MIL-STD-1359B
24 June 1987
SUPERSEDING
MIL-STD-1359A
31 October 1977

MILITARY STANDARD

CLEANING METHODS AND PROCEDURES FOR BREATHING OXYGEN EQUIPMENT

AMSC N/A

FSC 1660

DEPARTMENT OF DEFENSE
WASHINGTON, D.C. 20301

Cleaning Methods and Procedures for Breathing Oxygen Equipment

MIL-STD-1359

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Systems Engineering and Standardization Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

This document supersedes MIL-STD-1359A dated 31 October 1977. The purpose of MIL-STD-1359B is to standardize the cleaning methods and procedures for oxygen equipment used for breathing purposes by establishing guidelines.

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1. SCOPE

1.1 Purpose. The purpose of this document is to provide minimum requirements for cleaning aircraft breathing oxygen systems and components, inspection methods and packaging after cleaning, and guidelines for oxygen equipment cleaning areas.

1.1.1 Applicability. When this standard is specified in an acquisition document, the applicable requirements of this standard that apply to the acquisition document shall be identified.

1.1.2 Application guidance. Certain provisions of this standard and the manufacturer's cleaning inspection and packaging procedures may differ due to oxygen equipment complexity of construction, material, etc. These differences shall be identified in the acquisition document with a determination of what is acceptable; the provisions of this standard, the manufacturer's procedure, or a specified acceptable alternate, as applicable.

1.2 Classification. For the purpose of this standard, breathing oxygen equipment shall be classified as follows:

Category 1 - Parts and assemblies exposed to oxygen pressures over 450 psi (3.1 MPa) or liquid oxygen.

Category 2 - Parts and assemblies exposed to oxygen pressures from 10 to 450 psi (6.89 kPa to 3.1MPa), inclusive.

Category 3 - Parts and assemblies exposed to oxygen pressures up to 10 psi (6.9 kPa) (such as face masks, large bore regulator-to-connector hoses, oxygen mask hose connectors, etc.).

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

P-S-1792	-	Soap, Laundry, (Neutral and Built).
BB-A-1034	-	Compressed Air, Breathing.
BB-N-411	-	Nitrogen, Technical.
PPP-B-566	-	Boxes, Folding, Paperboard.
PPP-B-636	-	Boxes, Shipping, Fiberboard.
PPP-B-676	-	Boxes, Setup.

MILITARY

MIL-P-116	-	Preservation, Methods of.
MIL-C-5501	-	Caps and Plugs, Protective, Dust and Moisture Seal, General Specification for.
MIL-D-16791	-	Detergents, General Pupose (Liquid, Nonionic).
MIL-P-26514	-	Polyurethane Foam, Rigid or Flexible, For Packaging.
MIL-O-27210	-	Oxygen, Aviators Breathing, Liguid and Gas.
MIL-C-81302	-	Cleaning Compound, Solvent, Trichlorotrifluoroethane.
MIL-T-81533	-	Trichloroethane 1,1,1 (Methyl Chloroform) Inhibited, Vapor Degreasing.

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-129	-	Marking for Shipment and Storage
MIL-STD-2073-1	-	DOD Materiel Procedures for Development and Application of Packaging Requirements.

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein.

PUBLICATIONS

NAVAL AIR SYSTEMS COMMAND

NAVAIR 13-1-6.4 - Oxygen Equipment.

AIR FORCE

USAF T.O. 15X-1-1 - Oxygen Equipment.

ARMY

TM55-1660-245-12 - Oxygen Equipment.

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

2.2 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Clean. Cleaned to a specified cleanliness level by the removal of contaminants, which include: oil, grease, other organic materials, odors, and particles such as loose scale, corrosion products, grit and filings.

3.2 Clean area. An enclosed working area employing control, as required, over the particulate matter in air with temperature, humidity, and pressure control.

3.3 Cleaning agent. Any compound or substance which promotes the removal of contaminants through mechanical or chemical action.

3.4 Cleaning method. A procedure for bringing a suitable cleaning agent in contact with all surfaces to be cleaned under the proper conditions and for a sufficient length of time to remove all contaminants and loose particles.

3.5 Clean item. A part, component, or system which is wholly cleaned or has critical surfaces which have been cleaned and verified to a specific level of cleanliness.

3.6 Cleanliness level. An established maximum allowable distribution of contamination of a given size and quantity in a stipulated area or volume (see MIL-STD-1246 for specifying cleanliness level).

3.7 Clean work station. A work bench or similar working enclosure characterized by having its own filtered air or gas supply.

3.8 Component. An integral unit part of an assembly or system. Examples are tubes, ducts, tanks, valves, actuators, reservoirs, and accumulators.

3.9 Contaminant. Any unwanted foreign material which could be detrimental to the required operation, reliability, or performance of a part, component subsystem, or system.

3.10 Contamination control. The planning, organization and implementation of all activities needed to determine, achieve, and maintain a required cleanliness level.

3.11 Critical surface. That surface of a component which comes in contact with the oxygen in the system.

3.12 Decontamination. The process of removing unwanted matter; the reduction of contamination to an acceptable level.

3.13 Dew point. The temperature at which the gas becomes saturated with water vapor.

3.14 Equipment cleaned for oxygen service. Equipment that has been cleaned and tested to verify that organic contaminants and loose particles do not exceed specified levels.

3.15 Filtration.. The process of removing contaminants from a gas or liquid by passing them through porous media.

3.16 Gaseous oxygen. A colorless, odorless, tasteless gas slightly heavier than air. Oxygen, although nonflammable, strongly supports and rapidly accelerates the combustion of all flammable materials.

3.17 Gross cleaning. Preliminary or rough cleaning to remove scale, rust, metal chips, dirt, etc; this cleaning is done in a normal work area to visual inspection standards.

3.18 Intimate package. A clean material closure, wrap, or container that will have intimate contact with or is environmentally adjacent to the clean item or surface and is sealed to provide a barrier to external contaminants and environments.

3.19 Laminar airflow. Airflow in which the entire body of air within a confined area moves with uniform velocity along parallel flow lines.

3.20 Liquid oxygen. An extremely cold, -297 degrees F (-183 degrees C), pale blue, clear liquid, slightly more dense than water and strongly paramagnetic. It is nonflammable but strongly supports and rapidly accelerates the combustion of all flammable materials.

3.21 Liquid oxygen storage, transfer, and vaporizing system. An assembly of equipment that includes oxygen storage containers, pumps, vaporizers, pressure regulators, safety devices, and interconnected piping.

3.22 Non-volatile residue (NVR). Material remaining after evaporation of the solvent or volatile liquid.

3.23 Packaging. The application or use of appropriate closures, wrappings, cushioning, containers, and complete identification up to, but not including, the shipping container and associated packaging.

3.24 Particulate matter. The general term applied to matter of miniature size, with observable length, width, and thickness, as contrasted to non-particulate matter without definite dimension.

3.25 Precision cleaning. Final or fine cleaning accomplished in a controlled environment to remove minute quantities of contaminants to achieve specific levels of cleanliness.

3.26 Purge. To flow a gas through a system (or line, tank, etc.) for the purpose of ridding the system of a residual fluid or for providing a positive flow of gas from some opening in the system.

3.27 Purity. The percentage by volume (gases) or by weight (liquids) of the major constituent; the remainder is undesirable materials.

3.28 Solvent. That solution or constituent of a solution which exhibits the capability to dissolve other substances to effect their removal.

3.29 Standard cubic foot of gas. A cubic foot of gas at one atmosphere pressure (760 mm mercury) and 32 degrees F (0 degrees C).

3.30 Ultrasonic cleaning. A process where high frequency vibrations are used to produce a cleaning action.

3.31 Vaporizing system. An assembly of equipment used to convert LOX to gaseous oxygen.

4. GENERAL REQUIREMENTS

4.1 Basic considerations. Oxygen equipment and parts require a cleaning procedure that will achieve an adequate level of cleanliness commensurate with its use and operating pressure. To establish an adequate cleaning procedure, the following shall be considered:

a. Clean areas.

b. Selecting a suitable cleaning agent.

c. Selecting the proper cleaning method.

d. Cleanliness inspection.

e. Cleaning agent removal and drying.

f. Packaging (when required).

g. Solvent precautions.

4.1.1 Clean area requirements. To ensure that oxygen equipment and parts are properly cleaned and remain clean until reassembled or packaged, it is essential to maintain a controlled environment to prevent recontamination during cleaning, drying, assembly, testing and, when required, packaging. The room should be of adequate size, isolated from oil, grease, paper and lint particles and other airborne contaminants. The walls, ceiling and floors of the room shall be non-dusting. Work areas should be lighted to at least 75 foot-candles. Minimum facility requirements may include, but not be limited to, the following.

4.1.1.1 Environmental control. The clean area should be maintained at a temperature of 72 $\pm$ 10 degrees F (22.2 $\pm$ 5.55 degrees C) with a relative humidity of 20 to 60 percent.

4.1.1.2 Room air pressure. All rooms used for cleaning, drying, assembling, and testing and packaging of oxygen equipment, shall maintain a pressure above that of surrounding areas to assure that all leakage will be outward.

4.1.1.3 Airflow. When the critical nature of a particular operation may require it, the airflow within a work station should be filtered through a high efficiency particulate air filter and, whenever possible, a laminar flow across the work area should be provided.

4.1.1.4 Equipment. The work benches, tools, and processing equipment must be maintained free of grease, oil, or other combustible materials. Tools used on oxygen equipment should not be used for any other purpose. Paper in the area should be limited to the nonshedding type and only ballpoint pens should be used for writing. Pencils and erasers should not be permitted in the work area.

4.1.1.5 Personnel cleanliness. Personnel in the cleaning work area must maintain themselves and their clothing in a condition which prevents transferring contaminants to the oxygen equipment. When specified, all personnel shall wear lint free smocks or coveralls and head coverings in the area. Smoking or eating shall not be permitted in the area.

4.1.1.6 Work area cleanliness. The work area shall be maintained in a clean and dust free condition. Dust and dirt removal shall be accomplished by a vacuum system. Damp mopping shall be used after the vacuum cleaning for the removal of adhering dust or dirt. All parts in process shall be removed from work benches or covered with a clean lint free covering at the end of the last work shift each day. Work benches and test equipment shall be wiped clean with a lint free cloth at the start of each work day.

4.1.1.7 Optional requirements. If higher levels of environmental cleanliness are required, the methods and techniques described in FED-STD-209 may be used as guidelines to achieve the desired level of environmental control for a work area.

4.1.2 Selecting a suitable cleaning agent. The function of a cleaning agent is to assist in the removal of organic and inorganic material without attacking the parts being cleaned or creating unreasonable hazards to personnel. The ideal cleaning agent is nonexistant. A good cleaning agent:

a. Is capable of removing contaminants.

b. Does not leave residues or solids.

c. Is nonflammable.

d. Will not react chemically with the item being cleaned.

e. Will not alter the physical dimensions or properties of the materials being cleaned.

f. Has a relatively low toxicity.

4.1.2.1 Cleaning agents. The following cleaning agents are acceptable:

4.1.2.1.1 Solvents.

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

b. MIL-T-81533 Trichloroethane, 1,1,1, (Methyl chloroform), Inhibited, Vapor Degreasing.

4.1.2.1.2 Water soluble cleaner and water solution.

a. MIL-D-16791, Type I Detergents, General Purpose (Liquid, Nonionic). Use in a concentration of 1/2 ounce per gallon (3.7 kilograms per cubic meter) of water.

b. P-S-1792, Type II Soap, Laundry (Neutral and Built). Use in a concentration of one ounce per gallon (7.5 kilograms per cubic meter) of water.

4.1.3 Selecting the proper cleaning method. There is no single method of cleaning which will completely remove all types of contaminants. Also, it must be clearly understood that, unless a satisfactory cleaning method is selected and properly carried out, more harm than good may result. The cleaning method chosen should bring a reliable cleaning agent in contact with all surfaces to be cleaned for sufficient length of time and in such manner as to remove all contaminants. See 4.2 for cleaning methods. If possible, some means of agitating the cleaning agent or scrubbing of the surface with the cleaning agent should be used in the process. Hard to reach places should be given special attention. In order to select the proper cleaning method, the following factors should be considered:

a. Composition of the part to be cleaned.

b. Complexity of construction.

c. Properties of the cleaning agent.

d. Availability of cleaning materials and equipment.

4.1.3.1 Composition of the part to be cleaned. The function of a cleaning agent is to assist in the removal of contaminants without attacking the material of the part being cleaned or leaving irremovable residues. Cleaning agents should not be used haphazardly for cleaning. There should be a full understanding of what effect, if any, the cleaning agent may have on the part being cleaned. Cleaners suitable for use on one material may react with another material. When cleaning aluminum parts with a water soluble cleaning agent, use an approved aluminum surface cleaning compound that does not contain free alkali.

4.1.3.2 Complexity of construction. Parts or assemblies of complex construction which may trap portions of the cleaning fluid or residue that can not be removed by final rinse and drying should not be cleaned in any type of fluid cleaner. In general, components cannot be cleaned in the assembled state since solvents may damage non-metallic parts or residues may be trapped in inaccessible areas. Components of complex assemblies (such as threaded joints, press fits, etc.) should be cleaned individually prior to assembly so that as many areas as possible can be inspected for cleanliness. When assembly cannot be accomplished immediately after cleaning, the cleaned parts shall be packaged, cleaned and marked "Oxygen Cleaned" to protect against recontamination. Clean parts or components removed from a system should be packaged immediately or recleaned before reinstallation.

4.1.3.3 Properties of the cleaning agent. The cleaning agent should have properties which make it useable with the cleaning materials and equipment that are available. For example, a solvent that would be suitable for cleaning by immersing or scrubbing may not be suitable for vapor degreasing.

4.1.3.4 Availability of cleaning materials and equipment. The availability of cleaning materials and equipment should be a determining factor in the selection of a cleaning method only when other primary factors of composition, complexity of construction, and contamination permit. Allowing the availability of materials and equipment to overrule other primary factors in the selection of a cleaning method may result in the selection of a method which may damage the items being cleaned.

4.1.4 Cleanliness inspection. The results of cleaning are not normally visible to the unaided eye. Special detection and measurement techniques are necessary and should be used to monitor and verify the achievement of the desired level of cleanliness. For cleanliness inspection methods and recommended cleanliness criteria, see 5.2.

4.1.5 Cleaning agent removal and drying. Water soluble cleaning agents shall be removed by flushing with large quantities of distilled or de-ionized water. After flushing, dry thoroughly by purging with dry, oil-free air (BB-A-1034) or dry, oil-free nitrogen (BB-N-411, Type I, Class I, Grade B) or heat in a temperature controlled oven at a temperature not to exceed 250 degrees F (122 degrees C). Solvent cleaner shall be evaporated from all surfaces by purging with warm, dry, filtered, oil-free air or nitrogen (see above) or oven dried (see above). Oven drying can be used in conjunction with an evacuation procedure on some equipment, such as cylinders. This method requires placing the unit in an oven, connecting it to a vacuum pump and then heating the unit during the evacuation process and maintaining the vacuum and temperature until the cleaning agent is removed. In no case shall the temperature of the purging gas or oven temperature be so high as to have a deleterious effect on any material present.

4.1.5.1 Drying verification. Carefully examine for any traces of the cleaning agent or moisture. After solvent cleaning and drying, check for solvent residues with a Halogen Detector (see 5.2.1.5). After cleaning with a water soluble cleaning agent and drying, visually inspect the equipment for complete moisture removal. An indication of complete internal moisture removal is when all outlets of the equipment being purged with hot gas become heated.

4.1.6 Packaging. The packaging material shall have been cleaned to the same level of cleanliness as the items being packaged. For packaging instructions refer to paragraph 5.3.

4.1.7 Solvent precautions. Due to the potential hazards of high concentration of solvent vapors, especially in indoor work spaces, precautionary measures should be taken to insure safety. For specific safety precautions, refer to 4.3.

4.2 Cleaning methods.

4.2.1 Vapor degreasing. The vapor degreasing process consists of using a vapor degreaser which heats a solvent in a tank, creating a vapor area above the boiling solvent in such a manner that the vapor will condense on and flush all surfaces within the vapor area. Parts to be cleaned are placed in a screen basket which is lowered into the vapor. Vapor phase tanks are equipped with cooling coils below the tank top to recondense vapors which would otherwise escape and an exhaust system to maintain atmospheric concentrations of solvent vapors below toxic levels. Oxygen storage and transfer tanks may be cleaned by vaporizing the solvent in a separate tank and blowing the vapors into the tank being cleaned. The solvent condensate is drained from a bottom outlet. Following the vapor degreasing process, tube assemblies and other items that have irregular interior shapes should be power flushed with solvent that is provided directly from the vapor degreaser's still. Following the vapor degreasing and power flush treatment, if required, all solvent shall be removed by purging with filtered, dry, oil-free air or nitrogen; or by evacuation. The vapor degreasing process removes oils, greases and other soluble organic contaminants from components.

4.2.2 Solvent cleaning. The solvent cleaning process removes soluble organic contaminants and particulate matter. For the solvent cleaning process, use an oxygen-safe cleaning solvent at ambient temperatures to thoroughly wash all surfaces requiring degreasing. During the washing process, scrubbing with a soft brush or agitation of the solvent may be required to facilitate the removal of contaminants. After cleaning the component, rinse or flush with clean solvent. Following the cleaning process, all residual solvent shall be removed by purging with dry filtered, preferably hot, oil-free air or nitrogen, or by evacuation.

4.2.3 Detergent/water cleaning. Detergent/water cleaning is a process in which the components to be cleaned are washed with a water soluble cleaner and water solution until free from oil, grease, and other contaminants. During the washing process, scrubbing with a soft brush or agitation of the solution may be required to facilitate the removal of contaminants. Following the cleaning process, all surfaces shall be rinsed thoroughly with clean, hot, distilled or de-ionized water until all residues of the cleaning agent are removed, and dried by blowing with filtered, dry, oil-free air or nitrogen or by oven drying until all liquid is removed.

4.2.4 Ultrasonic cleaning. Ultrasonic cleaning is a process where high frequency vibrations are used to produce a cleaning action. Items to be cleaned are placed in a screen basket and completely covered with liquid in an ultrasonic cleaning tank. The liquid can be a solvent or water and a soluble detergent solution depending on the type of ultrasonic equipment and the items to be cleaned. Ultrasonic energy is then transmitted through the liquid in the tank to the items in the screen basket resulting in a scrubbing action. It should be noted that the ultrasonic equipment, if improperly used, will not clean effectively. Following the cleaning operation, all solvent or water and detergent solution shall be removed by purging with hot, dry filtered, oil-free air or nitrogen when a solvent is used, or a distilled or de-ionized water rinse followed by purging when water and detergent solution is used.

4.3 Safety precautions.

4.3.1 Chlorinated solvents. Chlorinated solvents, such as trichloroethylene, trichloroethane, dichloromethane (methylene chloride), perchloroethylene and others, including those sold under trade names, should not be used. These solvents evaporate very rapidly even at room temperature and are dangerous narcotic, anesthetic, and poisonous agents when used without adequate ventilation. Poisoning may occur from inhaling their vapors, from long or repeated contact with the skin, or from swallowing them. These liquids also remove the natural oil from the skin and thus may cause dermatitis.

4.3.2 Trichlorotrifluoroethane (MIL-C-81302). Trichlorotrifluoroethane shall be used with adequate ventilation and prolonged breathing of vapors shall be avoided. The vapor is heavier than air and can build up dangerous concentrations when used in small, poorly ventilated areas or confined spaces by reducing oxygen available for breathing. Usage under these conditions will require forced air ventilation. The solvent shall not be used near open flames or heat as the products of thermal decomposition are toxic and very irritating.

4.3.3 Cleaning operation precautions. Maximum safe atmosphere concentrations have been established for the approved chlorinated solvent. Most materials may be safely used with careful planning and careful supervision of processes, equipment, work methods and personnel. In addition to engineering control measures, all necessary personnel protective equipment should be available and used by the personnel during cleaning operations. Before engaging in any cleaning method, all involved personnel shall be aware of all the safety hazards concerning that cleaning method. The following are minimum precautions to be observed during any cleaning operation:

a. The work area for cleaning operation using solvents shall be under the surveillance of qualified personnel.

b. Eyes are protected with cover-all goggles, full face shields or safety spectacles with shields as a minimum.

c. Skin contact with solvents shall be avoided. Hands and other parts of the body shall be protected by gloves, boots, and aprons.

d. An industrial shower shall be available in the event of accidental splashing or contact with solvent.

e. Ventilation shall be provided to assure the prevention of unsafe concentrations of solvent vapor from accumulating in the work area atmosphere. Outdoor cleaning sites shall be selected so that the vapors will not flow into a building occupied by other people. Most indoor cleaning requires mechanical ventilation equipment to provide the necessary air changes. Where a small amount of vapor remains in the area, despite ventilation, canister type or supplied-air type respirators should be worn for added protection.

f. Heating solvents above approved high temperatures is to be avoided. Some chlorinated solvents will decompose and form a lethal gas upon being overheated.

g. Chlorinated solvents shall not be sprayed except in a booth equipped with forced air ventilation equipment or where all persons in the vicinity are wearing approved air-supply respirators.

h. Under no circumstances shall the concentration of solvent vapors in the ambient air exceed acceptable limits. Gases or vapors normally considered non-toxic, when added to air, can reduce the oxygen content to a hazardous level.

i. Solvents shall be stored in cool, well ventilated places, in tightly closed containers. All containers shall be properly identified and labeled. Adequate warning signs shall be prominently posted.

j. Welding, burning, open flames, and smoking, etc., shall not be permitted in the vicinity of solvents. Extremely toxic vapors may be produced.

5. DETAILED REQUIREMENTS

5.1 Equipment cleaning instructions.

5.1.1 General. Cleaning methods and procedures for oxygen equipment and parts will vary with the type of equipment and its intended use. When practicable, existing cleaning methods and procedures for that equipment should be used; such as, specified in Technical Manual NAVAIR 13-1-6.4 or T.O. 15X-1-1, or TM 55-1660-245-12 or the manufacturer's instructions. All cleaning operations shall be conducted under the direct supervision of individuals who are familiar with the components being cleaned, the properties of the cleaning materials being used, the cleaning equipment employed, and the necessary safety precautions associated therewith. All personnel shall use protective equipment to adequately protect eyes, face, hands, and other parts of the body. Mechanical ventilation equipment shall provide necessary air changes for indoor cleaning. Outdoor cleaning sites shall be selected so that solvent vapors will not flow into occupied buildings.

5.1.2 Cleanliness level. All oxygen equipment and parts shall be cleaned to a level of cleanliness necessary to assure safety and reliability. MIL-STD-1246 can be used for determining item cleanliness level desired.

5.1.3 General cleaning procedures.

5.1.3.1 Metallic components. A cleaning procedure for metallic components should consist of the following steps:

a. Precleaning, if required, by wiping, brushing, scraping, descaling, rinsing, etc., to remove visible external contaminants without causing physical damage to the item being cleaned.

CAUTION

Solvents can cause deterioration of most non-metallic materials. Remove all non-metallic O-rings, gaskets and other non-metallic materials before cleaning with solvent. When such materials cannot be removed, clean with a water soluble cleaning agent.

b. Clean with a solvent (see 4.1.2.1.1) by flushing, ultrasonics, scrubbing or by vapor degreasing (see 4.2.1).

c. Flush with a clean solvent.

d. Dry thoroughly to remove all traces of the solvent (see 4.1.5).

e. Verify that all traces of solvent are removed (see 4.1.5.1).

f. Package components, if required, immediately after cleaning is completed in approved closures (see section 7) to prevent recontamination.

5.1.3.2 Non-metallic components. A cleaning procedure for non-metallic components should consist of the following:

a. Clean all surfaces thoroughly using a solution of water and a nonionic detergent or a low titer soap. A clean lint-free cloth or a small soft brush may be used with the cleaning solution.

b. Flush with a clean solution of water and a nonionic detergent or a low titer soap (see 4.1.2.1.2).

c. Remove all free liquid with a stream of dry, oil-free nitrogen gas or air.

d. Rinse thoroughly with demineralized or distilled water.

e. Dry thoroughly with pre-filtered dry, oil-free nitrogen gas or air, preferably warm. CAUTION: Oven drying non-metallic components is not recommended.

f. Package components, if required, immediately after cleaning is completed to prevent recontamination.

5.1.3.3 Oxygen system. Cleaning an oxygen system by flushing solvent through the system should only be performed when purging with a hot gas will not remove the contaminants because of the possibility of solvent being trapped in small crevices within the system.

5.1.3.3.1 Oxygen system (purging method). Purge the oxygen system with either oxygen conforming to MIL-O-27210, Type I, dry nitrogen conforming to BB-N-411, Type I, Class I, Grade B or dry air, conforming to BB-A-1034, Grade A or C. The purging gas temperature at the inlet of the system, if heated, shall not exceed 250 degrees F (121.1 degrees C). Purge in accordance with instructions in appropriate technical manual and then test outlet gas for odors. If odors are still present, continue purging operation. If odors persist after purging operations, the system may require cleaning with a solvent. After purging, close all openings with approved closures.

CAUTION

Sniff test nitrogen gas only for odors. Breathing anything other than oxygen or air can cause unconsciousness.

5.1.3.3.2 Oxygen system (flushing method). Fill the oxygen system using solvent, MIL-C-81302, Type I, let the system soak and then flow the solvent through the system. At the end of the cleaning period, take a sample of the solvent from the outlet and check for contaminants. Repeat the cleaning procedure if required. After cleaning, dry by purging (see 5.1.3.3.1) until no trace of solvent can be detected. Halogen Detector (see 5.2.1.5) shall be used to indicate removal of all solvent. After purging, close all openings with approved closures.

5.2 Cleanliness verification.

5.2.1 Cleanliness test methods. The following test methods can be used to determine item cleanliness. The method or methods of cleanliness inspection used should be determined by the degree of cleanliness verification necessary to assure safety and reliability. For each category of oxygen equipment, the following test methods are the minimum requirements for cleanliness verification:

a. Category 1 - As a minimum cleanliness verification test method, use a non-volatile residue (NVR) test.

b. Category 2 - NVR test unless parts or assemblies are affected by solvent. Visual inspection for parts or assemblies affected by solvent.

c. Category 3 - Visual inspection.

5.2.1.1 Visual inspection.

5.2.1.1.1 White light test. Visual "daylight" inspection of all accessible surfaces which will be in contact with oxygen in service shall disclose no evidence of rust scale, dirt, paints, preservative and organic materials such as grease, oil, ink, and dye. The presence of such deposits will necessitate recleaning of the part. Large items shall be tested at critical points along seams, joints, threads, outlets, etc., by wiping with clean filter paper. Discoloration due to welding and passivation will be permitted providing no scale or rust is associated with the discoloration.

CAUTION

Do not look directly at the ultraviolet light source as eye damage can result. Overexposure of the skin to ultraviolet light will result in "sun-burn".

5.2.1.1.2 Black light (ultraviolet light) test. Ultraviolet light (wave length 3600-3900 Angstrom units) will cause hydrocarbons to fluoresce. However, some contaminants such as mineral oil, or animal and vegetable fats leave a residue which fluoresces weakly or not at all. Therefore, whenever possible, the weight of the solvent residue should be checked as specified in the solvent rinse test, in addition to the ultraviolet light as a final check. Ultraviolet light inspection may be conducted in any dark location where an ultraviolet light source is available. Small parts may be inspected in a closed box with a peephole; this shields the part from visible light.

5.2.1.1.3 Wipe test. The wipe test can be made on each clean surface and normally accessible interior surface of each component using a new clean filter paper (Whatman No. 42, Sands No. 602 or equal). This test shall consist of at least two movements of the filter paper across the surface. There shall be no discoloration of the filter paper when viewed by normal light and no fluorescence shall be observed when the filter paper wipe sample is subjected to the ultraviolet (black light) test. A representative sample of the filter paper used shall be checked for fluorescence prior to conducting this test.

5.2.1.2 Non-volatile residue (NVR) test. Rinse the equipment surfaces with solvent, MIL-C-81302, Type I; volume of fluid used shall be 200 ml per square foot of surface area and in no case less than 150 ml. One-half of the solvent used for the rinse shall be used for determining weight of residue and the

other half can be used for determining particle content. The weight of residue is determined by separately evaporating to dryness at a maximum temperature of 113 degrees F (45 degrees C) one-half of the solvent used for the rinse and an equal amount of clean solvent. The residue from the solvent used for the rinse shall not exceed that of the clean solvent by more than ~ 0.003 gram per square foot of part surface area., Not less than 0.75 square foot of surface area will be required for these tests. Washings from items of essentially equivalent configuration and size may be combined to provide the solvent volume to surface area ratio specified. After the inspection, all surfaces shall be dried immediately unless there is a need for recleaning.

5.2.1.2.1 Particulate test. For increased assurance of equipment cleanliness, examine the remaining half of the solvent used for the rinse for particles. To determine particle content, filter the solvent through a 1.2 micron millipore or equivalent membrane filter. Then inspect the filter surface for the presence of particles. The particle size and quantity shall not exceed 5 particles between 100 and 175 micrometers and no particles larger than 175 micrometers per 100 ml of solvent.

5.2.1.3 Water break test. Many contaminants will not fluoresce. Their presence may be determined as follows: Place distilled water on the surface of the part being inspected. The water shall remain as a film and not form drops for at least ten (10) seconds after application to indicate an oil- or grease-free surface. Evidence of droplets or a water break will require recleaning of the part per the applicable procedure specified herein. Water shall be dried from the test surface by blotting with a lint-free cloth or by blowing with warm gaseous nitrogen conforming to BB-N-411.

5.2.1.4 Acidity or alkalinity (pH) test. After the final rinse, the cleaned surfaces shall be checked for proper cleaning as follows:

a. Wet cleaned surface with a few drops of distilled water and test with pH indicating paper (Hydrion paper pH 2 to 10 range or equivalent).

b. If pH indicating paper does not indicate a value between 6.0 and 8.0, reclean per applicable procedure.

5.2.1.5 Halogen test. To detect any solvent residue, after solvent cleaning, use a Halogen or Halide Detector having a minimum sensitivity of not less than 3 x 10^{-4} standard cc/second.

5.2.1.6 Infrared spectrophotometry test. The infrared spectrophotometry test may be used when it is desirable to determine trace amounts of hydrocarbon contaminants present in the cleaning solvent. Infrared analysis of the cleaning solvent for hydrocarbon content can be performed with an infrared spectrophotometer or an infrared analyzer. Operating instructions shall be as specified by the manufacturer. This procedure requires a sample of the unused cleaning solvent be analyzed first to establish a calibration curve that will be used for determining the amount of hydrocarbon content. The amount of hydrocarbon present in the solvent at the completion of the cleaning procedure shall not exceed the solvent sample used for the calibration curve by more than 10 ppm by weight.

5.3 Packaging.

5.3.1 General. Immediately after the final drying operations, all openings (where configuration permits) shall be sealed using clean aluminum or plastic caps or plugs in accordance with MIL-C-5501. Paper, pressure sensitive materials, hot dip coatings, rubber, or soft plastic closures that may introduce moisture, adhesives, or particles shall not be used. High density clean plastic closures such as polyethylene are acceptable. Where a cap or plug cannot be used, the opening shall be sealed in a manner that insures airtightness. No preservative shall be applied to the part or assembly. The part or assembly shall then be packaged, if required, in accordance with the part or assembly acquisition document, when applicable, or in accordance with MIL-P-116, Method IC-1 without the use of contact preservatives, or using approved plastic wrap, or bags, such as polyethylene. Polyethylene is one type of approved material for packaging oxygen parts and assemblies. Items to be reassembled after the final cleaning and drying need not be packaged if they remain in the "clean area" and are assembled as soon as possible.

5.3.2 Small unit packaging. Small components or units shall be individually wrapped with or sealed in bags made of approved plastic material of not less than 0.004 inch thickness before removal from clean area. All openings shall be individually sealed using approved closures (see 5.3.1) prior to packaging. The packaging material shall be of such cleanliness that items will not be recontaminated. The openings in the package shall be sealed; heat sealing is preferred, if size and shape of unit permit, but an approved tape may be used. Zip lock bags shall not be used. Approved cushioning material shall be provided around the packaged items to prevent damage to the plastic packaging material from protruding parts and sharp corners. Cushioning material should not be used within the inner bag. Cushioning material shall conform to MIL-STD-2073-1. Polyurethane cushioning material shall conform to MIL-P-26514, Type I, Class 1 or 2.

5.3.2.1 Intermediate packaging. Intermediate packaging shall be in accordance with PPP-B-566, PPP-B-636 or PPP-B-676. If more than one unit is packaged in an intermediate container, each individual component bag shall be sufficiently protected by spacers or dunnage to prevent damage or puncture of the bag.

5.3.3 Large unit packaging. If size or weight makes it impractical to completely wrap an item, all openings to critically clean surfaces shall be sealed by approved closures (see 5.3.1).

5.3.4 Marking. Nomenclature tags, marked in accordance with MIL-STD-129, shall be inserted in each bag or securely attached to the package and shipping container, showing title, part number or other data as required, so that the contents can be readily identified without breaking the seals. In addition, labels shall be attached to the unit package and shipping container and shall include the following, or similar, information:

CLEANED FOR OXYGEN SERVICE.

DO NOT ALLOW PETROLEUM CONTAMINANTS
OF ANY KIND TO BE USED/STORED ON OR ABOUT
THESE CONTAINERS.

6. NOTES

6.1 Intended use. To provide minimum requirements for cleaning, cleanliness verification, and packaging of aircraft breathing oxygen systems and components and for maintaining a clean work area to prevent recontamination. It is not intended to supersede manufacturer's or technical manual instructions, when available.

6.2 Subject term (keyword) listing.

Acidity test
Airflow test
Alkalinity test
Black light test
Clean
Cleaning
Cleaning, agent
Cleaning method
Cleaning, ultrasonic
Contamination
Decontamination
Degreasing, vapor
Detector, halogen
Detergent, water soluble
Flushing
Halogen test
Infrared spectrophotometry test
Inspection, cleanliness
Non-volatile residue test
Oxygen
Oxygen systems
Packaging
Particulate test
Purging
Solvents
Water break test
Wipe test
White light test

6.3 Changes from previous issue. Asterisks or vertical lines are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians
Navy - AS
Air Force - 99
Army - AV

Review activities:
Air Force 11, 68, 82, 84

Preparing Activity:
Navy - AS

(Project 1660-0539)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-1359R	CLEANING METHODS AND PROCEDURES FOR BREATHING OXYGEN EQUIPMENT

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

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

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