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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

CLEANING OF SHIPBOARD COMPRESSED AIR SYSTEMS

AMSC N/A FSC 4310

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FOREWORD

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

3. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, Engineering Standards Division, Code 03Q, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Scope. This standard provides the requirements for cleaning of compressed air systems and components. Each activity should 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 shall obtain procedure approval from the applicable certifying activity. This standard does not apply to reactor plant air systems.

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 Compressed air systems and components. The cleanliness boundary includes all material designed for and normally wetted by low, medium, or high pressure air as specified in NAVSEA S9086-SY-STM-010/CH-551. Specific systems included are diver's life support air, air supplying oxygen generating equipment, emergency breathing air, emergency main ballast tank blow, electronics air, low pressure vital and non-vital air, and deballast air.

1.2.2 Compressed gaseous and liquid nitrogen systems and components supporting or interfacing with services containing 25% or less oxygen. The cleanliness boundary includes all material designed for and normally wetted by compressed gaseous or liquid nitrogen. For all cases, if the system or component interfaces with an oxygen or oxygen-enriched system or component, including gaseous or liquid oxygen generating equipment, containing greater than 25% by volume oxygen during normal operation, it shall be cleaned as specified in MIL-STD-1330.

1.2.3 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 and 1.2.2 when such interface is intended to maintain the cleanliness requirements specified herein.

1.2.4 Open ended applications, other than air supplying diver's life support, shall use best commercial practice to remove loose scale, dust, grit, filings, oil, and grease. Open ended applications supplying air for diver's life support shall be cleaned as specified herein.

2. REFERENCED DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 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, and 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

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SPECIFICATIONS

FEDERAL

A-A-58020 - Drums, Shipping, Steel with Polyethylene Insert
BB-N-411 - Nitrogen, Technical
O-S-642 - Sodium Phosphate, Tribasic, Anhydrous; Dodecahydrate; and Monohydrate; Technical
TT-I-735 - Isopropyl Alcohol
BB-A-1034 - Compressed Air, Breathing

DEPARTMENT OF DEFENSE

MIL-D-16791 - Detergents, General Purpose (Liquid, Nonionic)
MIL-G-18997 - Gauge, Pressure, Dial Indicating
MIL-L-25567 - Leak Detection Compound, Oxygen Systems
MIL-DTL-24800 - Cleaning Compound - Aqueous - Oxygen Systems Components

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-278 - Welding and Casting Standard
MIL-STD-1330 - Standard Practice For Precision Cleaning Testing and of Shipboard Oxygen, Helium, Helium-Oxygen, Nitrogen, and Hydrogen Systems

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available 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 are those cited in the solicitation.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

SS521-AA-MAN-010 - U.S. Navy Diving and Manned Hyperbaric Systems Safety Certification Manual
S6430-AE-TED-010 - Technical Directive for Piping Devices, Flexible Hose Assemblies
SS800-AG-MAN-010/ P-9290 - System Certification Procedures and Criteria Manual for Deep Submergence Systems
0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems
0902-018-2010 - General Overhaul Specifications for Deep Diving SSBN/SSN Submarines
S9086-H7-STM-010/ CH-262 - NSTM, Lubricating Oils, Greases, Hydraulic Fluids 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-WK-STM-010/ CH-670 - NSTM, Stowage, Handling, and Disposal of Hazardous General Use Consumables.

(Unless otherwise indicated, copies of the above technical manuals are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA-Method-1664 - N-Hexane Extractable Material (HEM) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM) by Extraction and Gravimetry (Oil and Grease and Total Petroleum Hydrocarbons).

(Application for copies should be addressed to the Water Resource Center, Mail Code RC-4100, 401 M Street, SW 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 Air. Air refers to gaseous air as specified in 4.5.2.

3.2 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.

3.3 Bleed air system. A bleed air system is a system in which air is supplied from the compression stage of a gas turbine generator or a propulsion gas turbine.

3.4 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.

3.5 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 shall not affect the form, fit or function of the item being cleaned.

3.6 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, are 100% volatile. Examples include halogenated solvents such as HFE-7100 which is non-flammable and hydrocarbon solvents such as isopropyl alcohol (IPA) which is very flammable.

3.7 Clean area. A clean area is an area that is free of air borne debris or contamination resulting from work accomplished in the immediate area.

3.8 Clean cloth. A clean cloth is used for local cleaning or wiping surfaces to evaluate loss of cleanliness. The cloth shall be adequately free of contaminants which could pose a compatibility, flammability, or toxicity hazard considering the specific application.

3.9 Components. Components refers to items such as valves, fittings, gauges and regulators in the systems.

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3.10 Critical applications. Critical applications are systems or components requiring more detailed cleanliness requirements than general applications because of unique operating parameters and environments. Air systems supplying diver life support and air systems supplying oxygen generating equipment are classified as critical applications because of the increased toxicity hazard associated with high partial pressure environments for diver air, and flammability due to the interface with the oxygen system for air systems supplying oxygen generating equipment.

3.11 Deballast air system. A deballast air system is a low pressure air system which is used for deballasting amphibious assault ships.

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 temperatures listed in this standard are at atmospheric pressure.

3.13 Dry air. Dry air refers to air that has been dried to a dew point temperature low enough to prevent condensation. The dew point is application specific, and is based on the maximum pressure and minimum temperature that the application will normally experience. As an example, air that operates at 125 psig and is subjected to a 0°F operating environment would require a dew point temperature of about -35°F to prevent condensation.

3.14 Electronics dry air main. An electronics dry air main is that portion of the vital air main which is used for pressurization of various types of radar waveguides and antennas, electronic equipment, and transmission systems.

3.15 Emergency breathing air system. Emergency breathing air systems distribute emergency breathing air throughout submarines and to specified pump rooms and machinery spaces on surface ships.

3.16 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.

3.17 General applications. General applications are systems or components not defined as a critical application.

3.18 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.

3.19 High pressure air system. A high pressure air system is an air system which operates at pressures not less than 1000 lb/in^2.

3.20 Low pressure air system. A low pressure air system is an air system which operates at pressures not greater than 150 lb/in^2.

3.21 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 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

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pressure rating is applied, for the purpose of the requirements stated herein, it may be substituted as the maximum operating pressure.

3.22 Medium pressure air system. A medium pressure air system is an air system which operates at pressures greater than 150 lb/in^2 and not greater than 1000 lb/in^2.

3.23 Nitrogen. Nitrogen refers to gaseous nitrogen as specified in 4.5.3.

3.24 Non-vital air main. A non-vital air main is that portion of the ship service low pressure air system which serves other than vital users.

3.25 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. Examples of hydrocarbon materials include most fuels and compressor lubricating oils, while examples of fluorocarbon materials include MIL-G-27617 grease used for lubricating high pressure o-rings.

3.26 Precleaner. A precleaner is any aqueous cleaning solution or cleaning solvent used to initially clean parts to visually clean. Examples include Navy Oxygen Cleaner (NOC), dissolved tribasic sodium phosphate (TSP), isopropyl alcohol (IPA), and non-ionic detergent (NID) mixed with water.

3.27 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.

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

3.29 Vital air main. A vital air main is that portion of the ship service low pressure air system which serves users whose continuous operation is essential for safety and mission capability of the ship.

3.30 Water. Water refers to water as specified in 4.1.

4. GENERAL REQUIREMENTS

4.1 Water.

4.1.1 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.

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

4.1.3 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 of Appendix A.

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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		

1/ Demineralized water meeting the requirements of ASTM D 1193, type II, satisfies grade A or B requirements.
2/ Potable water and municipal water generally meets 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 Cleaning solutions.

4.2.1 Navy Oxygen Cleaner (NOC).

4.2.1.1 Applicability. NOC is an aqueous alkaline cleaning solution approved for use as a precleaner or final cleaner for all compatible piping and components. NOC shall be in accordance with MIL-DTL-24800.

4.2.1.2 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 worker's goggles for all operations where eye contact with NOC could occur. 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 a minimum of 15 minutes, then seek prompt medical attention. An eye wash system conforming to the design requirements of the American National Standards Institute (ANSI)

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Z358.1 shall be in the immediate vicinity of all operations. Eye wash systems shall be capable of providing a minimum of 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°F, such a possibility is unlikely, considering the magnitude and frequency of use. If irritating solution mist is present, approved respirators shall be worn to avoid inhalation (see 6.4). In the event any adverse health effects are experienced, cease operations involving NOC and consult the cognizant medical department representative for additional guidance.

4.2.1.3 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.

4.2.1.4 Compatibility. Appendix A gives the compatibility of NOC with various materials. Where specific information is lacking, perform compatibility testing as specified in A.3 of Appendix A. NOC used to clean aluminum or anodized aluminum should be diluted 50% with water.

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

(a) A shake test as specified in 5.14.2 and a visual clarity inspection as specified in 5.14.3.2 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 micron nominal or finer filter to remove the suspended particulate or fiber or rejected and returned to the vendor.

(b) Government purchases of NOC are origin inspected, origin accepted with a Certificate of Analysis for each lot maintained by Defense Supply Center Richmond. Other purchasers of 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).

4.2.1.6 Dilution. NOC shall be diluted as follows:

(a) Concentration: NOC can be diluted with water up to 50%. NOC should be diluted 50% with grade B water when cleaning aluminum or anodized aluminum.

(b) Water quality: The preferred quality of water is 5 micron 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 5 micron filter installed. For short term use, such as a few hours, 10 micron filtered grade C water may be used.

(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.

4.2.1.7 Use of NOC in previously used equipment. For critical application 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.

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(a) Fill the cleaning equipment with NOC diluted 25 to 50% 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 4.2.1.7(e), and repeat the process.
(e) Deposits can be removed by soaking in hot water, or scrubbing and/or soaking with commercial white vinegar or a warm (up to 110°F) 10 to 16% citric acid solution, followed by a water rinse. A 10 to 16% 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.

4.2.1.8 Use for extended periods. Extended use of NOC should be in covered equipment to minimize evaporation. Evaporative losses can be made-up with grade B water. NOC can be recycled using filtration, and continuously used or reused, provided the following conditions are satisfied:

(a) For critical applications, a shake test as specified in 5.14.2 reveals no excessive foam.
(b) For critical applications, a clarity inspection as specified in 5.14.3.2 reveals no oil, grease, or excessive particulate.
(c) An alkalinity test as specified in 5.14.5 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 5.14.5 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 4.2.1.6 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.

4.2.1.9 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. For critical applications, filters used for the first time shall be checked for extractable organic material. This is accomplished by recirculating through the filter with clean NOC at 140 to 160°F for no less than 1 hour and then checking for foam as specified in 5.14.2, and performing a visual inspection of the effluent as specified in 5.14.3.2. 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

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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 filter manufacturer that the temperature, pressure and flow rating of any filter is adequate for the intended application. Disposal of used filters or separated oil shall be in accordance with local, state and federal regulations.

4.2.1.10 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. For critical applications, 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 no less than 10 days then checking for foam as specified in 5.14.2, and performing a visual inspection as specified in 5.14.3.2. 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. 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 S9086-WK-STM-010/CH-670 for alkalies.

4.2.2 Tribasic Sodium Phosphate (TSP).

4.2.2.1 Applicability. TSP is a solid crystalline material mixed with water to prepare an aqueous alkaline cleaning solution approved for use as a precleaner or final cleaner for all compatible piping and components. TSP shall conform to O-S-642, type I or II, or equal. Type II is recommended because it is less susceptible to precipitation.

4.2.2.2 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) Chemical safety goggles or face shield, rubber gloves, and rubber aprons or coveralls shall be worn to prevent skin contact. In the event of eye contact, personnel should flush their eyes thoroughly with fresh water for a minimum of 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 be capable of providing a minimum of 15 minutes of water for emergency flushing.

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(c) If skin contact occurs, exposed areas shall be washed with large amounts of fresh water. If irritating dust or solution mist is present, approved respirators shall be worn to avoid inhalation (see 6.4).

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

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

4.2.2.4 Compatibility. Appendix A gives the compatibility of TSP with various materials. Where specific information is lacking, perform compatibility testing as specified in A.3 of Appendix A.

4.2.2.5 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 better dissolve 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.

4.2.2.6 Stowage. If a TSP stowage tank is not large enough, do not mix a solution stronger than as specified in 4.2.2.5 and attempt to dilute it in a piping system. Failure to maintain the temperature of a solution stronger than as specified in 4.2.2.5 at 160 to 180°F can result in the TSP precipitating and developing a hardened 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 S9086-WK-STM-010/CH-670 for alkalies.

4.2.3 Non-Ionic Detergent (NID)

4.2.3.1 Applicability. NID is a concentrated non-ionic hydrocarbon surfactant that is mixed with water to prepare an aqueous detergent cleaning solution acceptable for use as a precleaner for critical applications and as a cleaner for general applications. NID shall conform to MIL-D-16791, type I, or commercial equivalent, such as Triton X-100.

4.2.3.2 Safety precautions. Follow the safety precautions recommended in the vendor's Material Safety Data Sheet (MSDS). If irritating solution mist is present, approved respirators shall be worn to avoid inhalation (see 6.4). In the event any adverse health effects are experienced, cease operations involving NID and consult the cognizant medical department representative for additional guidance.

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

4.2.3.4 Compatibility. Appendix A gives the compatibility of NID solutions with various materials. Where specific information is lacking, perform compatibility testing as specified in A.3 of Appendix A.

4.2.3.5 Solution preparation. Prepare NID solution by adding 0.1 to 0.5 ounces of NID to each gallon of water. Use of higher concentrations of NID in water will not increase soil removal performance, and can cause difficulty in rinsing the NID solution from the surface. NID solutions shall be used at temperatures no greater than 140°F. At temperatures greater than 140°F, the solubility of NID will decrease leading to possible precipitation of NID.

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4.2.4 Isopropyl alcohol (IPA).

4.2.4.1 Applicability. Isopropyl alcohol (IPA) is a cleaning solvent that is acceptable for use as a precleaner for critical applications and as a cleaner for general applications with compatible material. IPA shall not be used as a precleaner for teflon in either a diver's air systems or an air system supplying oxygen generating equipment. IPA should conform to TT-I-735 or equal. IPA is soluble in water and commercial grades can have as much as 30% water.

4.2.4.2 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, 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. If excessive solvent concentration is present, approved respirators shall be worn (see 6.4). 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.
(d) In the event any adverse health effects are experienced, cease operations involving IPA and consult the cognizant medical department representative for additional guidance.

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

4.2.4.4 Compatibility. Where specific information with respect to compatibility is lacking, perform compatibility testing as specified in A.3 of Appendix A.

4.2.5 NAVSEA approved halogenated solvents.

4.2.5.1 Applicability. A NAVSEA approved halogenated solvent, as specified and subject to the limitations in Appendix B, can be used as a cleaner for instruments as specified in 5.5, for cryogenic systems and piping as specified in 5.7, and for field wipe as specified in 5.13.4. Use of a NAVSEA approved halogenated solvent for any other application requires local engineering, environmental and industrial hygiene approval.

4.2.5.2 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) 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,

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excluding accidents or spills (see 6.4). If excessive solvent concentration will be present, approved respirators shall be worn (see 6.4). If necessary, use portable blowers. Exhaust ventilation is preferable to blowing air into the space. Solvent vapor 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.

(b)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.

(c)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.

(d)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.

(e)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 warning 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.

(f)Carefully check the system for leaks before pumping solvent through the system (see 5.7.3.2).

(g)Chemical safety goggles or a full-length face shield shall be used 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 the eyes with fresh water for a minimum of 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

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immediate vicinity of all operations. Eye wash systems shall be capable of providing a minimum of 15 minutes of water for emergency flushing.

(h) 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.

(i) 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.

(j) In the event of any adverse health effects are experienced, cease operations involving halogenated solvents and contact 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:

SOME HALOGENATED SOLVENTS CAN CAUSE CARDIAC SENSITIZATION. THE ATTENDING PHYSICIAN MUST BE INFORMED OF THE HALOGENATED SOLVENT IN-USE. ADMINISTERING AN INJECTION OF EPINEPHRINE OR SIMILAR HEART STIMULANT CAN LEAD TO CARDIAC ARRHYTHMIA, INCLUDING VENTRICULAR FIBRILLATION IF THE SOLVENT IN-USE CAUSES CARDIAC SENSITIZATION. REGARDLESS OF THE SOLVENT IN-USE, 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 can not 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 the components and piping placed in an oven and/or heated to assure all solvent is volatized and removed before assembly, test and operation. Samples as specified in 5.10.3 are required to confirm removal of all solvent.

4.2.5.3 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).

4.2.5.4 Compatibility. Appendix B gives the compatibility of NAVSEA approved halogenated solvents with various non-metallic materials. Where specific information is lacking, perform compatibility testing as specified in A.3 of Appendix A.

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

4.2.5.6 Water previously used in systems. Halogenated solvents containing chlorine can 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 4.5.3. An outlet dew point of a -40°F at atmospheric pressure shall be obtained prior to introducing any halogenated solvent that is known or believed to produce acids in contact with water.

4.3 Other cleaners.

4.3.1 Other cleaners for general applications. Any materially compatible aqueous cleaning solution or cleaning solvent may be used for general applications 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 4.2. The selection criteria for approving alternative cleaners is specified in 4.4.

4.3.2 Other final cleaners for critical applications. No aqueous cleaning solution other than TSP solutions, or MIL-DTL-24800 compositions, shall be used as a final cleaner. Use of pre-cleaners shall be as specified in 4.3.1. Other than NAVSEA approved halogenated solvents specified in Appendix B, approval shall be obtained prior to using any 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).

4.4 Other cleaner selection criteria. The selection of a cleaner for precleaning of critical applications or cleaning of general applications shall consist of an evaluation of each requirement specified in Table II. Failure to complete the evaluation as specified in Table II can result in component damage or personal injury.

4.4.1 Cleaning performance. The cleaner shall be tested to verify acceptable cleaning performance with target soil, substrates and processes. Examples of test methods to determine cleaning performance by soaking, using ultrasonic tanks or by pipe flushing are in MIL-DTL-24800.

TABLE II. Testing requirements for other cleaners.

Requirement	Paragraph
Cleaning performance	4.4.1
Health and safety	4.4.2
Material compatibility	4.4.3
Disposal	4.4.4
Process application	4.4.5
Cleaner quality	4.4.6

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4.4.2 Health and safety. Data on the cleaner, including the Material Safety Data Sheet (MSDS) shall be reviewed by cognizant health and safety personnel to determine the following:

(a) Flammability of the cleaner to include flash point, and upper and lower explosion limits if applicable. The fire hazard resulting from leaving the cleaner in a system shall be evaluated and mitigated.
(b) Toxicity of the cleaner to the worker. Vendors should have either tested the cleaner or reviewed each constituent of the cleaner with an acceptable toxicology data base such as Registry of Toxic Effects of Chemicals (RTECs). Activities are cautioned that biodegradability is not a measure of toxicity, and should never be substituted as such. For solvent cleaners ensure an 8-hour time weighted average exposure criteria is recommended. Additionally, for solvents, ensure the vendor specified a method to monitor workplace exposure. Cleaners used on board submarines shall be evaluated as specified by the Submarine Atmosphere Material Control Program directed by the Navy Environmental Health Center.

4.4.3 Material compatibility. Data on the cleaner shall be reviewed by cognizant engineering personnel to determine the compatibility of the cleaner with metallic, plastic and rubber materials. Examples of acceptable test methods and acceptance criteria are in MIL-DTL-24800. Ensure the cleaner was tested at a temperature and duration equal to or greater than the maximum process application, and that data presented by the vendor supports their recommendations. Also, be aware that some structural plastics, such as valve seats, need to be tested in the stressed condition to obtain realistic results.

4.4.4 Disposal. Information on the cleaning process including data on the cleaner, as well as rinse water, if applicable, shall be reviewed by cognizant environmental personnel to determine the appropriate waste disposal requirements. The cleaner vendor should have data on the effluent toxicity of the cleaner performed in accordance with approved Environmental Protection Agency (EPA) test methods. Activities are cautioned that biodegradability is not a measure of effluent toxicity, and should never be substituted as such.

4.4.5 Process application. A process procedure shall be developed to specify how the cleaner will be safely and effectively used if different from that specified by this standard. Items that should be addressed in the cleaning process by either the approving activity or the vendor include the following:

(a) Cleaner safety precautions.
(b) Specifications for the equipment used in the cleaning process that includes the application temperature of the cleaner, and fluid velocity if applicable.
(c) Minimum and maximum limits for cleaner concentration, cleaning duration, and cleaner stowage requirements.
(d) Directions to remove and verify removal of aqueous cleaners after the cleaning process. This includes application of rinse water and methods used to verify completion of the rinse step such as measurement of pH or conductivity, or checking for foam by a shake test.
(e) Directions to dry the component or system after cleaning or rinsing. Solvent cleaning processes shall specify a minimum time duration necessary to ensure the solvent has completely evaporated. Aqueous cleaning processes shall use the direction contained in this standard.

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(f) Material compatibility tables for metals, plastics and rubber.
(g) Methods to monitor cleaner stability or usability if applied for extended periods. Examples include monitoring pH for aqueous alkaline cleaners, and monitoring non-volatile residue (NVR) for solvent cleaners.
(h) Process waste disposal.

4.4.6 Cleaner quality. All cleaners used in the process shall have provisions to ensure consistent quality is received from the vendor. At the very least, the vendor should agree to issue advance notification of any changes to the cleaner composition. Realize that minor changes in composition can significantly effect material compatibility and toxicity.

4.5 Gases.

4.5.1 Safety precautions. Inert gases, such as nitrogen, although not toxic, will not support human respiration and can cause asphyxiation. Accumulation of this gas 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).

4.5.2 Air. Air shall be used for purging when specified herein. Air shall meet the quality requirements of the system in which it is used. Air shall be filtered to 10 micrometers nominal or finer.

4.5.3 Nitrogen. Nitrogen shall be used for purging when specified herein. Nitrogen shall meet the requirements of BB-N-411, type I, Class 1, grade A or B by vendor or laboratory statement of conformance. Nitrogen shall be filtered to 10 micrometers nominal or finer. If residual nitrogen in a system will present a problem, it shall be purged with air as required.

4.6 Cleaning silver-brazed piping. For systems with new silver brazed joints, residual brazing flux can be removed in accordance with NAVSEA 0900-LP-001-7000 prior to cleaning. Residual brazing flux can also be removed with NOC, TSP, or other aqueous cleaners that will remove flux. In either case, the brazing flux shall be removed prior to the hydrostatic test.

4.7 Lubricants. Lubricants shall be approved for the application as specified in NAVSEA S9086-H7-STM-010/CH-262, component specification or other approved source. During reassembly, lubricants shall be used sparingly. 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 under these conditions.

5. DETAILED REQUIREMENTS

5.1 Facility requirements. Unless otherwise specified, the removal, replacement, repair, and cleaning of components and assembling, testing, and packaging of components cleaned in accordance with this standard shall be performed in a clean area. The clean area shall be free of air borne debris or contamination resulting from work accomplished in the immediate area.

5.2 Component cleaning process for general applications.

5.2.1 Applicability. This component cleaning process is for general applications items with surfaces that can be visually inspected. Items with

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surfaces inaccessible for visual inspection should be cleaned as specified in 5.3 or as otherwise approved by local engineering. Large components such as flasks shall be cleaned as specified in 5.4 or as otherwise approved (see 6.3).

5.2.2 Material and equipment.

(a) A supply of rinse water and associated equipment such as sinks or spray nozzles.
(b) A supply of compatible cleaner as specified in 4.2 or 4.3, and associated equipment such as brushes, sinks, spray nozzles, ultrasonic tanks, and steam cleaners.
(c) A supply of air or nitrogen if used for drying.
(d) A clean area as specified in 5.1.
(e) Equipment to dry clean parts.
(f) Packaging material as specified in 5.16.1.

5.2.3 Clean and rinse. Cleaning and rinsing shall be accomplished in a well ventilated area as follows:

(a) Each component shall be cleaned until it passes the visual inspection as specified in 5.14.1.1. Methods such as ultrasonics, wiping with clean cloths, vacuuming, brushing, and spraying with compressed air or steam have been successfully used.
(b) When applying a compatible cleaner selected as specified in 4.3, use the cleaner in accordance with the process determined as specified in 4.4. If using NOC or TSP, review 5.3.3(f), 5.3.5(a) and 5.3.5(b) for applicable equipment and process procedures.
(c) When removing difficult soils such as heavy waterproof greases, silicone greases, and fluorinated greases, most cleaners will have limited effectiveness if used without agitation in a soak or ultrasonic tank. Hand scrubbing is often the best alternative.
(d) If an aqueous cleaner selected as specified in 4.3 is used, it shall be rinsed as specified in 4.4.5 until all cleaning agent is removed. If using NOC or TSP, rinse as specified in 5.3.5(e), except grade C water may be used. When using multiple cleaners, rinse between each different cleaner application to prevent any harmful reaction which may occur when different cleaning agents are combined.
(e) 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 should be used.

5.2.4 Dry, reassemble and package. Drying, reassembling, and packaging shall be accomplished in a clean area 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 air or nitrogen have been successfully used. Appropriate precautions shall be taken to prevent damaging components and software from excessive heat. For components with inaccessible areas, drying to -20° dew point is acceptable.
(b) During reassembly, use lubricants as specified in 4.7.
(c) Components shall be packaged as specified in 5.16.1.

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5.3 Component cleaning process for critical applications.

5.3.1 Applicability. This component cleaning process is for critical application items that can be fully immersed in the ultrasonic tank or parts washer specified in 5.3.3. Large components such as flasks shall be cleaned as specified in 5.4 or as otherwise approved (see 6.3).

5.3.2 Objective. The objective of this aqueous component cleaning process is to remove all visible soil and particulate during the preclean and rinse step as specified in 5.3.4 before proceeding to a final clean, verification, and rinse step as specified in 5.3.5. The objective of the final clean, verification, and rinse step is to apply a breathing system safe cleaning agent to remove thin soil films and particulate that may remain after the preclean step and to verify the required cleanliness. An effective preclean step increases the probability of a successful final clean and verification step reducing overall process cost and time.

5.3.3 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 precleaner as specified in 4.2 or 4.3 and associated equipment such as brushes, sinks, spray nozzles, and ultrasonic tanks.
(c) A supply of NOC or TSP as specified in 4.2 in an ultrasonic tank or parts washer meeting 5.3.3(f).
(d) A supply of air or nitrogen if used for drying.
(e) A clean area 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 capable of being 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 4.2.1.9. 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 ft/sec. The parts washer shall be capable of being 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 4.2.1.9.
(g) Equipment to dry clean parts.
(h) Equipment to perform the applicable analyses of 5.14. This includes clean containers of no less than twice the sample volume to obtain the required samples.
(i) Packaging material as specified in 5.16.1.

5.3.4 Preclean and rinse. Precleaning should be accomplished in a well ventilated area as follows:

(a) Each component shall be precleaned using a compatible precleaner and then rinsed with water until all visible soil, particulate,

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and cleaning agent are removed. Components shall be disassembled to achieve maximum cleanliness. Components which are visibly clean may eliminate the preclean step and proceed directly to the final clean, verification, and rinse step specified in 5.3.5.

(b) Light corrosion or tarnish on brass and bronze components can be removed by soaking in a weak acid such as white vinegar. After soaking, rinse with water to remove the white vinegar.

(c) 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.

(d) When using multiple precleaners, rinse between each different precleaner application to prevent any harmful reaction which may occur when different cleaning agents are combined.

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

(f) Components shall be dried if the delay between completion of precleaning 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.

5.3.5 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 software such as o-rings and valve seats, limit exposure to a maximum of 10 minutes.

(c) If the final cleaner is NOC, obtain a sample of no less than 200 mL of used NOC, and verify organic cleanliness as specified in 5.14.2 and in 5.14.3.2. If either analysis fails, replace the NOC and repeat the final clean, verification, and rinse process. Do not wait for analysis results before proceeding to rinsing as specified in 5.3.5(e).

(d) If the final cleaner is TSP, obtain a 500 to 600 mL sample of the used TSP and verify organic cleanliness by analyzing for hydrocarbons or NVR as specified in MIL-STD-1330, or by an approved EPA Oil and Grease and Total Petroleum Hydrocarbon test methods such as EPA Method 1664, or equal. The acceptance criteria is 15 ppm maximum. If the analysis fails, replace the TSP and repeat the final clean, verification, and rinse process. Do not wait for analysis results before proceeding to rinsing as specified in 5.3.5(e).

(e) Remove the component(s) from the ultrasonic tank or parts washer and immediately rinse with grade B water in an ultrasonic tank, batch tank, and/or flowing water. The rinse water shall be no less than 110°F for NOC and 120°F for TSP. Continue rinsing until the effluent rinse water pH measured as specified in 5.14.4 is 8.0 or less, but rinse for no 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.

(f) Obtain a sample of no less than 200 mL of the effluent rinse water and verify particulate cleanliness as specified in 5.14.3.1. If the analysis of 5.14.3.1 fails, replace the rinse water if applicable and repeat the final rinse step.

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5.3.6 Dry, reassemble and package. Drying, reassembling, and packaging shall be accomplished in a clean area 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 air or nitrogen have been successfully used. Appropriate precautions shall be taken to prevent damaging components and software from excessive heat. For components with inaccessible areas, drying to -20° dew point is acceptable.
(b) During reassembly, use lubricants as specified in 4.7.
(c) Components shall be packaged as specified in 5.16.1.

5.4 Flask cleaning.

5.4.1 Applicability. Steel flasks in the boundaries defined in 1.2 shall be inspected, preserved, and cleaned as specified in NAVSEA S9086-SY-STM-010/CH-551. The flask cleaning process specified in Table III may be used in place of those specified in NAVSEA S9086-SY-STM-010/CH-551 for uncoated flasks or phosphate coated flasks used in general or critical applications. Do not use NOC or TSP on painted flasks as these alkaline cleaners will damage the coating. Use of the following flask cleaning process requires local engineering approval.

5.4.2 Material and equipment.

(a) A supply of rinse water and associated equipment for rinsing flasks.
(b) For general applications, a supply of NOC or TSP as specified in 4.2, or other low foaming cleaner selected as specified in 4.3. For critical applications, a supply of NOC or TSP as specified in 4.2.
(c) A supply of air or nitrogen.
(d) Equipment to perform visual inspections and clean the flask.
(e) Equipment to perform the applicable analyses of 5.14. This includes clean containers of no less than twice the sample volume 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 -20°F (420 ppm H_2O).

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Table III. Flask cleaning matrix.

Requirement	General Applications		Critical Applications	
	Uncoated	Phosphate Coated	Uncoated	Phosphate Coated
Cleaning	5.4.3(a)	5.4.3(a)	5.4.3(b) and 5.4.3(c) or (d)	5.4.3(b) and 5.4.3(c)
Hydrocarbon cleanliness verification	5.4.3(a)	5.4.3(a)	5.4.3(e) or 5.4.3(f)	5.4.3(e)
Rinse for cleaner removal	5.4.3(g) or (h)	5.4.3(g) or (h)	5.4.3(h)	5.4.3(h)
Particulate cleanliness verification	5.4.3(i)	5.4.3(i)	5.4.3(i)	5.4.3(i)
Drying	5.4.4	5.4.4	5.4.4	5.4.4
Final Inspection	5.4.5	5.4.5	5.4.5	5.4.5

5.4.3 Clean, verification, and rinse. Cleaning, verification, and rinsing should be accomplished as specified in Table III in a clean area with the flasks positioned vertically to facilitate drainage.

(a) Clean general application flasks using a low foaming compatible cleaner selected as specified in 4.3. Use the cleaner in accordance with the process determined as specified in 4.4. If using NOC, apply the cleaner as specified in 5.4.3(c). If using TSP, apply the cleaner as specified in 5.4.3(d). Remove cleaning agent by rinsing as specified in 5.4.3(g) or 5.4.3(h).

(b) Critical application flasks final cleaned with a fill and recirculate process as specified in 5.4.3(c) or 5.4.3(d) shall be pre-cleaned as specified in 5.3.4 using a low foaming compatible pre-cleaner and then rinsed with water until all visible oil, grease, ink, dye, and cleaning agent are removed. Flasks final cleaned with a spray process as specified in 5.4.3(c) or 5.4.3(d), or flasks with no visual evidence of oil, grease, ink, or dye may eliminate this pre-clean step.

(c) Clean critical application flasks with NOC (or TSP as specified in 5.4.3(d) for uncoated flasks) 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 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.

(d) Clean critical application flasks with TSP (or NOC as specified in 5.4.3(c)) at 160 to 190°F for a time sufficient to ensure all wetted surfaces are in contact with the cleaner for no less than 10 minutes if using a spray process, or 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 or spraying

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hot grade B water through the flask. 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 5.4.3(h).

(e) If the final cleaner is NOC, obtain a sample of no less than 200 mL of used NOC, and verify organic cleanliness as specified in 5.14.2 and in 5.14.3.2. If either analysis fails, replace the NOC and repeat the clean, verification, and rinse process. Do not wait for analysis results before proceeding to rinsing as specified in 5.4.3(h).

(f) If the final cleaner is TSP, obtain a 500 to 600 mL sample of used TSP and verify organic cleanliness by analyzing for hydrocarbons or NVR as specified by MIL-STD-1330, or by an approved EPA Oil and Grease Total Petroleum Hydrocarbon test method such as EPA Method 1664, or equal. The acceptance criteria is 15 ppm. If the analysis fails, replace the TSP and repeat the final clean, verification, and rinse process. Do not wait for analysis results before proceeding to rinsing as specified in 5.4.3(h).

(g) For general applications that used a cleaner selected as specified in 4.3, immediately rinse the flask with grade C water in accordance with the process determined as specified in 4.4. Do not dry the flask between cleaning and rinsing.

(h) After cleaning with NOC or TSP, immediately rinse the flask with grade B water for critical applications or grade C water for general applications. For corrosion resistant or phosphated 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 5.14.4 is no greater than 8.0. Do not dry the flask between cleaning and rinsing.

(i) Recirculate or spray grade B water for critical applications or grade C water for general applications through the flask for no 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 5.14.3.1. If the analysis of 5.14.3.1 fails, repeat this rinse step.

5.4.4 Drying. Drying after exposure of a flask to water or, for unpainted flasks, moist gas such as ambient air shall be accomplished as quickly as possible with air or nitrogen until a minus 20°F dew point is reached. Air or 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.

5.4.5 Final inspection and end fitting installation.

(a) While maintaining cleanliness as specified in 5.11, perform a visual inspection on the internal flask surfaces as specified in 5.14.1.1, except swipe inspections are not required. Flask surfaces that fail the inspection criteria of Table VIII shall be recleaned. Flask surfaces with evidence of corrosion shall be processed as specified in NAVSEA S9086-SY-STM-010/CH-551.

(b) While maintaining cleanliness as specified in 5.11, install end fittings and seal weld, if required, in accordance with the applicable specification. Uncoated steel flasks shall be evacuated to 20 inches or less of mercury or purged with dry air or nitrogen to remove moist air, and then pressurized to 5 to 15 lb/in^2 with dry air or nitrogen.

5.5 Instruments and gages. For general applications, the requirements for cleaning instruments and gauges, including flowmeters and dead end

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pressure switches are as specified in MIL-G-18997. For critical applications, the requirements shall be as directed (see 6.3) using a NAVSEA approved halogenated solvent. Instruments and gauges should be calibrated in place by a comparative calibration procedure specified in NAVSEA 0987-LP-022-3010 except air as specified in 4.5.2 may be used.

5.6 System aqueous cleaning process.

5.6.1 Applicability. The system aqueous cleaning process defined by Table IV is applicable to all compatible systems. It may be used for cryogenic systems within the boundaries specified in 1.2.2 provided the aqueous system cleaning process can be successfully accomplished.

Table IV. Aqueous system cleaning matrix.

Requirement	General Applications		Critical Applications	
	Other Cleaner	NOC or TSP	NOC	TSP
Material and equipment	5.6.2	5.6.2	5.6.2	5.6.2
System preparation	5.6.3	5.6.3	5.6.3	5.6.3
Leak-check	5.6.4	5.6.4	5.6.4	5.6.4
Preflush	5.6.5	5.6.5	5.6.5	5.6.5
Hydrostatic test	5.6.6	5.6.6	5.6.6	5.6.6
Final flushing/ cleaning	5.6.7	5.6.7(a), (b), and (c)	5.6.7(a),(b), (c),(d), and (e)	5.6.7(a),(b), (c),(d), and (f)
Rinsing	5.6.8	5.6.8(a), (b),(c),(d) and (f)	5.6.8(a), (b), (c),(e), and (f)	5.6.8(a),(b), (d),(e), and (f)
Drying	5.6.9	5.6.9	5.6.9	5.6.9

5.6.2 Material and equipment.

(a) For general applications, a supply of NOC or TSP as specified in 4.2, or other low foaming cleaner selected as specified in 4.3. For critical applications, a supply of NOC or TSP as specified in 4.2.
(b) A supply of rinse water.
(c) A supply of air or 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 capable of attaining the pressure, temperature, flow rates, and filtering required by this standard.
(e) Equipment to perform the applicable analyses of 5.14. This includes clean containers of no less than twice the sample volume to obtain the required samples.

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(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 -40°F (128 ppm H_2O).

5.6.3 System preparation.

5.6.3.1 If shipboard conditions prevent flushing or testing a system as a single unit, the system may be divided into sections and flushed in any order. Precautions shall be taken to ensure that portions of the system which have been certified clean are not flushed with contaminated cleaning agent.

5.6.3.2 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 not be less than the piping they are bypassing.
(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 clean instruments shall be maintained as specified in 5.11.
(e)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.
(f)Ensure that any electrically operated components such as compressors, dehydrators, and solenoid valves are secured and safety tagged.

5.6.3.3 All removed items shall be cleaned as specified in 5.2 or 5.3, as applicable. 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 or 5.3, as applicable.

5.6.3.4 Large in-line volumes that will not support minimum flushing velocities should be individually cleaned and bypassed when flushing. The concern is that some cleaners such as NOC and TSP remove soil by displacement. In areas of low flow, suspended oil can separate from NOC or TSP and collect. Because of this, perform the following when flushing large in-line volumes:

(a)For general applications, recommend flushing as specified in 5.6.7 with a low foaming detergent cleaner that will emulsify oil contamination selected as specified in 4.3. If using NOC or TSP, review 5.6.3.4(b) for applicable direction.
(b)For critical applications where the volume cannot be bypassed, cannot be inspected and locally cleaned as specified in 5.13.4, and will collect separated oil, perform the following with local engineering approval: isolate the volume into the smallest possible flushing loop possible, preclean with a low foaming detergent that will emulsify oil contamination selected as specified in 4.3, and then perform the preflush as specified in 5.6.5 prior to the final flush. The precleaner is used to remove oil and grease contamination, and then NOC or TSP final cleaner is used to remove any precleaner residue and verify cleanliness. For

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volumes that cannot be bypassed, but can either be locally cleaned as specified in 5.13.4 or the configuration of the volume will not collect separated oil during the final flush, such as an in-line vertically oriented flask, a preclean flush is not required.

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

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

(a) Perform forward and backward preflush at a minimum of 3 ft/sec using grade C water for general applications or grade B water for critical applications. 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 visual evidence of debris.

5.6.6 Hydrostatic test. Hydrostatic testing as specified in 5.10 should normally be accomplished after the preflush, if applicable, and before the final flush.

5.6.7 Final flush/pipe line cleaning. For general applications using a low foaming cleaner selected as specified in 4.3, flush the system with the cleaner in accordance with the process determined as specified in 4.4. Final pipe line cleaning with NOC or TSP 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 5.6.7(b). The temperature of the NOC at the outlet of the system being cleaned shall be maintained at no 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 5.6.8. If NOC is used, it may be recirculated in the system cold and heated in place. For NOC or TSP, the flush starts when the outlet temperature reaches 140°F.
(b) The fluid velocity shall be no less than 3 ft/sec. The flow rate in gallons per minute 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 and temperatures for various applications are given in 5.6.7(a) and Table V.

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TABLE V. Applicability matrix for flush duration and back flush. 1/

Configuration	Flush duration 2/	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 precleaned piping and components	Not less than 30 minutes	Not less than an additional 30 minutes

1/ Regardless of the configuration, the back flush can be deleted if all of the following conditions are met:
(1)It is authorized by local engineering.
(2)All pipe sections have been pre-cleaned.
(3)All valve bodies, filter housings, and other large component housings shall have been cleaned as specified herein.
(4)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 5.14.1. Any evidence of contamination shall be removed by either local cleaning as specified in 5.13.4 or additional flushing. The results of the visual inspection shall be recorded for critical applications.

2/ Shorter durations for general applications can be authorized by local engineering. The durations specified assume a worst case of particulate and heavy grease. Light oils can be removed using shorter durations.

(d)Upon completing the flush of critical applications, obtain a sample of not less than 200 mL of used NOC or 500 to 600 mL of used TSP 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)Inspect the NOC sample drawn as specified in 5.6.7(d) for organic cleanliness as specified in 5.14.2 and 5.14.3.2. 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 foam is present, replace the cleaning solution and repeat the pipe line cleaning process.
(f)Inspect the TSP sample drawn as specified in 5.6.7(d) for organic cleanliness by analyzing for hydrocarbons or NVR as specified in MIL-STD-1330, or an approved EPA Oil and Grease and Total Petroleum Hydrocarbon test method such as EPA Method 1664, or equal. The acceptance criteria is 15 ppm maximum. Do not wait for the results before proceeding to rinsing as specified in 5.6.8. If greater than 15 ppm hydrocarbon or NVR is present, replace the cleaning solution and repeat the pipe line cleaning process.

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5.6.8 Rinsing and particulate flushing. For general applications that used a cleaner selected as specified in 4.3, rinse the system with grade C water in accordance with the process determined as specified in 4.4. Rinsing and particulate flushing after final pipe line cleaning with NOC or TSP shall be accomplished as follows:

(a) Remove the majority of NOC with air or nitrogen and collect for future use, or proceed to 5.6.8(b). When using air or nitrogen, do not allow NOC to dry before proceeding to 5.6.8(b).

(b) Remove NOC or TSP cleaning solution by rinsing the system once-through with grade B water for critical applications or grade C water for general applications at a velocity of not less than 3 ft/sec. Remove, replace, or bypass any return filter(s) that was used during the flush step prior to rinsing. 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 5.14.4. 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) For general applications, at the completion of rinsing, obtain a sample of the rinse effluent from each branch and perform a clarity inspection as specified in 5.14.3.2. If any of the samples fail due to the presence of oil or grease, replace the cleaning solution and repeat the pipe line cleaning process. If any of the samples fail due to other contaminants such as sediment, paint chips, bead blast, or resin beads, recirculate grade C 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 clarity inspection as specified in 5.14.3.2.

(e) For critical applications, at the completion of rinsing, obtain a sample of the rinse effluent from each branch and verify particulate cleanliness as specified in 5.14.3.1. 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 inspection as specified in 5.14.3.1.

(f) 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 wiping each cavity and flush plug with a clean cloth wetted with grade B water at a temperature of 100 to 120°F. The flush plugs should be reinstalled prior to drying with air or nitrogen.

5.6.9 Drying and reinstalling components. Drying, if required by Table VI, and reinstallation of components shall be accomplished as follows:

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TABLE VI. Dryness level requirements.

System	Maximum allowable dew point	Maximum allowable water content
Submarine Medium-pressure air High-pressure air 1/ Nitrogen Surface craft Electronics dry air High-pressure air Oxygen-nitrogen plant air supply Nitrogen	-40°F at 14.7 lb/in^2	0.000079 lb H_2O/lb dry air
Submarines Diver's air Emergency breathing air Low pressure air Surface craft Diver's air Emergency breathing air Low-pressure vital & non-vital air Medium pressure air	+20°F at 14.7 lb/in^2	0.00214 lb H_2O/lb dry air
Surface craft Bleed air Deballast air	2/	2/

1/ Submarine EMBT blow bank dew points are verified to be -60°F or lower at 14.7 lb/in^2 prior to use.

2/ Drying of these systems shall consist of removing bulk moisture to minimize corrosion and formation of mold and mildew.

(a) Remove rinse water and dry the system with air or nitrogen until the dew point specified in Table VI is reached. Air or 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 air or 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. Do not exceed the maximum system operating pressure.

(c) While maintaining cleanliness as specified in 5.11, all items shall be removed which were installed in 5.6.3.2. A visual inspection of each cavity shall be performed as specified in 5.14.1.1. Additionally, where applicable, open and visually inspect all large volumes as specified in 5.14.1.1. If the visual inspection fails, reclean as specified in 5.13.4. While maintaining cleanliness as specified in 5.11, components cleaned as specified in 5.2 or 5.3, as applicable, shall be installed.

(d) The system shall be reassembled or packaged as specified in 5.16.1 to maintain cleanliness.

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

5.7 System solvent cleaning processes.

5.7.1 Applicability. The system solvent cleaning processes are given in Table VII.

TABLE VII. Solvent cleaning processes.

Application	Paragraph
Cryogenic nitrogen plant	5.7.2
Cryogenic nitrogen or liquid air piping 1/	5.7.3

1/ If moisture can be removed from the piping or item being cleaned, it may be cleaned as specified in 5.6 instead of 5.7.3.

5.7.2 Nitrogen plants.

5.7.2.1 Material and equipment.

(a)A supply of cleaning solvent as specified in 4.2.5.
(b)The required equipment depends on the specific plant configuration encountered which dictates what procedure will be employed to clean the plant. Specific procedures and equipment are not specified in this standard. The equipment shall be compatible with the cleaning solvent.

5.7.2.2 Cleaning solvent. The cleaning solvent for cleaning nitrogen plants shall be a NAVSEA approved halogenated solvent as specified in 4.2.5.

5.7.2.3 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 equipment to be cleaned.

5.7.2.4 Sample and removal of cleaning solvent from system. The nitrogen plant shall be certified clean and free of cleaning solvent as specified in 5.7.3.4(b) and 5.7.3.4(c).

5.7.3 Cryogenic nitrogen or liquid air piping.

5.7.3.1 Material and equipment. The following material and equipment are required.

(a)A supply of cleaning solvent as specified in 4.2.5.
(b)A supply of nitrogen.
(c)A vacuum pump capable of pulling a minimum of 25 inches mercury (Hg) vacuum for removing the cleaning solvent. The pump design shall preclude pump lubricant from being drawn into the system

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being cleaned in the event of a pump failure or stoppage. It shall be compatible with the cleaning agent.

(d) Gages, flowmeters, and thermometers as required which are compatible with the cleaning solvent.

(e) Equipment to perform the applicable analyses of 5.14.

5.7.3.2 Preliminary tightness test. A preliminary 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. All accessible mechanical joints, seal welds, and disturbed welded joints shall be tightness tested as specified in 5.10.

5.7.3.3 Hydrostatic. Hydrostatic testing as specified in 5.10 should normally be accomplished before the final flush.

5.7.3.4 Flush. Flushing shall be accomplished as follows:

(a) The piping shall be flushed with cleaning solvent at not less than 3 ft/sec for not less than 30 minutes. If the flushing circuit is through parallel paths, if necessary, the flow paths shall be isolated as necessary to ensure that each path is flushed with full flow for at least 5 minutes followed by a 30 minute flush of the entire system without full flow required in each leg.

(b) Obtain a sample of the cleaning solvent from all sampling locations. For critical applications, verify organic cleanliness by analyzing for hydrocarbons or NVR as specified in MIL-STD-1330, or approved EPA Oil and Grease and Total Hydrocarbon test methods such as EPA Method 1664, or equal. The acceptance criteria is 15 ppm. For all applications, verify particulate cleanliness as specified in 5.14.3.1. If any of the analyses fail, replace 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 ($200^{o}F$ 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. Evacuating and purging shall be continued until no trace of the solvent is detectable.

(d) The piping shall be pressurized with nitrogen to a minimum of 75 lb/in^2 or the maximum system operating pressure, whichever is less. Samples of nitrogen under pressure shall be taken after a period of no 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 piping shall be purged with nitrogen until acceptable samples are obtained.

5.7.3.5 Dry, reassemble and package. The piping shall be reassembled or packaged as specified in 5.16.1 to maintain cleanliness. To maintain the piping dry, the piping should be pressurized with no less than 10 lb/in^2 of nitrogen, or the maximum system operating pressure if lower, until the piping is restored to normal service. If the pressure should drop below 10 lb/in^2 before being restored to normal service, the responsible authority should investigate to ensure that moisture has not entered the piping. If excessive moisture is detected in the piping, remove moisture by purging with nitrogen, or other appropriate method, to the applicable cryogenic specification.

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5.8 System blowdown.

5.8.1 Applicability. The system blowdown is applicable to systems meeting the following conditions:

(a) New systems comprised of sections cleaned as specified herein prior to installation.
(b) Only particulate removal, such as desiccant, is required. Flux or hydrocarbon removal is not required.
(c) It is authorized by local engineering.
(d) For diver's air systems, NAVSEA approval is required.

5.8.2 System preparation. The following items shall be accomplished to prepare a system for blowdown:

(a) Valves, valve internals, pressure regulators, filter elements, or other mechanically jointed components that will interfere with the blowdown should be removed and flush plugs, spools, jumpers, and blanks shall be installed which can withstand the anticipated blowdown pressure. Where jumpers are used, their inside diameter should not be less than the piping they are bypassing.
(b) Remove items which could be damaged.
(c) Ensure that any electrically operated components such as compressors, dehydrators, and solenoid valves are secured and safety tagged.

5.8.3 Leak-check. All piping within the blowdown boundary shall be tightness tested at all mechanical joints with air or nitrogen to, at a minimum, the anticipated blowdown pressure.

5.8.4 Blowdown. The blowdown shall be accomplished as follows:

(a) Blowdown each outlet with air or nitrogen at the maximum system flow rate not to exceed normal system operating pressure for not less than 30 seconds. The maximum flow rate shall be determined by measurement or calculation.
(b) Open and inspect selected valves or other components that bound individually cleaned sections or areas of suspected contamination. Verify surface cleanliness as specified in 5.14.1.1. If particulate contamination is evident, repeat 5.8.4(a) or clean the system as specified in 5.9.

5.9 Hot or cold water flush.

5.9.1 Applicability. A hot or cold water flush is applicable to systems meeting the following conditions:

(a) The system is contaminated with particulate or sea water.
(b) Removal of organic contamination is not required.
(c) The flush is authorized by local engineering.

5.9.2 System preparation. The system shall be prepared as specified in 5.6.3.1 and 5.6.3.2. Components removed shall be visually inspected as specified in 5.14.1.1. Components contaminated with particulate or sea water shall be cleaned using one of the following methods.

(a) Rinse with grade C water for general applications or grade B water for critical applications until samples of the rinse water effluent meet the requirements of 5.9.5, or
(b) Locally clean as specified in 5.13.4, or

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(c)Clean as specified in 5.2 or 5.3, depending on application.

5.9.3 Hot water flush. Perform a hot water flush for particulate or seawater removal as follows:

5.9.3.1 Hot water flush for particulate removal. Flush with grade C water for general applications or grade B water for critical applications at a velocity of 3 ft/sec determined as specified in 5.6.7(b) maintaining an exit temperature of not less than 110°F for 30 minutes minimum. Recirculating water through a 10 micrometer nominally rated filter will minimize the volume of flushing water used. If flushing through parallel piping, flow shall be isolated to ensure that each path is flushed with full flow for at least 10 minutes. At the completion of flushing, obtain a sample of the effluent from each branch and inspect as specified in 5.9.5.

5.9.3.2 Hot water flush for sea water removal. Flush with grade C water for general applications or grade B water for critical applications at a velocity of 1 ft/sec maintaining an exit temperature of not less than 110°F for 30 minutes minimum. If flushing through parallel piping, flow shall be isolated to ensure that each path is flushed with full flow for at least 10 minutes. At the completion of flushing, obtain a sample of the effluent from each branch and inspect as specified in 5.9.5.

5.9.4 Cold water flush. Perform a cold water flush for particulate or seawater removal as follows:

5.9.4.1 Cold water flush for particulate removal. Flush with grade C water for general applications or grade B water for critical applications at a velocity of not less than 3 ft/sec determined as specified in 5.6.7(b) maintaining a temperature of not less than 60°F for 1 hour minimum. Recirculating water through a 10 micrometer nominally rated filter will minimize the volume of flushing water used. If flushing through parallel piping, flow shall be isolated to ensure that each path is flushed with full flow for at least 30 minutes. At the completion of flushing, obtain a sample of the effluent from each branch and inspect as specified in 5.9.5.

5.9.4.2 Cold water flush for sea water removal. Use grade C water for general applications or grade B water for critical applications for the soak and flush. Soak the system at not less than 60°F for 12 hours minimum. Drain and refill the system. Flush at a velocity of not less than 1 ft/sec maintaining a temperature of not less than 60°F for 30 minutes minimum. If flushing through parallel piping, flow shall be isolated to ensure that each path is flushed with full flow for at least 10 minutes. At the completion of flushing, obtain a sample of the effluent from each branch and inspect as specified in 5.9.5.

5.9.5 Inspection. If flushing to remove particulate contamination, verify critical application cleanliness as specified in 5.14.3.1 or general application cleanliness as specified in 5.14.3.2. If flushing to remove seawater contamination, measure chlorides and conductivity and verify the sample meets grade C water requirements as specified in 4.1.1. If any of the analyses fail, repeat the flushing for durations as needed. Continue flushing until a sample of the effluent from each branch passes the analyses.

5.9.6 Drying and reinstalling components. Drying, if required by Table VI, and reinstallation of components shall be accomplished as follows:

(a)Remove rinse water and dry the system with air or nitrogen until the dew point specified in Table VI is reached. Air or nitrogen preheaters, strip heaters, or vacuum pumps have been successfully

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used. Appropriate precautions shall be taken to prevent damaging piping and equipment.

(b) The recommended drying method is using air or 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 no greater than 100 lb/in^2 or maximum operating pressure, whichever is less.

(c) While maintaining cleanliness as specified in 5.11, all items shall be removed which were installed in 5.9.2. A visual inspection of each cavity shall be performed. If the visual inspection fails, locally clean as specified in 5.13.4. While maintaining cleanliness as specified in 5.11, components cleaned as specified in 5.2 shall be installed.

(d) The system shall be reassembled or packaged as specified in 5.16.1 to maintain cleanliness.

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

5.10 Testing.

5.10.1 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 NAVSEA 0902-018-2010, NAVSEA S9086-RD-STM-010/CH-505, NAVSEA S9086-SY-STM-010/CH-551. Flexible hoses shall be tested as specified in NAVSEA S6430-AE-TED-010. When contractually invoked, or otherwise specified by NAVSEA, the test requirements of NAVSEA SS800-AG-MAN-010/P-9290 shall take precedence.

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

5.10.3 Gas sampling and analysis. For diver air and emergency air breathing systems, a gas sample is required if work was accomplished that could introduce gaseous contaminants, such as solvents, into a component or system. 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 no less than 8 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 for diver air systems shall meet the requirements of NAVSEA SS800-AG-MAN-010/P-9290 or NAVSEA SS521-AA-MAN-010 and emergency air breathing shall meet the quality requirements for BB-A-1034.

5.11 Removal and replacement of components. Maintain cleanliness during repair or maintenance of a clean system by preventing the entry of foreign material. This shall be accomplished by plugging or capping openings using methods as specified in 5.16.3. Prevent airborne contamination near

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exposed openings by minimizing evolutions such as grinding, painting, and brazing.

5.12 Piping repairs between flask and isolation valve.

5.12.1 Applicability. For repairs of piping between permanently installed flasks and the first flask isolation valve, the following procedure may be employed to eliminate the need for flask removal to hydrostatically test and clean the piping. Local engineering approval is required to employ this procedure.

5.12.2 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. That portion of the system where cutting or grinding will occur shall be depressurized and isolated by shutting the boundary isolation valve. A convenient bleed point within the affected boundary shall be allowed.

5.12.3 Maintenance of purge. During cutting or grinding and when the system is open to the atmosphere, maintain a slight positive air or nitrogen purge of about 2 lb/in^2 to prevent possible entry of airborne contamination or contamination from cutting or grinding.

5.12.4 Cutting/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.

5.12.5 Cleaning. While maintaining the purge, locally clean the pipe internally and externally where the cutting or grinding occurred as specified in 5.13.4. If there are any significant delays during fit up and welding, the system shall be packaged as specified in 5.16.3. The purge shall be maintained during welding. Work shall be planned so as 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.

5.12.6 Inspection and testing. Inspect and tightness test the weld as specified in NAVSEA S9086-RK-STM-010/CH-505 using the procedures for replacing a post repair hydrostatic test with a tightness test. Hydrostatic testing is not required. The joint tightness test shall also satisfy the requirements as specified in 5.10.

5.13 Loss of cleanliness.

5.13.1 Definition. Contamination of a system or component which has previously been cleaned as specified by this standard due to other than normal system use is considered a loss of cleanliness. Examples include oil contamination from a compressor and system degradation causing pieces of material to deposit in the system.

5.13.2 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 5.14.1.1. The boundary of the contamination is determined based on the

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inspection results. Depending upon the application, the following would be considered as unacceptable potentially requiring corrective action as specified in 5.13.3. This list is for guidance only and does not include all items that may be encountered requiring corrective action.

(a) For critical applications and emergency breathing air, fluorescence under ultraviolet light or observable coatings attributed to other than approved lubricants. The procedure specified in 5.14.6 for detection of hydrocarbon contamination by swipe is useful in differentiating an approved non-flammable fluorinated lubricant from a flammable hydrocarbon lubricant.

(b) Large visible particles attributed to several causes such as failure of a valve seat, exposure to an uncontrolled atmosphere, inadequately filtered test gas, or corrosion of nearby components. If possible, particles should be collected and analyzed in order to determine the source.

(c) Sea water contamination detected by:

(1) Salt deposits noted by visual inspection.

(2) Analysis of water effluent indicating a chloride level greater than 50 ppm.

5.13.3 Corrective action. Contaminated systems shall be evaluated by local engineering for the need to reclean to the requirements specified herein. Consideration should be given to items such as the application, configuration, and potential hazards posed by the contamination. Loss of cleanliness in any critical system due to other than normal system use shall be noted (see 6.3) specifying corrective action. Corrective action options are as follows:

(a) Extensive organic contamination of any system can only be corrected using a chemical flush as specified in 5.6.

(b) Extensive particulate or sea water contamination of any system can be corrected using a hot or cold water flush as specified in 5.9.

(c) Organic contamination of a general application component can be removed as specified in 5.2 or by local cleaning as specified in 5.13.4.

(d) Organic contamination of a critical application component can be removed as specified in 5.3 or by local cleaning as specified in 5.13.4. However, if removing hydrocarbon contamination by local cleaning, in addition to the visual inspection requirements of 5.14.1.1, a swipe as specified in 5.14.6 shall be performed.

(e) Particulate contamination of a general application component can be removed as specified in 5.3, 5.9.2, or by local cleaning as specified in 5.13.4.

(f) Particulate contamination of a critical application component can be removed as specified in 5.2, 5.9.2, or by local cleaning as specified in 5.13.4.

5.13.4 Local cleaning. Clean using methods such as clean cloths, vacuuming, brushing, or any combination thereof. When large amounts of oil or grease, rust scale, or other foreign material is present, clean with a cloth wetted with warm (100 to 120°F) NOC or TSP or other cleaner as specified in 4.2 or 4.3, or, with local engineering approval, a NAVSEA approved halogenated solvent. Halogenated solvents are excellent for removing fluorinated greases. Remove aqueous cleaning solutions by wiping with a new cloth wetted with warm (100 to 120°F) grade C water for general applications or grade B water for critical applications. Dry the wetted surfaces with a clean cloth. This process shall be repeated until the parts pass the visual inspection as specified in 5.14.1.1. If necessary, use air or nitrogen to dry the surface.

5.14 Process verification methods.

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5.14.1 Visual surface inspection methods.

5.14.1.1 Applicability. When specified, surface cleanliness shall be verified using the visual inspection techniques specified in Table VIII. Ultraviolet light inspections shall be performed as specified in 5.14.1.2; white light inspections shall be performed as specified in 5.14.1.3, and swipe inspections shall be performed as specified in 5.14.1.4. These visual inspection techniques are limited only to determining the presence of organic or particulate contamination on a surface cleaned in accordance with this standard. For critical applications, visual inspection techniques shall not be used in place of cleaning or to establish the absence of organic contamination on surfaces not cleaned as specified in this standard. Be aware that, for other than critical applications, the acceptance criteria of Table VIII is intended to minimize fire hazards and major equipment failures. Use of components with very close tolerances may require critical application cleanliness to avoid accelerated equipment degradation.

5.14.1.2 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. The inspection criteria are as specified in Table VIII. 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.

5.14.1.3 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. The inspection criteria are as specified in Table VIII.

5.14.1.4 Swipe method. The surface shall be swiped with at least two movements with filter paper or a clean swipe cloth as specified in 3.7. The inspection criteria are as specified in Table VIII. Note that the swipe method is limited to surfaces with areas not less than 100 cm^2 (16 in^2).

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TABLE VIII. Inspection requirements.

Application	Inspection & criteria
Critical (diver's life support) (oxygen-nitrogen producer air supply)	Ultraviolet light: No evidence of fluorescence from oil, grease, ink, dye, particulate or fibers. White light: No evidence of oil, grease, ink, dye, particulate or fibers. Swipe: No evidence of oil, grease, ink, dye, particulate or fibers.
Emergency breathing air	Ultraviolet light: No evidence of fluorescence from oil, grease, ink, or dye. White light: A degree of cleanliness where internal surfaces are free of foreign material except visual trace particles including tap water residue are acceptable. Adherent light superficial rust on non-corrosion resistant surfaces, such as carbon steel, caused by exposure to the atmosphere is acceptable. Swipe: Not applicable.
High-pressure air Medium-pressure air Nitrogen Low pressure vital air Electronics dry air	Ultraviolet light: Not applicable. White light: A degree of cleanliness where internal surfaces are free of foreign material. A light film coating of oil is acceptable. A light film coating, which is about 0.1 mil thick, is that which remains on the surface when an oil-coated surface is wiped off with a rag. Tap water residue leaving visual trace particles is acceptable. Adherent light superficial rust on non-corrosion resistant surfaces, such as carbon steel, caused by exposure to the atmosphere is acceptable. Swipe: Not applicable.
Low pressure air systems (not specified above) Bleed air Deballast air	Ultraviolet light: Not applicable. White light: A degree of cleanliness where internal surfaces are reasonably free of foreign material and any remaining residue on the surface does not interfere with system operations. Adherent light superficial rust on non-corrosion resistant surfaces, such as carbon steel, caused by exposure to the atmosphere is acceptable. Swipe: Not applicable.

5.14.2 Shake test. A half-full capped sample container shall be vigorously agitated for not less than 5 seconds, then allowed to stand undisturbed for 15 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

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in NOC. As an example, NOC with only 5 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 preclean 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.

5.14.3 Particulate and clarity inspection methods.

5.14.3.1 White light visual particle inspection. Samples 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 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 particles shall be cause for rejection. This visual inspection corresponds to a quantitative limit of no particles greater than 50 micrometers.

5.14.3.2 White light visual clarity inspection. Samples shall be visually inspected for clarity. 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 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.

5.14.4 Rinse water pH analysis. 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.

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

5.14.5.1 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 5.14.5.3. Suitable balances are available through laboratory supply houses such as Thomas Scientific and Cole-Parmer.
(b) Beakers or erlenmeyer flasks of 100 to 250 mL capacity, plastic or glass; or equal.
(c) Graduated cylinder to 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.

5.14.5.2 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

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such as Sigma Chemical Company. 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 Company.

(c) Grade B water.

(d) Isopropyl alcohol as specified in 4.2.4.

5.14.5.3 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 5.14.5.2(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% wt/vol thymolphthalein pH indicator solution by adding 50.0 ± 1.0 mL of isopropyl alcohol (see 5.14.5.2(d)) to each 0.1 ± 0.01 grams of thymolphthalein (see 5.14.5.2(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.

5.14.5.4 Procedure.

(a) Transfer 50.0 ± 1.0 mL of the 4.0 percent KHP solution (5.14.5.3(a)) to the beaker or erlenmeyer flask.

(b) Add five drops of the 0.2 percent thymolphthalein pH indicator solution (5.14.5.3(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 or stirring the contents until a blue color end-point persists for 15 seconds. Record to the nearest 1 mL the final level of the NOC in the syringe or buret.

5.14.5.5 Calculation. Determine the volume of NOC used by subtracting the final level (5.14.5.4(d)) of NOC solution in the syringe or buret from the initial level (5.14.5.4(c)) of NOC solution in the syringe or buret. Record this volume difference in milliliters. Report this number as the alkalinity - mL of NOC.

5.14.6 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 5.14.1.2 to 5.14.1.4 during maintenance or loss of system cleanliness. The procedure does not measure the concentration of hydrocarbon contamination. The procedure has a sensitivity of 20 to 30 mg/ft^2 hydrocarbons.

5.14.6.1 Equipment.

(a) Disposable pure teflon membrane filters, 47 millimeter diameter, pore size 0.45 or 0.5 micron. Suitable filters include Savillex

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Corp., 6133 Baker Rd, Minnetonka, MN 55345, (612)935-4100, part number 1121; Millipore Corp., 80 Ashy Rd, Bedford, MA 01730, (617)275-9200, part number FHUP04700; or equal. 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.

5.14.6.2 Swipe procedure.

(a)Using clean rubber or plastic gloves, 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 5.14.1.4, 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 mm diameter.

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

5.14.6.3 FTIR procedure.

(a)Scan 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 7 to 10 times higher than background for critical applications or 25 to 30 times higher than background for general applications are discernable significant peaks that indicate the presence of hydrocarbon contamination requiring corrective action.

5.15 Personnel qualification and training.

5.15.1 Applicability. Piping systems and components to be certified clean shall be cleaned, assembled, tested (if cleanliness is being maintained), and packaged by qualified personnel. The local facility shall be responsible for the training.

5.15.2 Content of training. The training should entail instruction on the local instruction that performs the cleaning and the hazards related to the operations. The training may be performed by any qualified personnel. Formal training and documentation is not required.

5.16 Packaging.

5.16.1 Applicability. Components cleaned internally and externally shall be packaged as specified in 5.16.2. Items cleaned internally only, such as hoses or piping assemblies, shall be packaged as specified in 5.16.3. Critical application items shall be identified as specified in 5.16.4.

5.16.2 Internally and externally cleaned components. Using film as specified in 5.16.3(b), packaging shall be accomplished as follows:

(a)Sealing of openings. When the item has openings leading to cleaned inner surfaces, the openings should be sealed as specified in 5.16.3.

(b)Intimate cushioning. Heavy items or items having threads, sharp points, or edges which could damage the outer packaging shall be

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cushioned with film. Secure the cushioning film with tape whose adhesive shall not come in contact with the cleaned component.

(c) Outer packaging. After performing 5.16.2(a) and/or 5.16.2(b), if applicable, place the component in a film bag and gently compress the bag to force out excess air. Seal the bag using heat seal, tape, or other mechanism, such as zip-lock bags. Adhesive shall not come in contact with the cleaned component.

5.16.3 Internally cleaned items. The requirements for packaging internally cleaned items are as follows:

(a) Plugs and external caps. Plug or cap openings using methods such as metal or rigid plastic covers, polyethylene or other bagging, threaded and non-threaded plugs and caps, expandable and nonexpandable wafer plugs, and inflatable plugs. Caps or plugs shall be wiped with a clean cloth prior to use. A cap or plug shall not be used if it can completely be inserted into the opening which it protects without specific foreign material controls. Whenever installing a cap or plug, ensure that the seal is tight.

(b) Closure with film. Apply film over openings. The film shall be chosen considering items such as thickness, strength, sloughing resistance, and moisture permeability. Secure the film tape taking care so that the tape does not contact the open portions of the item.

5.16.4 Identification.

5.16.4.1 Acceptance. In order to identify critical application materials and components cleaned in accordance with this standard, a sticker or tag shall be completed. The sticker or tag shall be affixed to the capped or plugged item or package or placed inside the package in a manner that does not contact the cleaned surface. The sticker or tag may be of any shape, may be of any background color except green, and shall, at a minimum, specify the following information:

(a) CLEANED IAW MIL-STD-1622 FOR CRITICAL APPLICATIONS
(b) Do Not Open Until Ready for Use
(c) The name of the activity or organization that performed the cleaning
(d) The date cleaning was performed
(e) The name of the final cleaning agent used.

5.16.4.2 Rejection. In order to identify critical application materials and components which have been contaminated, action shall be taken by the shop processing the material or quality assurance office representative to clearly indicate that the material requires recleaning.

5.16.5 Inspection of packaging. Prior to use or transport, the packaging of all clean materials shall be inspected. If the package is torn or damaged exposing the cleaned surface to the ambient atmosphere, the item shall be inspected as specified in 5.14.1.1. Items that do not pass the inspection shall be handled as specified in 5.13.

6. NOTES

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

6.1 Intended use. This standard practice is for the cleaning of naval surface ship, submarine and diving compressed air systems. The cleaning

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processes specified herein are based on the processes in MIL-STD-1330. The performance of the cleaning process specified herein can directly effect the safe operation of naval surface ship, submarine and diving compressed air systems. Absence of conformance 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 Issue of DoDISS. When this standard is used in acquisition, the applicable issue of the DoDISS must be cited in the solicitation (see 2.2.1 and 2.3).

6.3 NAVSEA approval and direction. 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.

6.4 Safety precautions. If respiratory protection is used as specified in 4.2.1.2(c), 4.2.2.2(c), 4.2.3.2, 4.2.4.2(b), or 4.2.5.2(a), it should be selected and worn in accordance with OPNAVINST 5100.19, or equivalent. When verifying in 4.2.5.2(a) that ventilation in a space is adequate to keep the concentration of solvent below the recommended exposure criteria during anticipated operations consult OPNAVINST 5100.19, or its equivalent. If an oxygen monitor with alarm is used as specified in 4.5.1, it should be in accordance with OPNAVINST 5100.19, or equivalent.

6.5 Subject term (key word) listing.

Compressed air
Divers life support system
Non-Ionic detergent (NID)
Isopropyl alcohol (IPA)
Halogenated solvent
Navy oxygen cleaner (NOC)
Trisodium phosphate (TSP)

6.6 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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APPENDIX A
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 section 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 section A.3 of this standard, whether or not they are listed.

A.2.2 Government documents.

A.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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

QQ-B-654 - Brazing Alloys, Silver.
QQ-N-281 - Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
QQ-N-286 - Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500).
QQ-S-763 - Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting.
WW-T-700 - Tube, Aluminum and Aluminum Alloy, Drawn, Seamless, General Specification for.

DEPARTMENT OF DEFENSE

MIL-T-1368 - Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded.
MIL-P-5425 - Plastic Sheet, Acrylic, Heat Resistant.
MIL-P-5510 - Packing, Preformed, Straight Thread Tube Fitting Boss, Type I Hydraulic (-65° to 160°F).
MIL-P-5516 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160°F.
MIL-R-6855 - Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes, General Specification for.
MIL-C-15726 - Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod and Wire.
MIL-S-16216 - Steel Plate, Alloy, Structural, High Yield Strength (HY-80 and HY-100).

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APPENDIX A

DEPARTMENT OF DEFENSE (Continued)

MIL-T-16420 - Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706).
MIL-S-21923 - Synthetic Rubber Compound, Butadiene - Styrene Type, Ozone Resistant, for Low Temperature Service.
MIL-G-22050 - Gasket and Packing Material, Rubber, for Use With Polar Fluids, Steam, and Air at Moderately High Temperatures.
MIL-F-22606 - Flask Compressed Gas and End Plugs for Air, Oxygen and Nitrogen.
MIL-S-22698 - Steel Plate, Shapes and Bars, Weldable Ordinary Strength and Higher Strength: Structural.
MIL-S-23008 - Steel Castings, Alloy, High Yield Strength (HY-80 and HY-100).
MIL-T-24107 - Tube, Copper (Seamless)(Copper Alloy Numbers C10100, C10200, C10300, C10800, C12000, C12200, and C14200).
MIL-P-24691 - Pipe and Tube, Carbon, Alloy and Stainless Steel, Seamless and Welded, General Specification for.
MIL-P-24691/3 Pipe and Tube, Corrosion-Resistant, Stainless Steel, Seamless or Welded.
MIL-R-81828 - Rubber, Chlorosulfonated Polyethylene Elastomer, Sheet and Molded Shapes, Ozone Resistant.
MIL-R-83248 - Rubber, Fluorocarbon Elastomer, High Temperature Fluid, and Compression Set Resistant.
MIL-R-83285 - Rubber, Ethylene-Propylene, General Purpose.
MIL-P-83461 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F (135°C).

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

A.2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA (AIA)

AIA NAS 1613 - Packing, Preformed, O-Ring, Ethylene Propylene Rubber.

(Application for copies should be addressed to the Aerospace Industries Association of America, Inc., 1250 Eye Street, NW, Washington, DC 20005.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 336 - Standard Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts. (DoD adopted)
ASTM A 148 - Standard Specification for Aluminum-Bronze Sand Castings. (DoD adopted)
ASTM B 150 - Standard Specification for Aluminum Bronze Rod, Bar, and Shapes. (DoD adopted)

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APPENDIX A

AMERICAN SOCIETY FOR TESTING AND MATERIALS (Continued)

ASTM B 167 - Standard Specification for Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06690, N06025, and N06045) Seamless Pipe and Tube. (DoD adopted)

ASTM B 171 - Standard Specification for Copper-Alloy Plate and Sheet for Pressure Vessels, Condensers, and Heat Exchangers.

ASTM B 209 - Standard Specification for Aluminum and Aluminum - Alloy Sheet and Plate. (DoD adopted)

ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes. (DoD adopted)

ASTM B 265 - Standard Specification for Titanium and Titanium Alloy Strip, Sheet, and Plate. (DoD adopted)

ASTM B 337 - Standard Specification for Seamless and Welded Titanium and Titanium Alloy Pipe. (DoD adopted)

ASTM B 446 - Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06624) Rod and Bar.

ASTM D 471 - Standard Test Method for Rubber Property - Effect of Liquids. (DoD adopted)

ASTM D 543 - Standard Test Method for Resistance of Plastics to Chemical Reagents. (DoD adopted)

ASTM D 930 - Standard Test Method of Total Immersion Corrosion Test of Water-Soluble Aluminum Cleaners.

ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

ASTM D 1280 - Standard Test Method of Total Immersion Corrosion Test for Soak Tank Metal Cleaners.

ASTM D 1414 - Standard Test Methods for Rubber O-Rings. (DoD adopted)

ASTM D 1457 - Standard Specification for Polytetrafluoroethylene (PTFE) Molding and Extrusion Materials. (DoD adopted)

ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds. (DoD adopted)

ASTM D 2116 - Standard Specification for FEP-Fluorocarbon Molding and Extrusion Materials. (DoD adopted)

ASTM D 2287 - Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds. (DoD adopted)

ASTM D 4066 - Standard Specification for Nylon Injection and Extrusion Materials (PA). (DoD adopted)

ASTM D 4101 - Standard Specification for Propylene Plastic Injection and Extrusion Materials. (DoD adopted)

ASTM D 4181 - Standard Specification for Acetal (POM) Molding and Extrusion Materials. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

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APPENDIX A

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 IX through XI. 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 D 930 or ASTM D 1280 provide guidance for performing compatibility testing on metals. The allowable corrosion limits are as specified in MIL-DTL-24800.

A.3.3 Rubber. ASTM D 471 or ASTM D 1414 provide guidance for performing compatibility testing on rubbers. The criteria to determine the exposure limits are as specified in Table XII.

A.3.4 Plastic. ASTM D 543 provides guidance for performing compatibility testing on plastics. The criteria to determine the exposure limits are as specified in Table XIII.

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TABLE IX. 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 B 209, HT116	C	I	C/D	NH
ALUMINUM, Alloy 6061-T6; ASTM B 221	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 A 336 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 B 167 CW	C	C	C/D	C
INCONEL, Alloy N06600; ASTM B 167 HF	C	C	C	C
INCONEL, Alloy N06625; ASTM B 446 CR	C	C	C	C
NAVAL BRASS, Alloy 464; ASTM B 171	C/D	C/D	C	C
NICKEL-ALUMINUM-BRONZE, Alloy C95800; ASTM B 148	C	C/D	C	C
NICKEL-ALUMINUM-BRONZE, Alloy C63000-HR50; ASTM B 150	C	C/D	C/D	C
NICKEL-ALUMINUM-BRONZE, Alloy C64200-HR50; ASTM B 150	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 B 337	C	C	C	C
TITANIUM, Ti-6Al-4V; ASTM B 265 GR5	C	C	C	C

1/ See 1/ on Table X or XI.
2/ See 2/ on Table X or XI.

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TABLE X. 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, 88 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

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 a 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.

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TABLE XI. 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 D 4181	C	C	C	C
EPOXY, Epoxy resin; Commercial, unfilled	I	I	I	C
HDPE, High density polyethylene; ASTM D 1248	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 D 4066, 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 D 4101, unfilled	12L	C	C	C
PVC, Polyvinyl chloride; ASTM D 1784, rigid	C	C	C	C
PVC, Polyvinyl chloride; ASTM D 2287, 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 D 2116	C	C	C	C
TEFLON TFE, Polytetrafluoro-ethylene; ASTM D 1457	12L	12L	C	C
VESPEL-21, Polyamide resin + graphite; Commercial	1L	1L	NT	C

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 a 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.

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TABLE XII. 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 XIII. 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

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APPENDIX B

NAVSEA APPROVED HALOGENATED SOLVENTS

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 identifies the NAVSEA approved halogenated solvents, and specifies information regarding safe and effective use.

B.2 APPLICABLE DOCUMENTS

B.2.1 General. The documents listed in this section are specified in Appendix B 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 B of this standard, whether or not they are listed.

B.2.2 Government documents.

B.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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

A-A-50425 - Cleaning Compound, Halogenated Hydrocarbon, for Oxygen System Components, Aerosol (Spot Cleaner).
A-A-50427 - Cleaning Compound, Solvent, 1,1-Dichloro-1-Fluoroethane, HCFC-141b, for Oxygen Systems.
A-A-59150 - Cleaning Compound, Solvent, Hydrofluoroether for Oxygen Systems.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

B.3 HALOGENATED SOLVENTS

B.3.1 NAVSEA Approved Solvents. The halogenated solvents listed in Table XIV are approved for the applications specified in 4.2.5.1, subject to the limitations specified by Table XIV.

B.3.2 Safety Precautions. Use of any halogenated solvent listed in Table XIV shall follow the safety precautions of 4.2.5.2.

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APPENDIX B

TABLE XIV. NAVSEA approved halogenated solvents.

Attribute	Approved halogenated solvents 1/		
	HFE-7100 2/	HCFC-141b 3/	HCFC-225 4/
Applications			
1. Gauges	Yes	Yes	Yes
2. Cryogenic N2 plant	No	Yes	Yes
3. Field wipe 5/	2/	Yes	No
Specifications	A-A-59150 2/	A-A-50425 A-A-50427 3/	4/
Recommended 8-hour time weighted average exposure criteria	600	500	4/
Recommended short term exposure limit	900	750	4/
Boiling point	140°F	90°F	129°F
Ozone depleting substance	No	Yes	Yes
Ozone depletion potential	0.0	0.11	0.03
Production phase-out	NA	2003	2015
Process verification methods			
1. Infrared spectrophotometry	No	No	No
2. NVR	Yes	Yes	Yes
Non-metallic compatibility 6/	7/	7/	7/
1. PTFE Teflon	12L	C	C
2. Kel-F	C	C	C
3. Vespel SP-21	C	C	C
4. Viton	1L	1L	1L
5. Silicone	I	1L	I
6. Buna-n	C	I	I
7. Ethylene propylene	C	12L	C
8. Neoprene	12L	1L	C
9. Kalrez	I	NT	I

1/ Ozone depleting halogenated solvent CFC-113 approved for oxygen cleaning in accordance with MIL-STD-1330 shall not be used for any system or component within the boundary specified by 1.2.

2/ HFE-7100 halogenated solvent has marginal hydrocarbon soil removal performance. Use of HFE-7100 to clean critical application gauges or

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instruments shall only be accomplished with procedures approved or accepted by NAVSEA. The performance of HFE-7100 as a field wipe solvent is dependent of the type of soil being removed. HFE-7100 is an excellent wipe solvent for halogenated oils and greases. HFE-7100 is a poor wipe solvent for hydrocarbon oils and greases including silicone.

3/ Ozone depleting halogenated solvent HCFC-141b shall only be used for cleaning critical application gauges and instruments, flushing cryogenic plants, and field wipe of critical applications. HCFC-141b in accordance with A-A-50425 is restricted to field wipe since it is delivered only as spray can. 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 flushed 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 explosion level is toxic representing an immediate hazard to life. HCFC-141b in accordance with A-A-50425 and A-A-50427 has been satisfactory tested for compatibility with gaseous and liquid oxygen demonstrating no ignition or flash point.

4/ Ozone depleting halogenated solvent HCFC-225 is not authorized for use by any Navy uniformed or civilian personnel. Review of the health and safety aspects of HCFC-225 by the Navy Environmental Health Center concluded that the toxicity testing of the solvent is incomplete; 90-day inhalation and teratology (fetus development) testing have not been completed. Therefore, no exposure criteria can be recommended at this time. Vendors may use the solvent at their own risk, however, its use is not authorized on board any NAVSEA vessel or facility. HCFC-225 used for cleaning as specified in this standard shall be in accordance with the following which has passed oxygen liquid and gaseous flammability testing and soil removal performance testing.

Composition (HCFC-225):
3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)
(CAS No. 422-56-0).....45 ± 5%
1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)
(CAS No. 507-55-1).....55 ± 5%
Purity (impurities shall be other halogenated solvents)...99.90% min
Non-volatile residue.....5 ppm max
Acid (measured as HCl).....1 ppm max
Moisture.....20 ppm max
Appearance.....transparent and no turbidity

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

6/ The only non-metallic materials listed are those common to compressed air 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.

7/ 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.

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Concluding Material

Custodian:
Navy - SH

Preparing activity:
Navy - SH
(Project 4310-0032)

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INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4,5,6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of this form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-STD-1622	2. DOCUMENT DATE *(YYMMDD)* 971028

3. DOCUMENT TITLE
CLEANING OF SHIPBOARD COMPRESSED AIR SYSTEMS

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*	b. ORGANIZATION	
c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)* (1) Commercial (2) AUTOVON *(if applicable)*	7. DATE SUBMITTED *(YYMMDD)*

8. PREPARING ACTIVITY

a. NAME Technical Point Of Contact (TPOC) Mr. Neil Antin, SEA 03L215	b. TELEPHONE *(Include Area Code)* (1) Commercial (703) 602-6832 x555	(2) AUTOVON 332-6832 x555
c. ADDRESS *(Include Zip Code)* Commander, Naval Sea Systems Command ATTN: SEA 03Q, 2531 Jefferson Davis Hwy Arlington, VA 22242-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	