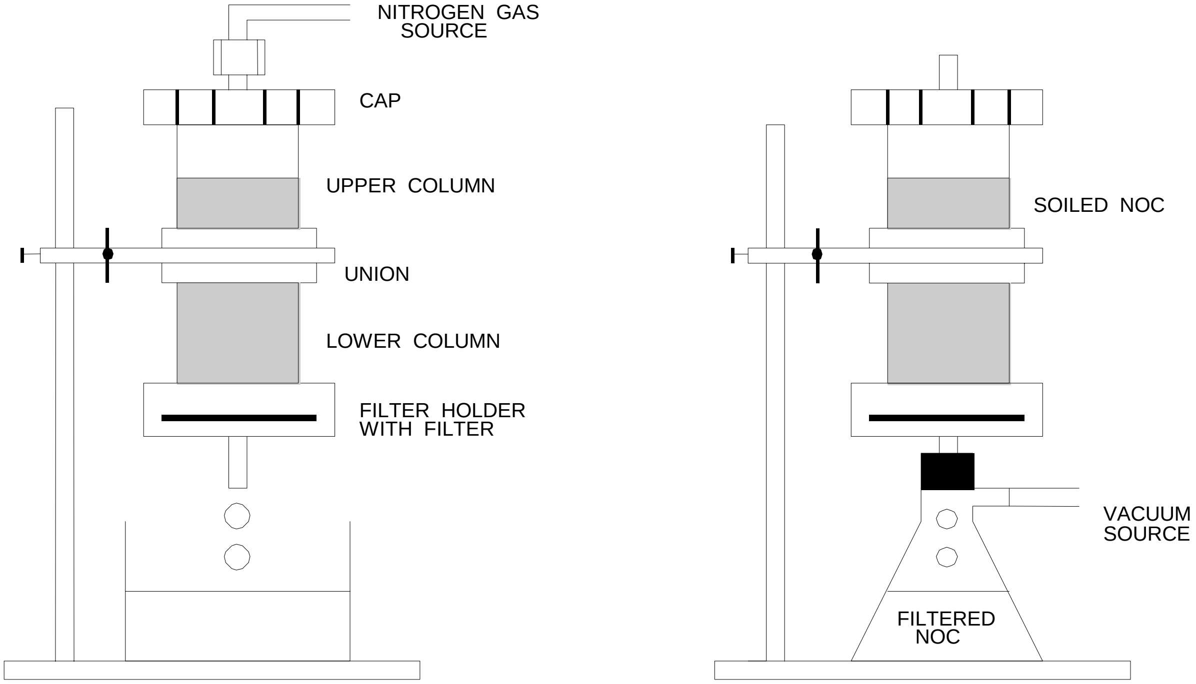
B.10.1.2 When determining baseline NVR in new-unused NOC, step B.9.4 may be deleted, and unhomogenized NOC may be used in step B.9.7.

B.10.2 Calculate the post-cleaning (after use) parts per million (ppm) above baseline NVR in NOC as follows:

B.10.2.1 Subtract the initial weight of the filter (step B.9.2) from the final weight of the filter (step B.9.13) after filtering used NOC. Record the weight difference in mg. Multiply the weight difference by five, and record as post-cleaning (after use) mg/L total NVR in NOC.

B.10.2.2 Subtract the baseline (before use) NVR (from stepB.10.1) from the post-cleaning (after use) total NVR (from step B.10.2.1). Record the difference as post-cleaning (after use) mg/L above baseline NVR in NOC.

B.10.2.3 Convert mg/L to ppm by dividing mg/L (from step B.10.2.2) by 1.075 (the average density of NOC in use) and record as ppm above baseline NVR in NOC.



PRESSURIZATION

VACUUM

FIGURE 3. Filtration for determining NVR in NOC by gravimetric.

TEST PROCEDURE FOR SOLVENT EXTRACTION OF AN AQUEOUS INORGANIC CLEANER

C.1 SCOPE

C.1.1 Scope. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance. This appendix provides a procedure for solvent extraction of inorganic aqueous Navy oxygen cleaner (NOC) or tri-sodium phosphate (TSP) cleaning solution. The solvent extract is subsequently analyzed for hydrocarbon oil and grease or non-volatile residue.

C.2 APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

C.3 PROCEDURE

C.3.1 Summary of test method. The solvent extraction is performed by serially extracting a 500 mL homogenized sample of NOC or TSP with three 160 mL volumes of CFC-113 or HCFC-225 if analyzing for non-volatile residue (NVR) by gravimetric, or serially extracting a 100 mL homogenized sample of NOC or TSP with three 30 mL volumes of CFC-113 solvent if analyzing for hydrocarbon oil and grease by infrared spectrophotometry. Extracts analyzed for NVR are subsequently diluted to 500 mL, while extracts analyzed for hydrocarbon oil and grease by infrared spectrophotometry are subsequently diluted to 100 mL.

C.4 Significance and use.

C.4.1 NOC in accordance with MIL-DTL-24800 and TSP in accordance with O-S-642 are aqueous inorganic solutions that generally contain less than 1 ppm solvent extractable material. NOC and TSP remove industrial oils and greases by displacement with the resultant removed insoluble contaminants existing as a suspension. When mixed with a solvent, the solvent extracts the oil and grease for post hydrocarbon oil and grease or NVR analysis depending upon the solvent used. Since HFE-7100 has marginal hydrocarbon solvency, it cannot be used for extraction.

C.4.2 All NAVSEA halogenated solvents are denser than NOC or TSP solutions so the solvent will settle to the bottom of a separatory funnel during an extraction process.

C.4.3 This test method does not acidify the NOC aqueous sample to a pH of 2 or less like common waste water analyses. Soluble organic materials that would be detectable when acidifying to a pH of 2 are easily detected as a stable foam when performing the shake test as specified in 5.13.2.2.

C.4.4 The homogenizing process cleans oil and grease from the sides of the sample container and equally distributes insoluble oil and grease through the sample as a fine emulsion. This ensures that samples drawn from the original 500 to 600 mL sample are representative.

C.4.5 During the extraction process, small quantities of aqueous cleaner solution will be captured by the solvent. The non-volatile inorganic constituents of the captured aqueous cleaner can interfere with subsequent NVR analyses. This interference can be avoided by establishing a baseline NVR analysis of the aqueous cleaner.

C.5 Apparatus.

a. Laboratory homogenizer with 500-1000 watt motor power with a no load speed control of 10,000 to 30,000 revolutions per minute (rpm), and a 20 millimeter diameter saw-tooth generator capable of homogenizing a 1 liter sample into a 1-5 micrometer emulsion at about 7,500 rpm loaded speed. Suitable homogenizers and generators are available from Omni International Inc., 6530 Commerce Court, Gainesville, VA (800)776-4431, homogenizer part number GLH-115 and generator part number G20-195ST; or PRO Scientific, PO Box 448, Monroe, CT (203)452-9431, homogenizer part number 01-01250 and generator part number 02-20200. A holder or stand for the homogenizer is recommended.

b. Sample/homogenizing bottles of 1 liter volume for collecting and homogenizing NOC or TSP samples. Ensure the opening is large enough to allow insertion of the homogenizer generator (item (a)). Wide mouth glass sample bottles with external safety coatings and Teflon lined caps are acceptable, as are sampling containers manufactured from Teflon, Teflon lined glass, Teflon lined plastic, or stainless steel. Suitable containers are available from laboratory supply houses such as Thomas Scientific.

c. Graduated cylinders of 50 mL minimum volume with minimum graduations of 10 mL to measure 30 mL of solvent and 100 mL minimum volume with minimum graduations of 50 mL to measure 100 mL of aqueous sample, or 250 mL minimum volume with minimum graduations of 10 mL to measure 160 mL of solvent and 500 mL minimum volume with minimum graduations of 100 mL to measure 500 mL of aqueous sample. Cylinders should be glass.

d. Separatory funnels of 250 mL volume minimum for extracting a 100 mL aqueous sample, or 1000 mL minimum volume for extracting a 500 mL aqueous sample. Funnels should be glass.

e. Beakers of sufficient capacity to collect 30 mL or 160 mL serial solvent extracts and transfer to the volumetric flask. Beakers should be glass.

f. Volumetric flasks, or equal, of 100 mL minimum volume with minimum graduations of 100 mL to collect the three 30 mL solvent extracts, or 500 mL minimum volume with minimum graduations of 500 mL to collect the three 160 mL solvent extracts.

C.6 Reagents.

a. Navy oxygen cleaner (NOC) in accordance with MIL-DTL-24800.

b. Tri-sodium phosphate (TSP) in accordance with O-S-642 prepared as specified in 4.3.2.

c. Hydrochloric or sulfuric acid (1+1), ACS reagent grade, prepared by slowly and carefully adding 1 volume of hydrochloric acid (HCl) or sulfuric acid (H_2SO_4) to 1 volume of water.

d. CFC-113 or HCFC-225 (see Appendix E).

C.7 Samples.

a. A 500 to 600 mL NOC or TSP sample shall be collected for hydrocarbon or NVR determination. The sample bottles used to collect the sample shall have been cleaned as specified in C.8.

b. A 500 mL sample of homogenized NOC or TSP will be used when performing a solvent extraction for post NVR analysis by gravimetric.

c. A 100 mL sample of homogenized NOC or TSP will be used when performing a solvent extraction for post hydrocarbon oil and grease analysis by infrared spectrophotometry.

C.8 Preparation and maintenance of apparatus.

C.8.1 When handling CFC-113 or HCFC-225, the safety precautions specified by the material safety data sheet (MSDS) and 4.4.1 shall be followed.

C.8.2 Apparatus used in the procedure, including the sample bottles, homogenizer, homogenizing container, graduated cylinder, filtration reservoir, and demineralized water container, shall have been cleaned using a component cleaning process as specified in this standard, or equal.

C.8.3 After contact with NOC or TSP cleaning solution, all apparatus shall immediately be rinsed with demineralized water to remove residual cleaner, to prevent formation of inorganic deposits and to maintain cleanliness.

C.9 Procedure.

C.9.1 Cool the 500 to 600 mL NOC or TSP sample to room temperature or less. Acidify TSP samples to a pH of 2 or less.

C.9.2 Homogenize the 500 to 600 mL sample for 3 minutes at a speed of about 7,500 rpm (position 3 on an OMNI Model GLH homogenizer).

NOTE 1: CFC-113 or HCFC-225 can be used for post NVR analysis. Only CFC-113 solvent can be used for post analysis by infrared spectrophotometry.

C.9.3 Transfer 100 mL or 500 mL of homogenized sample to the separatory funnel.

C.9.4 Transfer 160 mL of CFC-113 or HCFC-225, or 30 mL of CFC-113 to the separatory funnel. Cap and vigorously agitate for 30 seconds. Allow to stand until contents settle and bubbles disappear. Remove the cap carefully to release any pressure build-up. Drain solvent from separatory funnel and transfer to volumetric flask. Repeat two additional times.

C.9.5 Add fresh solvent to the volumetric flask and dilute solvent extract to 500 mL if serially extracted with 160 mL volumes or to 100 mL if serially extracted with 30 mL volumes. Shake to completely mix the solvent extract. Remove the cap carefully to release any pressure build-up.

C.9.6 Perform an NVR analysis of the 500 mL solvent extract as specified in 5.13.2.5, or perform a hydrocarbon oil and grease analysis of the 100 mL solvent extract as specified in 5.13.2.8.

ANALYSIS OF RESIDUE IN SOLVENT BY OPTICALLY STIMULATED ELECTRON EMISSION USING A SURFACE QUALITY MONITOR

D.1 SCOPE

D.1.1 Scope. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance. This appendix provides a procedure for determination of oil and grease in NAVSEA approved halogenated solvent by optically stimulated electronic emission (OSEE).

D.2 APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in Appendix D of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Appendix D of this standard, whether or not they are listed.

D.2.2 Government documents.

D.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-17331	-	Lubricating Oil, Steam Turbine and Gear, Moderate Service

(Copies of this document are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

D.3 PROCEDURE

D.3.1 Summary of test method. The concentration of non-volatile organic residue in solvent is determined to be less than, equal to, or greater than the established acceptance criteria by serially evaporating 0.5 mL of solvent in a specially machined dish and measuring the OSEE of the dish using a Surface Quality Monitor (SQM). The amount of solvent evaporated is determined by whether or not the baseline is applied. If the baseline is not applied, acceptance criteria of 5 ppm or less is determined by evaporating 1.5 mL of solvent and comparing to the result of 1.5 mL of 5 ppm standard. If the baseline is applied, acceptance criteria of 5 ppm above baseline is determined by evaporating 1.5 mL of solvent and comparing to the result of 1.5 mL of unused solvent (baseline), followed by 1.5 mL of 5 ppm standard.

D.4 Significance and use.

D.4.1 The quantitative cleanliness standard for systems cleaned as specified in this standard generally applies to hydrocarbon non-volatile residues. However, this method does not differentiate between hydrocarbon based products (such as TEP 2190 oil) and fluorocarbon based products (such as Krytox 240AC grease). Additionally, this method is not sensitive to small quantities of particulate.

D.4.2 The specially machined dishes concentrate the sample to a small area that is within the focal point of the ultraviolet light source used by the SQM. The theory of OSEE is that some very clean surfaces, such as stainless steel, illuminated by an ultraviolet light source will emit electrons from the surface that are measurable in the form of current. As the surface is contaminated, the electron emission decreases reducing the measured current. An exception to this rule is that in rare instances, such as some surfactants, the current can increase. Properly machined and cleaned evaporating dishes will measure similarly. Likewise, properly machined and cleaned evaporating dishes when uniformly contaminated with a known standard will also measure similarly. Therefore, comparing the results from a 5 ppm standard (with or without baseline) to the results of effluent or waste solvent can be used to quantitatively determine a go-no-go acceptance criteria. However, the electron emission is not linear, and therefore, empirical determination of the exact quantity of non-volatile organic residue cannot be determined by this method. Also, if the current increases more than an established amount, it is an indication that a contaminant other than oil and grease is present, which is considered a failure requiring recleaning.

D.4.3 Baseline can be applied as specified in Table X. The acceptance criteria of 5 ppm above baseline is established by evaporating 1.5 mL of unused solvent (baseline) followed by 1.5 mL of 5 ppm standard. The effluent or waste solvent is comprised of the unused solvent contaminated with as much as 5 ppm, therefore, only 1.5 mL of this solvent is needed for the analysis.

D.4.4 This analysis method uses three different laboratory standards: 7.80 mg TEP 2190 oil in one liter of CFC-113 or HCFC-225 solvent, and 1.75 mg Krytox 240AC grease in one liter of HFE-7100 solvent. Each standard is applicable only to the solvent used during the actual cleaning process, except HCFC-225G and HCFC-225M can be used interchangeably as standards, and will hereafter be referred to as HCFC-225. Consistent with previous practice, all laboratory standards are normalized to the measured response from 5 ppm hydrocarbon oil in solvent. For the HFE-7100 standard, Krytox 240AC grease was used as the contaminant because of its solvency in HFE-7100. However, Krytox 240AC grease has a higher sensitivity to OSEE, and therefore requires less contaminant to produce a measured response equivalent to 5 ppm hydrocarbon oil.

D.5 Apparatus.

D.5.1 The following is needed to perform OSEE analysis. Apparatus needed to prepare the 5 ppm laboratory standard is not listed, but needs to be adequate to prepare the standard as specified in D.9.

a. A Surface Quality Monitor (SQM), Model SQM 200 with sensor 60262, with 0.25-inch diameter aperture installed, for measuring residue on the evaporating dish by OSEE. The instrument can be purchased from Photo Emission Tech., Inc., (805) 499-7667. Note that “Surface Quality Monitor” is a trade name. However, since it is the only instrument of its kind capable of performing this type of analysis and is patented, the trade name is commonly used.

b. Evaporating dishes manufactured per Figure 4. With a vibro-etch tool or equivalent, mark the side of each dish with a letter or number to uniquely identify each dish.

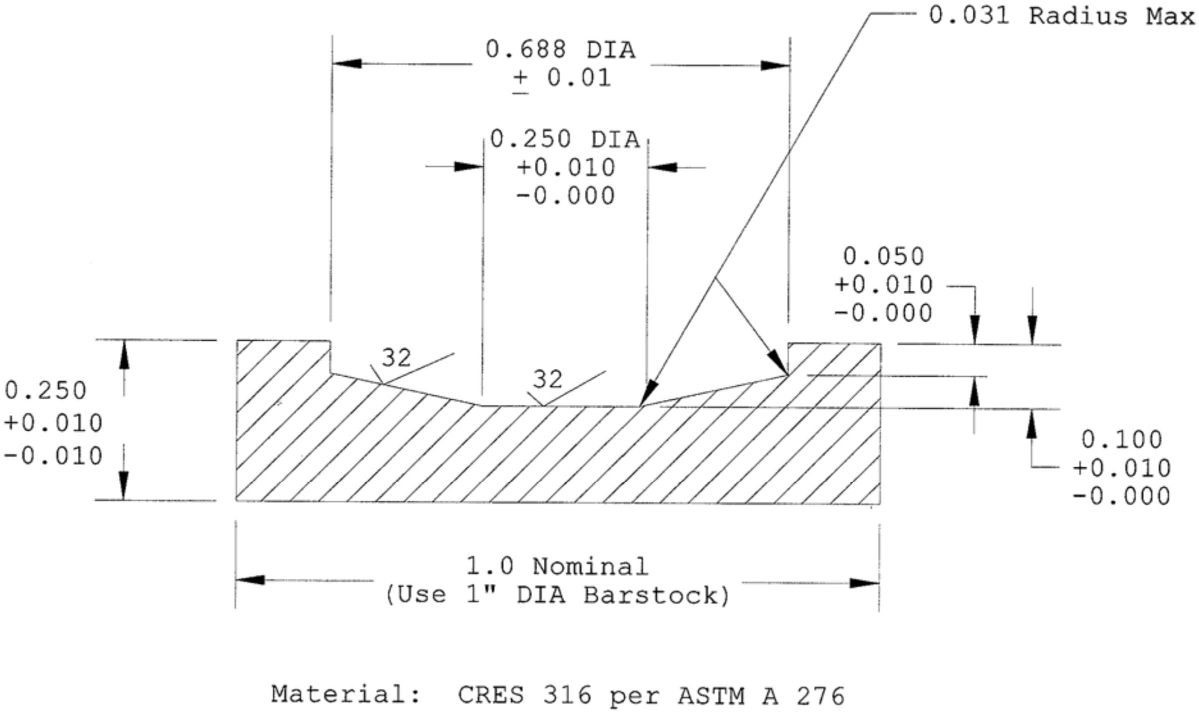


FIGURE 4. Cross-sectional view of evaporating dish.

c. A hot plate adjustable to about 90 and 100 °F with an accuracy of ±5 °F. Note that many hot plates are not adjustable to these low temperatures, they don't provide adequate accuracy, and adjustable plates with digital temperature readout are costly. An acceptable hot plate is Corning catalog number 440918 available from laboratory supply houses such as Fisher Scientific. This hot plate has a remote control that provides the required adjustability. Rather than a digital readout of temperature, it provides a digital readout of the heat setting to the nearest 0.1, with a maximum setting of 10. Many hot plates are only adjustable in increments of 1, with a maximum setting of 10.

d. A washing bottle used for spraying solvent for final cleaning of glassware and displacing water from the evaporating dishes. The bottles must not extract organics and must be compatible with the solvent, such as Teflon or glass. An acceptable washing bottle is VWR Scientific catalog number 16651-880.

e. Glass pipet with a capacity of 0.5 mL for measuring laboratory standard. Suitable pipets are available from laboratory supply houses such as Fisher Scientific or VWR Scientific.

f. Pipet filler/dispenser. Fisher Scientific catalog number 13-683B is acceptable.

g. Glass beaker with a capacity of 10 mL for transferring laboratory standard to evaporating dishes. The small size is necessary to minimize solvent evaporation. Other suitable beakers are available from laboratory supply houses such as Fisher Scientific or VWR Scientific.

h. Non-abrasive, heavy-duty, reinforced paper towels for cleaning evaporating dishes. Kimberly-Clark P/N 34865 available from Fisher Scientific catalog number 06-666-14A is acceptable. If available, stock number 7920-00-823-9773 per A-A-1432, Type IV, is acceptable.

i. A clean container for mixing detergent for cleaning evaporating dishes. An appropriate size is about 5½ inches square and 3 inches deep with an open top. This size allows use of minimum cleaner and adequate access for cleaning by hand. Any commercially available type is acceptable.

j. A thermometer capable of reading a surface temperature of 90 and 100±2 °F.

k. Equipment for performing maintenance on the SQM. For checking the ultraviolet lamp intensity, a research radiometer, model IL1400 and a detector at 185 nm, model SEL185 both available from International Light (978) 465-5923, and additionally, an adapter, part number 10528, available from Photo Emission Tech., Inc. (805) 499-7667. For checking the sensor electronics, a calibration load model #60054 available from Photo Emission Tech, Inc. (805) 499-7667.

D.6 Reagents.

D.6.1 The following are required to prepare 5 ppm laboratory standards in a chemistry laboratory:

a. New, unused NAVSEA approved halogenated solvent that will be used as the cleaning solvent is required to prepare laboratory standards (i.e., if HFE-7100 will be used as the cleaning solvent, then HFE-7100 must be used to prepare the laboratory standard).

b. MS2190-TEP, MIL-PRF-17331, if preparing the HCFC-225 or CFC-113 laboratory standards.

c. Krytox Grease DuPont 240AC, MIL-PRF-27617 if preparing the HFE-7100 laboratory standards.

D.6.2 The following are required to perform OSEE analysis of solvent:

a. Sparkleen available from Fisher Scientific, catalog number 04-3204 (3.25 pounds per box). Prepare the Sparkleen cleaning solution in a container (D.5.1(i)) by diluting with tap water per the manufacturer’s instructions. Use of other cleaners is not allowed. Disposal shall be in accordance with local, state, and federal regulations.

b. Tap water.

c. New, unused NAVSEA approved halogenated solvent as specified in 4.4 is needed to final clean glassware and rinse evaporating dishes. New, unused NAVSEA approved halogenated solvent is also required to prepare laboratory standards.

D.7 Samples. The following samples are required for analysis:

a. If baseline applies, a sample of new-unused solvent of not less than 20 mL shall be collected from each container or drum of each lot or batch.

b. A sample of solvent used as a final cleaning solvent shall be not less than 20 mL in a glass bottle with a screw cap having a Teflon liner.

D.8 Preparation and maintenance of apparatus.

D.8.1 Setting hot plate temperature.

D.8.1.1 For the hot plate of D.5.1 (c), adjust the rheostat and measure the surface temperature of the hot plate using the thermometer of D.5.1 (j). Continue adjusting until the desired temperature (85 to 90 °F for CFC-113 or HCFC-225 or 90 to 100 °F for HFE-7100) is attained and stays below the maximum specified temperature for 10 minutes. Note the digital readout for each of these temperatures (e.g., 0.2 may equate to 90 °F and 0.3 may equate to 100 °F). For subsequent use of this hot plate, the hot plate can be set using the digital readout and measurement of temperature is not necessary. The hot plate shall be checked every 3 months.

D.8.2 Set up SQM.

D.8.2.1 Turn the power to the control unit OFF. Inspect the sensor to confirm that the manufacturer installed a 0.25-inch diameter aperture. The aperture is needed so that only the horizontal surface at the center of the dish in the evaporating area is measured.

CAUTION 1: During installation, the person installing the aperture MUST be grounded. Electrostatic discharge can damage the sensor electronics. At a minimum, wear a properly grounded conductive wrist strap. Also during installation, handle the apertures with the tweezers provided to prevent contamination that can seriously degrade sensor performance.

If it was not installed, following the manufacturer’s instructions, install the 0.25-inch diameter aperture on the sensor.

D.8.2.2 With the dish next to (not directly under) the sensor, set the sensor so that it is slightly below the top of the evaporating dish. This setting will provide minimum movement of the sensor when sliding the dish under it. The micrometer reading is not important and can be changed provided that the sensor is set slightly below the top of the evaporating dish so that it will sit flush on the dish when taking a reading. For information, the micrometer on the stand can be used to set the sensor at a specified distance from the bottom of the stand. The purpose of this is to provide a means of attaining a consistent standoff distance from the sample being measured. The sensor can be moved up from this point, but when moved back down, it will end up at this point. The application in this appendix is different in that when taking a reading, the sensor is moved up, the dish is placed under the sensor, and the sensor is placed directly on the dish. Setting the sensor directly on the dish provides consistent standoff distances for each reading and allows the dish to be aligned with the sensor.

D.8.2.3 Install all connections per the manufacturer's instructions.

NOTE 1: Erratic readings may be attributed to a fluctuating power supply, such as a cycling hot plate in the same receptacle. This should be avoided if possible.

Turn the power ON. Once the power switch is turned ON, it takes approximately 15 seconds before the software boots up and the display comes to life and it takes 15 minutes for the control unit to warm up. To adjust the control unit settings, the SELECT button is used to cycle the display, and the UP and DOWN buttons are used to change the settings. An explanation of each item and the required setting is as follows:

1. **SIGNAL**: This is the initial power-on screen. The display should show a number with the word "signal" beneath it. If the words "GND SAMPLE" appear, the sample is not properly grounded. For this analysis, since the evaporating dish is placed on the sensor stand, plugging the sensor stand into the monitor will properly ground the sample (i.e., the evaporating dish). Refer to the manufacturer's instructions for making this connection. The signal is the real-time reading and does not represent the peak. This mode is not used while taking measurements for this procedure.

2. **PEAK**: The peak detect mode will search for the maximum OSEE signal and display it. This is the mode used for taking measurements throughout this procedure. Each reading taken per this manual is a peak reading. The units on the display are "centi-volts". Because this unit of measure is not common, the term "counts" will be used, and is commonly used by the manufacturer.

3. **LOW GATE**: The low gate setting can be adjusted to indicate when a reading is below established acceptance criteria. When the reading is below the low gate setting, the display will show the counts and the message "OUT LOW". This setting is not required or used in this procedure. Using the UP/DOWN buttons, set the low gate to 0 count to inactivate it and avoid confusion.

4. **HIGH GATE**: The high gate setting can be adjusted to indicate when a reading is above established acceptance criteria. When the reading is above the high gate setting, the display will show the counts and the message "OUT HIGH". This setting is not required or used in this procedure. Using the UP/DOWN buttons, set the high gate to 1000 counts to inactivate it and avoid confusion.

5. **GAIN**: The gain amplifies the signal, which can be interpreted as a multiplier for the output. There are two gain settings available, one on the sensor and the other on the control unit.

a. Sensor Gain. On the sensor, the gain setting is indicated by the number (on the outer ring of the rotary switch) opposite the dot (on the inner ring of the rotary switch). The available settings, from lowest to highest, are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0. Using the tool provided, set the sensor gain to 4. No further adjustments of the sensor gain will be made throughout this procedure.

b. Control Unit Gain. On the control unit, the available gain settings are 1, 2, 4, and 8. Using the UP/DOWN buttons, set the gain to 4. This is a starting point and will be adjusted at the control unit as needed for the evaporating dish. Each increase in gain will double the output, and each decrease will halve the output.

6. **TIME DELAY**: This is a standard feature on newer instruments. Time delay is the amount of time that elapses before a reading is taken (readings are taken in manual mode using ENTER button or automatic mode using Threshold for Peak as described below). Time delay can be set from 1 to 120 seconds. Using the UP/DOWN buttons, set the time delay to 1.

7. **THRESHOLD FOR PEAK**: It displays the Threshold for Peak setting. Using the UP/DOWN buttons, set the Threshold for Peak to 1000 counts. The Threshold for Peak automatically triggers a peak search when the signal is cycled below this value. For instance, suppose that the Threshold for Peak is set at 30 counts, and that an evaporating dish is measured at 600 counts. When the dish is taken away from the sensor, the signal needs to decrease below 30 counts to initiate a search for a new reading. As long as it goes below 30 counts, when another dish is placed under the sensor, the unit will automatically search for a new peak. If it does not drop below 30 counts, a search for a new peak will not be initiated. Using the automatic mode can cause erroneous results for the use specified in this appendix. This is because the automatic peak search occurs very quickly and the dish or sensor may not be in place when the peak search is initiated. To force use in the manual mode, the Threshold for Peak is set at 1000 counts. This will essentially inactivate the automatic feature and a peak search will begin when the ENTER button is pressed.

8. **SAVE CURRENT PARAMETERS**: This screen will only be displayed if any of the preceding parameters were changed. Press the ENTER button to save changes.

D.8.3 Maintenance of SQM. Check the SQM UV lamp intensity, sensor electronics, and control unit electronics every six months using the following procedure and equipment listed in D.5.1(k), or by sending the entire unit (control unit and sensor) to the manufacturer. Log all results in data sheets 1 and 2. If the manufacturer performs the check, obtain the data and log in data sheets 1 and 2. Annotate any corrective action required in the Remarks column.

D.8.3.1 Sensor electronics.

D.8.3.1.1 Turn the SQM control unit ON. Allow 15 minutes to warm up. Confirm the monitor is in SIGNAL mode.

D.8.3.1.2 Set the gain settings on the sensor and control unit to the settings used last time acceptance criteria were established for dishes.

CAUTION 2: When removing the sensor, do not touch the aperture on the end of the sensor. Contamination can seriously degrade performance.

WARNING 1: Do not look directly into the ultraviolet light source at the end of the sensor because it can cause eye damage.

D.8.3.1.3 Remove the screws holding the sensor in the stand and remove the sensor.

D.8.3.1.4 Place the Calibration Load (D.5.1(k)) at the end of the sensor. In order to read the calibration load, it needs to be held steady to yield stable readings. After the reading stabilizes, log the reading in data sheet 1.

D.8.3.1.5 Using the tool provided, increase the sensor gain by one unit from the setting of D.8.3.1.2 and repeat D.8.3.1.4.

D.8.3.1.6 Using the tool provided, decrease the sensor gain by one unit from the setting of D.8.3.1.2 and repeat D.8.3.1.4.

D.8.3.1.7 Referring to data sheet 1, for each set of gain settings, compare the first and last reading. If the reading drops by more than 5 percent, send the entire unit to the manufacturer for servicing. Note the first reading establishes the acceptance criteria and there is nothing to compare to. Also note that if the gain settings used for establishing acceptance criteria changed from the last time this calibration was accomplished, there will not be data to compare to for all of the readings; this is acceptable. When it gets returned from the manufacturer, repeat D.8.3.1.1 through D.8.3.1.7. This becomes the first reading.

D.8.3.1.8 Restore the gain settings on the sensor and control unit to the settings noted in D.8.3.1.2. Reinstall the sensor using the screws removed in D.8.3.1.3 and set the sensor per D.8.2.2.

D.8.3.2 UV lamp intensity.

D.8.3.2.1 Turn the SQM control unit ON. Allow 15 minutes to warm up.

D.8.3.2.2 Connect the detector to the radiometer. The orientation of the electrical connection makes no difference. Turn the radiometer ON. With the cap installed on the detector for the radiometer, press the ZERO key. When turned off, batteries retain the zero reading in the memory. If the memory is lost, repeat this step.

D.8.3.2.3 Loosen the screws holding the sensor in the stand so that the sensor can slide relative to the mounting bracket. Remove the cap from the detector. Place the adapter (D.5.1(k)) on the end of the sensor, and place the detector beneath the adapter. Slide the sensor down so that everything rests on the stand.

D.8.3.2.4 Press the SIGNAL key on the radiometer to measure the UV light intensity and log in data sheet 2. Move the detector away from the adapter, then again place it beneath the adapter to take a repeated reading. Take a total of 10 readings and log in data sheet 2. Add the readings and divide the total by 10 to calculate the average and log in data sheet 2. A variance in readings of 5 percent is possible because it is difficult to consistently measure ultraviolet light intensity. As the UV light intensity decreases over time, the light emitted from the surface, and all of the readings, will drop accordingly. Comparison of the established acceptance criteria for a dish and the UV light intensity can account for a drop in the established acceptance criteria. Over several years, the gain settings may need to be adjusted to account for this decrease in readings. The UV light intensity should decrease linearly by a maximum of 30 percent over a period of 5000 hours. If it exhibits a greater decrease in less hours or exhibits a rapid drop in UV lamp intensity, contact NAVSEA for direction.

D.8.3.2.5 Turn the radiometer OFF. Replace the cap on the detector. Disconnect the detector from the radiometer. Tighten the screws holding the sensor and set the sensor per D.8.2.2.

D.8.3.3 Control unit electronics.

D.8.3.3.1 Turn the SQM OFF and unplug the sensor from the rear of the control unit.

NOTE 2: After turning the SQM OFF, it takes about 15 to 30 seconds for it to boot down properly. If it is turned ON before it is booted down properly, the display will not come on. If this occurs, turn it off, wait about 30 seconds, then turn it on again.

D.8.3.3.2 Wait about 30 seconds, then turn the SQM ON. There will be an error message stating “CONNECT SENSOR-TURN POWER OFF 1ST”. Press the ENTER key to eliminate this error message. Set the GAIN on the control unit to 1. Allow 15 minutes to warm up.

D.8.3.3.3 Observe the reading and log in data sheet 2. If the reading is 5 or less, no action is required. If the reading is more than 5, send the control unit to the manufacturer for adjustment and calibration.

D.8.3.3.4 Restore the gain settings on the control unit to the setting noted in D.10.1.5.

D.8.3.3.5 Turn the SQM OFF and plug the sensor in the rear of the control unit. Wait about 30 seconds, then turn the SQM ON.

D.8.4 Safety precautions.

D.8.4.1 When handling CFC-113, HCFC-225, or HFE-7100, the safety precautions specified by the material safety data sheet (MSDS) and 4.4.1.2 shall be followed.

D.8.4.2 When handling Sparkleen, follow the safety precautions specified by the material safety data sheet (MSDS).

D.8.5 Cleaning of equipment.

D.8.5.1 Rinse the pipet and washing bottle with unused solvent. Clean the beaker with Sparkleen (soaking for one hour, then agitating by shaking has been shown to be effective), rinse with water several times, and final clean with unused solvent.

D.9 5 ppm equivalent laboratory standard.

D.9.1 Preparation. All laboratory standards shall be prepared, analyzed, and packaged by a certified laboratory. Puget Sound Naval Shipyard and Intermediate Maintenance Facility laboratory is certified and can provide the standards. Using the solvent specified by the user that will be used as the cleaning solvent, the preparation and analysis requirements for the standard are given in Table D-I. Large quantities of standard can be prepared, provided that the proportion of oil to solvent is as specified. Transfer the standard to 20 mL vials suitable for shipping and long-term storage. Vials from Fisher Scientific catalog number 05-719-110 are acceptable. Attach a sticker and mark the solvent level on each vial with a pen. Each container of laboratory standard shall be marked or tagged with a batch number traceable to the laboratory results. Store in a cool, dry, dark place until shipped.

D.9.2 Use of standard. Multiple containers with the same batch number are considered the same standard for comparison purposes. Considering that each container holds around 20 mL, ensure that if multiple containers are used for comparison, they are requested at the same time and are of the same batch. Store containers in a cool, dry, dark place where they can not tip over and break, such as a designated storage locker or refrigerator.

TABLE D-I. Preparation and analysis of 5 ppm equivalent laboratory standards.

Solvent	Soil and Loading	Analysis to Verify Soil Level
CFC-113	0.78±0.05 mg of MS2190TEP oil (D.6.1(b)) to 100±0.2 mL CFC-113 (D.6.1(a))	Measure the hydrocarbon oil and grease in CFC-113 solution by infrared spectrophotometry in accordance with ASTM D3921. The acceptance criteria is 5.0±0.5 ppm.
HCFC-225G or HCFC-225ca/cb	0.78±0.05 mg of MS2190TEP oil (D.6.1(b)) to 100±0.2 mL HCFC-225 (D.6.1(a))	Measure the NVR in 500 mL minimum of HCFC-225G or HCFC-225ca/cb solution by evaporative gravimetrics using a laboratory-approved procedure similar to ASTM D2109. The acceptance criteria is ±20%.
HFE-7100	1.75±0.05 mg of Krytox grease (D.6.1(c)) to 1000±0.3 mL HFE-7100 (D.6.1(a))	Measure the NVR in 500 mL minimum of HFE-7100 solution by evaporative gravimetrics using a laboratory-approved procedure similar to ASTM D2109. The acceptance criteria is ±20%.

D.10 Establishing dish acceptance criteria. Each dish has two acceptance criteria: clean dish and 5 ppm (with or without baseline). The applicable paragraphs and dosing requirements for establishing these acceptance criteria are summarized in Table D-II. The clean dish and 5 ppm acceptance criteria shall be established for a new dish, every six months after performing equipment maintenance specified in D.8, and whenever the need is identified during routine analysis (Section D.11). Normal aging of a dish and the sensor will require periodic determination of dish acceptance criteria. If baseline applies, the 5 ppm acceptance criteria is required for each batch or lot of solvent.

TABLE D-II. Dish acceptance criteria applicability matrix.

Baseline Applies	Clean Dish	5 ppm	
	Para	Para	Dosing
No	D.10.1	D.10.2	3 doses of 5 ppm standard
Yes	D.10.1	D.10.3	3 doses of unused solvent, followed by 3 doses of 5 ppm standard

D.10.1 Clean dish acceptance criteria.

NOTE 3: If a dish has been in long-term storage in excess of one year, it may be necessary to remove a thin corrosion layer. This can be accomplished by applying a small amount of polish with a cotton or foam-tipped swab and rubbing gently for 1 minute. The recommended polish is available from Buehler, 1-800-283-4537, Buehler Master Polish Suspension, catalog #40-6375-032.

D.10.1.1 Turn the SQM control unit ON. After 15 seconds when the system boots up, set the mode to PEAK. Allow 15 minutes to warm up. Check that the control unit gain setting is at 4 for a new dish, or the previous gain setting recorded on data sheet 3.

D.10.1.2 Using Sparkleen cleaning solution (D.6.2(a)) in a container (D.5.1(i)), **THOROUGHLY** clean the evaporating dish by scrubbing by hand using a paper towel (D.5.1(h)) for about one minute. Rinse **THOROUGHLY**, for about 20 to 30 seconds, under running tap water. Shake off excess water.

NOTE 4: Do not touch the inside surface after cleaning and do not dry the inside surface with a towel or cloth.

D.10.1.3 Using the washing bottle (D.5.1(d)) filled with CFC-113, HCFC-225, or HFE-7100, tilt the dish and spray it with solvent to displace the water droplets off of the dish, particularly from the flat area at the bottom of the evaporating area. Droplets remaining near the top edge are acceptable. The solvent shall be directed into a “solvent waste” container.

D.10.1.4 Place the dish on a hot plate set per D.8.1.1. Keep the dish on the hot plate until no solvent or water droplets remain on the surfaces where evaporation occurs. On the flat top edge and bottom, any residual water can be wiped with a clean cloth.

NOTE 5: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to the temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.1.5 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading on data sheet 3. Place the dish back on the hot plate.

a. If the reading is greater than 1000 counts (off scale), reduce the gain setting on the control unit. Do not reduce the gain below 2. A gain setting less than 2 indicates a possible problem with the equipment. Check the equipment by performing D.8.3.

b. If the reading is less than 500 counts, increase the gain setting on the control unit. A gain setting that needs to be greater than 8 generally indicates a dirty dish or a problem with the equipment. Clean dish per D.10.1.2. If this does not correct the problem, check the equipment by performing D.8.3.

c. Log the control unit gain setting on data sheet 3.

D.10.1.6 After 3 minutes has elapsed, repeat D.10.1.5 (reading #2).

D.10.1.7 Repeat steps D.10.1.2 to D.10.1.6 (cleaning #2) until two consecutive readings from D.10.1.6, using the same control unit gain, are within the following acceptable range: the difference between the readings shall be less than 100 counts.

D.10.1.8 The average of the two acceptable readings shall be recorded in data sheet 3 as the Clean Dish Acceptance Criteria.

D.10.2 5 ppm acceptance criteria without baseline.

D.10.2.1 Turn the SQM control unit ON. After 15 seconds when the system boots up, set the mode to PEAK. Allow 15 minutes to warm up. Check that the control unit gain setting is as specified in data sheet 3 for the dish being used.

D.10.2.2 Using Sparkleen cleaning solution (D.6.2(a)) in a container (D.5.1(i)), **THOROUGHLY** clean the evaporating dish by scrubbing by hand using a paper towel (D.5.1(h)) for about one minute. Rinse **THOROUGHLY**, for about 20 to 30 seconds, under running tap water. Shake off excess water.

NOTE 6: Do not touch the inside surface after cleaning and do not dry the inside surface with a towel or cloth.

D.10.2.3 Using the washing bottle (D.5.1(d)) filled with CFC-113, HCFC-225, or HFE-7100, tilt the dish and spray it with solvent to displace the water droplets off of the dish, particularly from the flat area at the bottom of the evaporating area. Droplets remaining near the top edge are acceptable. The solvent shall be directed into a “solvent waste” container.

D.10.2.4 Place the dish on a hot plate set per D.8.1.1. Keep the dish on the hot plate until no solvent or water droplets remain on the surfaces where evaporation occurs. On the flat top edge and bottom, any residual water can be wiped with clean cloth.

NOTE 7: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to the temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.2.5 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading on data sheet 3. Place the dish back on the hot plate.

D.10.2.6 After 3 minutes has elapsed, repeat D.10.2.5.

D.10.2.7 Check that the dish baseline cleanliness (reading #2) is within 100 counts of the baseline cleanliness acceptance criteria recorded in data sheet 3 for the specific dish being used for the analysis. Readings outside this range indicate a problem with dish cleanliness. Repeat steps D.10.2.2 through D.10.2.6 to check dish cleanliness.

NOTE 8: The solvent used for preparing the laboratory standard needs to be the same as the cleaning solvent (i.e., if HFE-7100 will be used as the cleaning solvent, then HFE-7100 must be used to prepare the standard).

NOTE 9: Never transfer calibration standard from the laboratory standard to the dish using the pipet to prevent contamination of the standard.

NOTE 10: If the standard inadvertently reaches the dispenser, the dispenser will contaminate the contents of the pipet. If this occurs, dump the contents of the pipet into the waste solvent storage flask and fill the pipet several times above the 0.5 mL mark with unused solvent to clean the pipet.

WARNING 2: Thermal decomposition of solvent can cause harmful vapors. As a check, feel the hot plate with bare hand to confirm it is only “warm to the touch” prior to evaporating solvent in the dish. If it is hot, determine the cause and correct the problem before proceeding.

D.10.2.8 For the standard prepared in D.9, if it is used for the first time that day, confirm that the solvent level is at the last mark on the standard. If it is not, obtain another standard. Shake the standard vigorously for no less than 15 seconds. Remove the cap from the laboratory standard. Pour approximately 2 to 3 mL of the laboratory standard into the 10 mL beaker. Immediately replace the cap on the standard to minimize evaporative losses. Fill the pipet with 0.5 mL of solution by rotating the filler/dispenser knob. With the dish on the hot plate, transfer this 0.5 mL of solution to the evaporating dish by rotating the knob in the opposite direction. Allow the solvent to completely evaporate.

D.10.2.9 Repeat D.10.2.8 for a total of 3 doses (1.5 mL total) for other than instruments, or 3 doses (1.5 mL total) for instruments. Clean the beaker and pipet by rinsing with unused solvent.

NOTE 11: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.2.10 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading in data sheet 3. Place the dish back on the hot plate.

NOTE 12: If an error occurs while taking a reading, such as pressing the wrong key or dropping the dish, the reading can not be repeated. If this occurs, start over from D.10.2.2.

D.10.2.11 Repeat D.10.2.2 through D.10.2.10 until three data points (they do not have to be consecutive) are within the following acceptable range.

TABLE D-III. Acceptable range for 5 ppm acceptance criteria without baseline.

Solvent	Acceptable Range: Maximum allowable difference between highest and lowest reading
CFC-113	60 counts
HCFC-225	50 counts
HFE-7100	30 counts

D.10.2.13 The average of the three acceptable data points shall be recorded in data sheet 3 as the Dish 5 ppm Acceptance Criteria.

D.10.2.14 At the end of the day or when D.10.2.13 is completed, mark the solvent level on the laboratory standard.

D.10.3 5 ppm acceptance criteria with baseline.

D.10.3.1 Perform D.10.2 to determine the 5 ppm acceptance criteria for the dish for comparison to baseline.

D.10.3.2 Turn the SQM control unit ON. After 15 seconds when the system boots up, set the mode to PEAK. Allow 15 minutes to warm up. Check that the control unit gain setting is as specified in data sheet 2 for the dish being used.

D.10.3.3 Using Sparkleen cleaning solution (D.6.2(a)) in a container (D.5.1(i)), **THOROUGHLY** clean the evaporating dish by scrubbing by hand using a paper towel (D.5.1(h)) for about one minute. Rinse **THOROUGHLY**, for about 20 to 30 seconds, under running tap water. Shake off excess water.

NOTE 13: Do not touch the inside surface after cleaning and do not dry the inside surface with a towel or cloth.

D.10.3.4 Using the washing bottle (D.5.1(d)) filled with CFC-113, HCFC-225, or HFE-7100, tilt the dish and spray it with solvent to displace the water droplets off of the dish, particularly from the flat area at the bottom of the evaporating area. Droplets remaining near the top edge are acceptable. The solvent shall be directed into a “solvent waste” container.

D.10.3.5 Place the dish on a hot plate set per D.8.1.1. Keep the dish on the hot plate until no solvent or water droplets remain on the surfaces where evaporation occurs. On the flat top edge and bottom, any residual water can be wiped with clean cloth.

NOTE 14: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to the temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.3.6 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading on data sheet 3. Place the dish back on the hot plate.

D.10.3.7 After 3 minutes has elapsed, repeat D.10.3.5.

D.10.3.8 Check that the dish baseline cleanliness (reading #2) is within 100 counts of the baseline cleanliness acceptance criteria recorded in data sheet 3 for the specific dish being used for the analysis. Readings outside this range indicate a problem with dish cleanliness. Repeat steps D.10.3.3 through D.10.3.7 to check dish cleanliness.

NOTE 15: The solvent used for preparing the laboratory standard needs to be the same as the cleaning solvent (i.e., if HFE-7100 will be used as the cleaning solvent, then HFE-7100 must be used to prepare the standard).

NOTE 16: Never transfer calibration standard from the laboratory standard to the dish using the pipet to prevent contamination of the standard.

NOTE 17: If the standard inadvertently reaches the dispenser, the dispenser will contaminate the contents of the pipet. If this occurs, dump the contents of the pipet into the waste solvent storage flask and fill the pipet several times above the 0.5 mL mark with unused solvent to clean the pipet.

WARNING 3: Thermal decomposition of solvent can cause harmful vapors. As a check, feel the hot plate with bare hand to confirm it is only “warm to the touch” prior to evaporating solvent in the dish. If it is hot, determine the cause and correct the problem before proceeding.

D.10.3.9 Transfer 2 to 3 mL of unused solvent into the 10 mL beaker. Fill the pipet with 0.5 mL of solution by rotating the filler/dispenser knob. With the dish on the hot plate, transfer this 0.5 mL of solution to the evaporating dish by rotating the knob in the opposite direction. Allow the solvent to completely evaporate. Repeat for a total of 2 doses.

NOTE 18: Accomplish the following actions quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.3.10 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading in data sheet 3. Place the dish back on the hot plate.

NOTE 19: If an error occurs while taking a reading, such as pressing the wrong key or dropping the dish, the reading can not be repeated. If this occurs, start over from D.10.3.3.

D.10.3.11 Compare to the data taken in D.10.3.1. If the reading is greater than or equal to the Dish 5 ppm Acceptance Criteria, then the baseline solvent is acceptable for use. Continue with dosing the dish with 5 ppm standard as specified in the following paragraphs. If the reading is less than the Dish 5 ppm Acceptance Criteria, perform troubleshooting to determine the source of the contamination.

D.10.3.12 For the standard prepared in D.9, if it is used for the first time that day, confirm that the solvent level is at the last mark on the standard. If it is not, obtain another standard. Shake the standard vigorously for no less than 15 seconds. Remove the cap from the laboratory standard. Pour approximately 2 to 3 mL of the laboratory standard into the 10 mL beaker. Immediately replace the cap on the standard to minimize evaporative losses. Fill the pipet with 0.5 mL of solution by rotating the filler/dispenser knob. With the dish on the hot plate, transfer this 0.5 mL of solution to the evaporating dish by rotating the knob in the opposite direction. Allow the solvent to completely evaporate.

D.10.3.13 Repeat D.10.3.12 for a total of 3 doses (1.5 mL total). Clean the beaker and pipet by rinsing with unused solvent.

NOTE 20: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.10.3.14 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading in data sheet 3. Place the dish back on the hot plate.

NOTE 21: If an error occurs while taking a reading, such as pressing the wrong key or dropping the dish, the reading can not be repeated. If this occurs, start over from D.10.3.3.

D.10.3.15 Repeat D.10.3.3 through D.10.3.14 until three data points (they do not have to be consecutive) are within the following acceptable range.

TABLE D-IV. Acceptable range for 5 ppm acceptance criteria with baseline.

Solvent	Acceptable Range: Maximum allowable difference between highest and lowest reading
CFC-113	60 counts
HCFC-225	50 counts
HFE-7100	30 counts

D.10.3.16 The average of the three acceptable data points shall be recorded in data sheet 3 as the Dish 5 ppm Acceptance Criteria with Baseline.

D.10.3.17 At the end of the day or when D.10.3.16 is completed, mark the solvent level on the laboratory standard.

D.11 Procedure for performing analysis. For instrument cleaning, the sample is taken in conjunction with performing the analysis as specified in D.7. For other than instrument cleaning, the sample is taken in a container during the cleaning process. Log all results in data sheet 4. Results shall be retained as long as the item cleaned is in use.

D.11.1 Assign a unique control number for the analysis and log in data sheet 4.

D.11.2 Turn the SQM control unit ON. After 15 seconds when the system boots up, set the mode to PEAK. Allow 15 minutes to warm up. Check that the control unit gain setting is as specified in data sheet 3 for the dish that will be used for the analysis.

D.11.3 Using Sparkleen cleaning solution (D.6.2(a)) in a container (D.5.1(i)), **THOROUGHLY** clean the evaporating dish by scrubbing by hand using a paper towel (D.5.1(h)) for about one minute. Rinse **THOROUGHLY**, for about 20 to 30 seconds, under running tap water. Shake off excess water.

NOTE 22: Do not touch the inside surface after cleaning and do not dry the inside surface with a towel or cloth.

D.11.4 Using the washing bottle (D.5.1(d)) filled with CFC-113, HCFC-225, or HFE-7100, tilt the dish and spray it with solvent to displace the water droplets off of the dish, particularly from the flat area at the bottom of the evaporating area. Droplets remaining near the top edge are acceptable. The solvent shall be directed into a “solvent waste” container.

WARNING 4: Thermal decomposition of solvent can cause harmful vapors. As a check, feel the hot plate with bare hand to confirm it is “warm to the touch” prior to evaporating solvent in the dish. If it appears too warm, determine the cause and take the necessary corrective action.

D.11.5 Place the dish on a hot plate set per D.8.1.1. Keep the dish on the hot plate until no solvent or water droplets remain on the surfaces where evaporation occurs. On the flat top edge and bottom, any residual water can be wiped with a clean cloth.

NOTE 23: Accomplish the following actions as quickly as possible to minimize the time the dish is exposed to the UV light. Since the monitor is not sensitive to the temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.11.6 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading on data sheet 4. Place the dish back on the hot plate.

a. The above actions shall be accomplished as quickly as possible to minimize the time the dish is exposed to the UV light.

b. Since the monitor is not sensitive to the temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

D.11.7 After 3 minutes has elapsed, repeat D.11.6.

D.11.8 Check that the dish cleanliness (reading #2) is within 100 counts of the Clean Dish Acceptance Criteria recorded in data sheet 3 for the specific dish being used for the analysis. Readings outside this range indicate either a problem with dish cleanliness or equipment operation. Repeat D.11.3 through D.11.7 to check dish cleanliness. If still unable to meet the baseline cleanliness acceptance criteria, perform equipment maintenance per D.8 and determine new dish acceptance criteria as specified in D.10.

D.11.9 Shake the sample container vigorously for no less than 15 seconds. Remove the cap from the sample container. Pour approximately 2 to 3 mL of the sample into the 10 mL beaker. Immediately replace the cap on the sample to minimize evaporative losses. Fill the pipet with 0.5 mL of solution by rotating the filler/dispenser knob. With the dish on the hot plate, transfer this 0.5 mL of solution to the evaporating dish by rotating the knob in the opposite direction. Allow the solvent to evaporate. Repeat for a total of 2 doses.

D.11.10 Slide the dish under the SQM sensor. Place the sensor directly on the top edge of the dish. Align the dish so that the outside of the dish aligns with the outside of the sensor. Press the ENTER key on the SQM and observe the reading. Remove the dish. Log the reading in data sheet 4. Place the dish back on the hot plate.

a. The above actions shall be accomplished as quickly as possible to minimize the time the dish is exposed to the UV light.

b. Since the monitor is not sensitive to temperatures specified in this procedure, there is no need to allow the dish to cool before taking a reading.

c. If an error occurs while taking a reading, such as pressing the wrong key or dropping the dish, the reading cannot be repeated. If this occurs, start over from D.11.3.

NOTE 24: Oil and grease, along with most other contaminants, will cause the counts to decrease. In rare instances, such as some surfactants, the counts can increase.

D.11.11 Compare the reading from D.11.10 to the Clean Dish Acceptance Criteria and the Dish 5 ppm Acceptance Criteria recorded in data sheet 3 as described below, and as shown in Table D-V and Figure 5:

a. If the reading is less than the Clean Dish Acceptance Criteria **plus** 50 counts **and** greater than or equal to the Dish 5 ppm Acceptance Criteria, the results are acceptable and are reported as less than 5 ppm oil and grease. Log all results on data sheet 4.

b. If the reading is less than the Dish 5 ppm Acceptance Criteria, the results are **not** acceptable and the instrument requires recleaning.

c. If the reading is greater than or equal to the Clean Dish Acceptance Criteria **plus** 50 counts, the results are **not** acceptable and the instrument requires recleaning.

TABLE D-V. 5 PPM acceptance criteria for sample.

Acceptance Criteria	Action
Reading < [Clean Dish Acceptance Criteria] + [50 counts] **and** Reading > Dish 5 ppm Acceptance Criteria	Results are acceptable. Report as less than 5 ppm oil and grease and log on data sheet 4.
Reading < Dish 5 ppm Acceptance Criteria	Results are **not** acceptable. Reclean the instrument.
Reading ≥ [Clean Dish Acceptance Criteria] + [50 counts]	Results are **not** acceptable. Reclean the instrument.

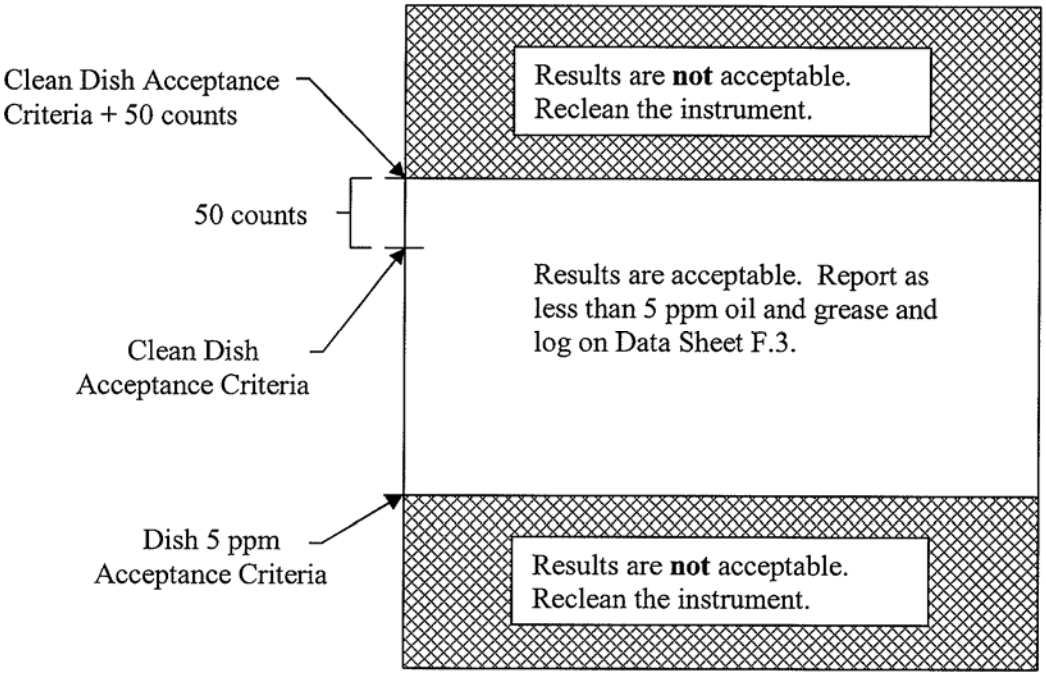


FIGURE 5. 5 PPM acceptance criteria for sample.

Not To Scale

DATA SHEET 1. Surface Quality Monitor maintenance record for sensor electronics.

Date	Name and ID	Sensor Gain Setting used for establishing dish acceptance criteria from D.S. 3 (e.g., 4) Setting:_________ (see D.8.3.1.2)		Increase Sensor Gain Setting by 1 unit (e.g., 5) Setting:_________ (see D.8.3.1.5)		Decrease Sensor Gain Setting by 1 unit (e.g., 3) Setting:_________ (see D.8.3.1.6)	
		SQM Reading	Acceptance Criteria = SQM reading X 0.95	SQM Reading	Acceptance Criteria = SQM reading X 0.95	SQM Reading	Acceptance Criteria = SQM reading X 0.95

Instructions for filling out data sheet:

1. Enter date, name, ID. Enter the Sensor Gain Settings that will be used.
2. The first set of readings is entered in the first row. This is used to calculate acceptance criteria for subsequent readings. There are no acceptance criteria for these first readings.
3. For subsequent readings, compare the SQM reading to the acceptance criteria in the first row. If the SQM reading is less than the acceptance criteria, send the entire unit to the manufacturer for servicing.
4. If the first reading needs to be reestablished (e.g., if maintenance is performed by the manufacturer), start a new sheet.

DATA SHEET 2. Surface Quality Monitor maintenance record for lamp intensity and control unit electronics.

Date	Reading	Name and ID	Lamp Intensity (see D.8.3.2.4)	Control Unit Electronics- SQM Reading [1] (see D.8.3.3.3)	Remarks
	1				
	2				
	3				
	Average				
	1				
	2				
	3				
	Average				
	1				
	2				
	3				
	Average				
	1				
	2				
	3				
	Average				
	1				
	2				
	3				
	Average				

NOTE:

[1] If the reading is more than 5, send the control unit to the manufacturer for adjustment and calibration.

DATA SHEET 3. Establishing Dish Acceptance Criteria.

EVAPORATING DISH:________

Name and ID (e.g., badge):_______________________________Date:_________

Date evaporating dish was last calibrated:______________________

Batch number for standard:______________________

Solvent used for standard:____________(Shall be same as solvent used for cleaning the instrument.)

Baseline applies: Yes____ No____; if "yes" lot or batch #_______________

Gain Settings: Sensor:___________ Control Unit:______________

Clean Dish Acceptance Criteria

Reading and Average	SQM Readings	
	Cleaning #1	Cleaning #2
Reading #1		
Reading #2		
Average for Reading #2 [1/] (Clean Dish Acceptance Criteria)		

NOTE:
[1/] For reading #2, the difference between the readings shall be less than 100 counts.

Dish 5 ppm Acceptance Criteria

Reading/Dose and average	SQM readings		
	Trial 1	Trial 2	Trial 3
Cleaned Dish			
Reading #1			
Reading #2 [2/]			
Dish 5 ppm Acceptance Criteria			
Dose #3			
Average Dose #3 [3/] **(Dish 5 ppm Acceptance Criteria)**			

NOTES:
[2/] For all trials, for reading #2, the difference between the clean dish acceptance criteria and each result must be less than 100 counts.
[3/] For dose #3, calculate the difference between the highest and lowest readings. If it meets the acceptance criteria in Table D-III or D-IV, as applicable, the data is acceptable. If it does not meet the acceptance criteria, perform additional trials until results are acceptable.

DATA SHEET 4. OSEE (SQM) Analysis of Cleaned Item.

Control Number:____________________

Name and ID (e.g., badge):_____________________ Date:____________

Description of item being cleaned:
____

____

Visual inspection of effluent or waste solvent:
Particulate:____
Turbidity or color:____

Evaporating Dish:__________________

Results from data sheet 3:

Clean Dish Acceptance Criteria:__________
Dish 5 ppm Acceptance Criteria:__________

Cleaning Solvent:____________________ (HCFC-225G, HCFC-225M, HFE-7100 or CFC-113)

Gain Settings: Sensor:___________ Control Unit:______________

Reading/Dose	SQM Reading
Cleaned Dish	
Reading #1	
Reading #2 [1/]	
Analysis of Effluent or Waste Solvent	
Dose #3 [2/]	

NOTES:

[1/] Reading #2 must be within 100 counts of Clean Dish Cleanliness Acceptance Criteria entered above from data sheet 3.

[2/] (a) If dose #3 is less than the Clean Dish Acceptance Criteria **plus** 50 counts **and** greater than or equal to the Dish 5 ppm Acceptance Criteria, the results are acceptable and are reported as less than 5 ppm oil and grease.

(b) If dose #3 is less than the Dish 5 ppm Acceptance Criteria, the results are **not** acceptable and the item requires recleaning.

(c) If dose #3 is greater than or equal to the Clean Dish Acceptance Criteria **plus** 50 counts, the results are **not** acceptable and the item requires recleaning.

Remarks:____

____

____.

NAVSEA APPROVED HALOGENATED SOLVENTS

E.1 SCOPE

E.1.1 Scope. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance. This appendix identifies the NAVSEA approved halogenated solvents, and specifies information regarding safe and effective use.

E.2 APPLICABLE DOCUMENTS

E.2.1 General. The documents listed in this section are specified in Appendix E of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Appendix E of this standard, whether or not they are listed.

E.2.2 Government documents.

E.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-50427	-	Cleaning Compound, Solvent, 1,1-Dichloro-1- Fluoroethane, HCFC-141B, for Oxygen Systems
A-A-59150	-	Cleaning Compound, Solvent, Hydrofluoroether (HFE)
A-A-59743	-	Cleaning Compound Solvent, Dichloropentafluoropropane (HCFC-225)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-C-81302	-	Cleaning, Compound, Solvent, Trichlorotrifluoroethane

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

TABLE E-I. NAVSEA approved halogenated solvents.

Attribute	Approved halogenated solvents [1/]			
	CFC-113 [2/]	HCFC-141b [3/]	HCFC-225 [4/]	HFE-7100 [5/]
Applications				
1. Gauges	Yes	Yes	Yes	Yes
2. O2N2 producers	Yes	Yes	Yes	No
3. Field wipe [6/]	Yes	No	[4/]	Yes
Specifications	[2/]	A-A-50427 [3/]	A-A-59743	A-A-59150
Recommended 8-hour time weighted average exposure criteria	1000 ppm	500 ppm	[4/]	600 ppm
Recommended short term exposure limit	1250 ppm	750 ppm	[4/]	900 ppm
Boiling point	118 °F	89 °F	129 °F	140 °F

TABLE E-I. NAVSEA approved halogenated solvents. Continued.

Attribute	Approved halogenated solvents [1/]			
	CFC-113 [2/]	HCFC-141b [3/]	HCFC-225 [4/]	HFE-7100 [5/]
Ozone depleting substance	Yes	Yes	Yes	No
Ozone depletion potential	0.8	0.11	0.03	0.0
Production phase-out	1996	2003	2015	NA
Process verification methods				
1. Infrared spectrophotometry	Yes	No	No	No
2. NVR	Yes	Yes	Yes	Yes
3. SQM	Yes	Yes	Yes	Yes
Non-metallic compatibility [7/]	[8/]	[8/]	[8/]	[8/]
1. PTFE (Teflon)	C	C	C	C
2. PCTFE (Kel-F)	C	C	C	C
3. Vespel SP-21	C	C	C	C
4. Viton	12L	1L	1L	1L
5. Silicone	I	12L	I	I

NOTES:

[1/] HFE-7100 is the preferred solvent for cleaning gages and instruments. HCFC-225 is the preferred solvent for cleaning oxygen-nitrogen producers.

[2/] For naval activities, the use of CFC-113 is restricted to those authorized by NAVSEA to access the mission critical reserve maintained by the Defense Logistics Agency or reserves maintained by Naval Shipyards. Refer to Navy ODS Advisories 95-01 and 96-01 for additional information. CFC-113 procured for gauge cleaning shall be equivalent to MIL-C-81302, Type I. CFC-113 procured for oxygen-nitrogen producer cleaning and field wipe shall be equivalent to MIL-C-81302, Type I or II. Recycled CFC-113 shall be equivalent to MIL-C-81302, Type I, with the following exceptions: moisture content shall be 35 ppm maximum; organic cleanliness shall be less than 5 ppm determined as specified in 5.13.2; and particulate cleanliness shall be as specified in 5.13.3.2.

[3/] Domestic availability of HCFC-141b is extremely limited based on the production phase-out, and there is no mission critical reserve. If available, HCFC-141b in accordance with A-A-50427 can be used for cleaning gauges and oxygen-nitrogen producers. To comply with environmental regulations, and since approved alternatives exist, HCFC-141b should not be used for field wipe. Be advised that HCFC-141b is reported to have upper and lower explosion limits of 17.7 and 7.6 percent, respectively. When purging or drying equipment cleaned with HCFC-141b, ensure purging is performed with nitrogen and is directed to a well ventilated area free of any ignition sources. Recognize that HCFC-141b at the lower explosive level is toxic representing an immediate hazard to life. HCFC-141b in accordance with A-A-50427 has been satisfactory tested for compatibility with gaseous and liquid oxygen demonstrating no ignition or flash point.

[4/] HCFC-225 in accordance with A-A-59743 has been satisfactory tested for compatibility with gaseous and liquid oxygen demonstrating no ignition or flash points, and is available as either HCFC-225G or HCFC-225M. The recommended 8-hour time weighted average exposure for HCFC-225G is 400 ppm and for HCFC-225M is 100 ppm. The recommended short term (30-minute) exposure limit for HCFC-225G is 900 ppm and for HCFC-225M is 180 ppm. HCFC-225G in accordance with A-A-59743 is approved for cleaning gauges, oxygen-nitrogen producers and for field wipe. HCFC-225M in accordance with A-A-59743 is approved for oxygen-nitrogen producers when appropriate ventilation and other engineering controls can minimize personnel exposure. HCFC-225M in accordance with A-A-59743 should not be used shipboard, for gauges or for field wipe because of the low allowable exposure limit.

TABLE E-I. NAVSEA approved halogenated solvents. Continued.

NOTES:

[5] HFE-7100 in accordance with A-A-59150 is approved for use to clean gages and instruments. Since HFE-7100 has marginal hydrocarbon soil removal performance, it shall not be used as a precleaner. An acceptable precleaner is HFE-71DE, which is a blend of HFE-7100 and 1,2 TransDichloroethylene (TDCE). This solvent has soil removal performance similar to CFC-113. However, HFE-71DE is not compatible with gaseous or liquid oxygen, and is more toxic than CFC-113, having a vendor recommended allowable exposure limit of 200 ppm. Therefore, HFE-71DE shall only be used as a precleaner. The performance of HFE-7100 as a wipe solvent is dependent on the type of soil being removed. HFE-7100 is an excellent wipe solvent for halogenated oils and greases. HFE-7100 is a poor solvent for hydrocarbon oils and greases including silicone.

[6] For critical applications, a NAVSEA approved halogenated solvent may only be used for field wipe with local engineering approval.

[7] The only non-metallic materials listed are those common to oxygen systems. For other materials, consult the manufacturer, local engineering, or NAVSEA. Where specific information is lacking, perform compatibility testing as specified in A.3.1 of Appendix A.

[8] C = Compatible. 12L = Limit exposure to a maximum of 12 hours per cleaning. 1L = Limit exposure to a maximum of 1 hour per cleaning. I = Incompatible. NT = Not tested.

Preparing activity:
Navy – SH
(Project 4730-2352-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.