MILITARY STANDARD

CLEANING OF SHIPBOARD COMPRESSED

AIR SYSTEMS

TO ALL HOLDERS OF MIL-STD-1622(SHIPS)

1. THE FOLLOWING PAGES OF MIL-STD-1622(SHIPS) HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
1	18 March 1975	1	20 September 1973
2	18 March 1975	2	20 September 1973
3	18 March 1975	3	20 September 1973
4	20 September 1973	4	Reprinted without change
5	18 March 1975	5	20 September 1973
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2. RETAIN THIS NOTICE PAGE AND INSERT BEFORE THE TABLE OF CONTENTS.

3. Holders of MIL-STD-1622(SHIPS) will verify that page changes indicated above have been entered. The notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or cancelled.

Preparing activity:
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1. SCOPE

1.1 This standard provides the requirements for cleaning of shipboard compressed air systems, including the air compressors installed on nuclear and non-nuclear surface ships and submarines which normally operate at pressures in excess of 250 pounds per square inch gage (psig). This standard does not apply to reactor plant air systems.

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

GOVERNMENTAL

SPECIFICATIONS
O-T-620 - Trichloroethane (Methyl Chloroform).
P-C-437 - Cleaning Compound, High Pressure (Steam) Cleaner.
BB-N-411 - Nitrogen, Technical.
MIL-I-18997/2 - Indicators, Pressure, Bourdon Tube Circular Dial, Oxygen Service, Bleeder Tip (3-1/2 and 4-1/2 Inch Sizes).
MIL-P-19453 - Primer, Coating, Shipbottom Paint, Anticorrosive.
MIL-H-25579 - Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure.
MIL-C-81302 - Cleaning Compound, Trichlorotrifluoroethane.
MIL-STD-419 - Cleaning and Protecting Piping for Hydraulic Power Transmission Equipment.

PUBLICATIONS
NAVSHIPS
0901-581-0002 - Distilling Plants, Low Pressure Submerged Steam Plants.
0901-600-0002 - Electric Plant - General.

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

NONGOVERNMENTAL

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
D471-72 - Change in Properties Of Elastomeric Vulcanizates Resulting From Immersion In Liquids.
D1414-72 - Testing Rubber O-Rings.

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

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

3. DEFINITIONS

3.1 Clean. Clean is being free of all loose scale, rust, grit, filings and other foreign substances; and free of oil, grease, and other organic materials.

3.2 Components. Components as used in this standard shall be valves, gages, regulators, and flasks for the system.

3.3 Cleaning solvent or compound. Cleaning solvent or compound as used in this standard shall refer to trichlorotrifluoroethane conforming to MIL-C-81302, type I or type II, unless otherwise specified herein.

4. REQUIREMENTS

4.1 General requirements.

4.1.1 This standard provides procedures for examining and cleaning, compressed air systems, operating above 250 psig, in nuclear and non-nuclear surface ships and submarines.

4.1.2 The reactor plant air system and its components shall be cleaned only in accordance with reactor plant instructions as promulgated by the Naval Sea Systems Command.

4.1.3 The cleaning medium shall be trichlorotrifluoroethane, conforming to type I or type II of MIL-C-81302. The cleaning compound may be reused provided it is distilled to meet the requirements of MIL-C-81302.

4.1.4 Samples of the cleaning compound shall be examined to determine if the system is clean. The contamination content of the samples as determined by the test procedure of MIL-C-81302 shall be 50 parts per million (ppm) or less to consider the system clean.

4.1.5 All new silver brazed joints shall be flushed according to procedures specified in 4.5.

4.1.6 Temporary piping and components as required for system flushing shall be cleaned as specified for system piping prior to each use.

4.1.7 All interconnected piping and components in the compressed air system shall be cleaned and maintained clean according to the procedures described herein.

4.1.8 To ensure that nitrogen is actually oil-free, the nitrogen shall either be type I. class 1, grade A or B of BB-N-411, or equal.

4.1.9 Waste solvents. Waste solvents shall not be discarded overboard. They shall be collected in suitable containers and stored for reclamation and shore disposal. Other materials used for cleaning solutions shall be checked to see that pH is in the range 6-9 before discharge.

4.2 Safety and precautions.

4.2.1 High pressure air systems constitute a hazard in themselves. Air under high pressure within a container which fails, will result in an explosion with associated missiles.

4.2.2 High pressure air shall be given particular attention to provide a safe system. As air is compressed, heat energy is added due to several factors; i.e. compression itself and frictional forces associated with the compressor and container boundaries. If a combustible material such as a hydrocarbon lubricant is present, a condition may be approached not dissimilar to that found in diesel engines. In some cases, this condition is reached causing auto-ignition. In severe cases, violent explosions have occurred with loss of life, limb, and property. The only sure way to eliminate the possiblity of ignition; i.e., fire and explosions, is to eliminate the contaminants which may serve as fuels in high pressure air systems.

4.2.3 Trichlorotrifluoroethane is a nonflammable solvent. The American Conference of Governmental Industrial Hygienists (ACGIH) states that the threshold limit value (TLV) (a concentration of solvent vapor in air to which nearly all workers may be repeatedly exposed, 8 hours per day, 5 days per week without adverse effect) for trichlorotrifluoroethane is 1000 ppm.

4.2.3.1 Although this solvent is reasonably safe, it should still be used with adequate ventilation, and prolonged breathing of its vapor should be avoided. The solvent should not be used near open flames, welding or temperatures exceeding 500°F, because the products of decomposition are toxic and very irritating to personnel and corrosive to metals. WARNING: High temperature will cause trichlorotrifluoroethane to decompose to compounds which are extremely corrosive to metals. Therefore, it is imperative that the solvent be completely removed from ship's systems after use.

4.2.3.2 If normal ventilation is not adequate, portable blowers should be used. The atmosphere shall be monitored by an industrial hygienist or safety officer to insure safe limits (1000 ppm) are not exceeded. For submarines, this cleaning procedure shall be used only when the submarine is surfaced and open to the atmosphere.

4.2.3.3 Since trichlorotrifluoroethane dissolves natural oils and is absorbed through the skin, contact with skin shall be avoided; protective clothing, goggles, and neoprene

gloves shall be worn to prevent contact with the skin and eyes. If contact occurs, the area shall be flushed with large quantities of water.

4.2.4 Trichlorotrifluoroethane shall not be used in rubber or plastic components, or coated components with which it is not compatible. Incompatibility may result in change in polymer structure and molecular weight, dissolution of plasticizers and an increase in brittleness, swelling, etc. Where specific information with respect to compatibility is lacking, tests shall be conducted. Compatibility tests shall consist in immersion of test specimens in the cleaning compound at 80° +9°F for 16 ± 1 hours. The conditions of immersion and testing shall be in accordance with ASTM D1414-72 and ASTM D471-72. The test specimens shall be completely surrounded by the fluid during immersion. The fluid volume shall be not less than 12 times the total volume of the specimen. The tensile strength, elongation and hardness shall be determined by the "Properties After Evaporation of Test Liquid" method of ASTM D471-72. The test requirements to establish compatibility are:

Volume change, percent - minus 0 percent, plus 10 percent
Retention of tensile strength, percent, minimum - 85 percent
Retention of ultimate elongation, percent, minimum - 85 percent
Change in durometer hardness, points maximum - plus or minus 5 percent

4.2.4.1 Trichlorotrifluoroethane is primarily to be used in all metal systems, but may be used in approved flexible hose or tubing for transferring the compound and testing. Only flexible metallic hose or hose of polytetrachlorofluoroethylene as specified in MIL-H-25579 or equivalent shall be used.

4.2.5 Where other cleaning solvents, such as methyl chloroform are used for cleaning small components, see precautions in NAVSHIPS 0901-600-0002. Other cleaning solvents, such as methyl chloroform shall be disposed of after use, to shore in suitable containers. Amounts less than one quart may be discharged overboard.

4.2.6 If any of the cleaning solvents or cleaning solutions are taken internally, a physician should be consulted immediately.

4.3 Prerequisites.

4.3.1 Prior to use, all equipment (pumps, hoses, piping, valves, etc.) used in the flushing procedure shall be cleaned oil-free, hydrostatically tested to 135 percent of system design pressure but not less than 50 psig and certified satisfactory for the cleaning solvent by a chemical laboratory.

4.3.2 A sample of cleaning solvent shall be taken from each drum, tank or other storage facility prior to each use and analyzed by the laboratory for total contamination content, to assure conformance with MIL-C-81302.

4.3.3 The systems shall be divided and segregated into sections as necessary for examination and cleaning. Components shall be disassembled where appropriate. Portions of associated systems or components which are not to be cleaned shall be removed or physically separated from the portions to be cleaned by blank flanges, removed pipe sections, or removed components. Where this cannot be accomplished, the uncleaned systems or components shall be sampled for freedom from the cleaning medium subsequent to the cleaning operation in accordance with 5.2.6.1.

4.4 Equipment materials.

4.4.1 Flushing and testing equipment. The flushing and testing equipment shall consist of the following:

(a) Vacuum pumps - Lieman Model 295-B-2 manufactured by ITT Pneumatic or Nash Mod. TS8, or equivalent. Pump shall be capable of pulling a minimum of 25 inches hg vacuum.

NOTE: Vacuum pump design shall preclude pump lubricant from being drawn into the system being cleaned in the event of a pump failure or stoppage, and must be compatible with the cleaning compound vapor.

(b) Hoses - flexible metallic hose or hose conforming to MIL-H-25579 or equivalent.
(c) Transfer pump - Kobe Inc., size 2, type E, triplex pump or equivalent, 6.5 gpm.

4.4.2 Materials. Materials shall be as follows:

(a) Sampling containers (glass - 1 gallon).
(b) G.E. Model H-10 leak detector or equivalent.
(c) Ultrasonic cleaning compound (in accordance with P-C-437).
(d) Supply of dry certified oil-free nitrogen.
(e) Supply of cleaning compound (in accordance with MIL-C-81302).

4.5 Flushing silver brazed piping.

4.5.1 A flush procedure shall be applied to remove residual flux remaining in the system after fabrication. Any one of the procedures specified in 4.5.1.1 through 4.5.1.3 may be used (the hot flush and hot circulation methods are preferred).

4.5.1.1 Hot flush shall be applied for 1 hour using fresh water making sure that the temperature at any part of the system does not go below 110°F.

4.5.1.2 As an alternate to the hot flush procedure, a hot recirculating procedure may be conducted for a period of 1 hour. Water temperature shall be maintained to ensure that the temperature does not fall below 110°F at any part of the system. Following the recirculation, the system shall be flushed with fresh water for 15 minutes.

4.5.1.3 The system shall be cold soaked for 12 hours using fresh water at a minimum of 60°F. At the completion of the 12 hour soak, the system shall be flush with water at a minimum of 60°F for 4 hours. The flush water may be discharged overboard.

4.5.2 For all flushing procedures outlined in 4.5.1.1 through 4.5.1.3, the minimum flow rate in gallons per minute (gpm) shall be 1.5 times the internal pipe diameter (ID) in inches.

4.5.2.1 For all flushing procedures outlined in 4.5.1.1 through 4.5.1.3, the system shall be full of water so that the joints are completely submerged at all times.

4.6 Cleaning small or delicate equipment.

4.6.1 Cleaning or degreasing small equipment shall be accomplished by soaking or scrubbing, as necessary, in cleaning compound conforming to MIL-C-81302 or trichloroethane (methyl chloroform) conforming to O-T-620. (CAUTION: See NAVSHIPS 0901-600-0002 for precautions required when using methyl chloroform). The equipment shall be drained and dried throughly using dry oil-free nitrogen. If applicable, the component shall be tested according to the applicable test document.

4.6.1.1 After successful completion of cleaning and testing of the component, it shall be dried and placed in a clean polyethylene bag. The component shall be properly identified and the bag shall be sealed. The component shall be stored until time for installation onboard ship. Larger components shall be protected by capping openings with secure oil resistant materials to prevent the intrusion of dust, oil, moisture or other foreign materials.

4.6.1.2 Except for pressure gages (see 4.7), small components may be cleaned in an ultrasonic cleaner, where experience shows this method to be effective. A detergent cleaning solution or other cleaning solvent shall be used as recommended in the ultrasonic cleaner manual. The used detergent solution may be disposed of by discharging overboard. Used cleaning solvents shall be placed in containers for disposal ashore.

4.7 Cleaning pressure gages.

4.7.1 Pressure gages shall be cleaned with cleaning solvent conforming to MIL-C-81302 by filling, soaking and draining of the bourdon tube at least 10 times. To fill, the bourdon tube shall be evacuated to 2 inches of mercury absolute, and the vacuum shall be broken with the cleaning solvent.

4.7.1.1 Upon completion, the bourdon tube shall be dried by evacuating to 2 $\pm$ 1 inches of mercury absolute. The vacuum shall be broken using, dry oil-free nitrogen. This shall be repeated at least twice.

4.7.1.2 After cleaning, draining and drying, all gages shall be sealed in a clean polyethylene bag and tagged with proper identification. Clean conditions shall be maintained during installation of gages.

4.7.2 If a detailed cleaning procedure is required, MIL-I-18997/2 (appendix) should be used.

5. CLEANING

5.1 Preparation.

5.1.1 All equipment used for cleaning, such as piping, circulation pumps, vacuum pumps, etc. shall be compatible with the cleaning compound and shall be cleaned oil-free by the same procedure, prior to use. It shall be ascertained that non-metallic coatings and components in the system which may come in contact with the cleaning compound, such as air flask coatings, gaskets, O-rings, etc., are compatible with the cleaning compounds. In case of doubt, laboratory tests shall be performed to assure that the materials do not absorb or dissolve in the cleaning solvent or result in swelling, shrinkage or embrittlement of gaskets or O-rings. In case of incompatibility, the components shall be removed and separately cleaned or the entire system cleaned using an alkaline solution as cleaning agent such as trisodiumphosphate solution, see for example MIL-STD-419. NOTE: Navy Formula 14N of MIL-P-19453 coating is incompatible with the cleaning solvent. It should be ascertained that air flask interiors are not coated with formula 14N coating before use of compound MIL-C-81302 for cleaning air flasks. The system shall be divided and segregated into sections as necessary, and components shall be disassembled as appropriate for the method of cleaning to be used.

5.1.2 All components which can be deteriorated by the cleaning compound, impede flow of the cleaning compound, or form dead ended sections shall be removed or disconnected at the nearest take-down joint. Such components may include compressors, desiccant type dryers, moisture separators, instruments, gages and relief valves. All components and component intervals removed shall be tagged to ensure cleaning and replacement.

5.1.2.1 Oil removal filter elements should be removed.

5.1.2.2 Internals shall be removed from check valves to provide unrestricted flow.

5.1.2.3 Solenoid valves shall be removed and jumpers shall be installed.

5.1.2.4 Before installation, air flasks and moisture separators shall be shop tested with "black light" (3200 to 4000 Angstrom Units). If there is any evidence of fluorescence on the interior or machined surfaces, the flasks shall be cleaned with cleaning solvent MIL-C-81302 (provided flasks are not coated with formula 14N - see note in 5.1.1). After draining, assure complete removal of cleaning compound by purging with oil-free dry nitrogen and testing as described in 5.2.5 to 5.2.6.2. All openings shall be sealed and seals maintained until installed and final connections are made with cleaned piping system. Seals and sealing shall be in accordance with MIL-STD-749. In lieu of the foregoing, air flasks and moisture separators may be cleaned with the piping system.

5.1.3 Using the applicable ship's drawing, the piping shall be arranged into sections by installing jumpers, blanks, and valves as necessary to form a continuous loop when connected to circulation equipment.

5.1.3.1 When possible, jumpers may be used to connect 2 open end pieces of pipe in order to provide more circulation. Flask's piping connections may be connected by jumpers. However, sufficient jumpers from open end pieces must be installed to return the cleaning solvent to a collecting tank.

5.1.4 For disposal of used cleaning solvent, see 4.1.9.

5.2 Compressed air piping system and components.

5.2.1 For portions of the system which can be flushed by circulation, connect the flushing equipment and solvent supply at any convenient low point.

5.2.2 The cleaning solvent shall be circulated for 30 minutes. The solvent shall be collected from the drains in receiving tanks, or pipe the solvent back into the piping system if possible.

5.2.2.1 For portions of the system which cannot be cleaned by flushing, the system shall be evacuated to at least 25 inches of Hg vacuum with a vacuum pump. Fill the system by vacuum pull with cleaning solvent and top-off, if necessary by pressurizing. The amount of cleaning solvent used shall be measured.

5.2.2.2 This portion shall be soaked for at least 1 hour with the cleaning solvent. This portion shall be drained of all cleaning solvent by applying pressure gradually with dry oil-free nitrogen or by evacuation. The amount of solvent removed shall be measured and compared to the amount used, to determine if all solvent has been removed.

5.2.3 A sample of the removed solvent shall be collected from all outlets. The laboratory will examine the spent solvent. This spent solvent must contain not more than 50 ppm total contamination as determined by the test procedure of MIL-C-81302, for the system to be considered clean.

5.2.4 If a second flushing is required to reduce the contamination to below 50 ppm, the above procedures should be repeated as necessary.

5.2.5 When a section of piping is certified clean, the spent solvent will be completely removed by draining and by either blowing with dry oil-free nitrogen or by using a vacuum pump.

5.2.6 A General Electric H-10 electronic halide detector (or equivalent) shall be used to check the vacuum pump exhaust or nitrogen discharged for solvent. Continue until no solvent is detected. Ensure that the detector is in proper working condition prior to use.

5.2.6.1 Portions of associated systems or components which could not be removed or physically separated from the cleaned systems or components in accordance with 4.3.3, shall be purged with air or dry, oil-free nitrogen or evacuated using a vacuum pump. The air, nitrogen, or vacuum exhaust shall be sampled in accordance with 5.2.6 to ensure freedom from the solvent.

5.2.6.2 For submarine systems, a final purge shall be made by blowing with oil-free nitrogen and finally charging the system to 100 psig. The pressure shall be maintained for about 1 hour. Gas samples shall then be taken at 100 psig and tested as follows. Samples of the nitrogen purge at 100 psig should be taken to the laboratory and analyzed by gas chromatographic procedures for cleaning solvent content. The quantity of cleaning compound should not exceed 10 ppm by volume.

5.2.7 All temporary jumpers, blanks, valves, etc. shall be removed. All open end piping shall be capped and be absolutely sure no foreign matter enter the system.

5.2.8 All sections of piping shall be cleaned by the procedures outlined above. All cleaned piping shall be kept isolated and free of contamination. The system shall be reassembled when all other parts (instruments, gages, flasks, valves, etc.) have been cleaned and tested as required.

5.2.9 For disposal of used cleaning solvent see 4.1.9.

5.3 High pressure air compressors.

5.3.1 The intercoolers, aftercoolers, moisture separators and collecting traps, and the interconnecting air piping and fittings between air coolers and compressor stages, the blowdown valves and associated piping and fittings, the air temperature monitor sensing elements if directly in the air stream, pressure gages, wells and fittings, cylinder air valves, unloader valves and check valves, shall be cleaned.

5.3.1.1 This cleaning shall be sufficiently thorough to restore the internal surfaces to the "as new" condition with respect to cleanliness.

5.3.2 The components shall be removed from the compressor for cleaning. Disassembly, reassembly (using a new set of gaskets) and testing of compressor and components shall be accomplished according to instructions and safety precautions specified in applicable maintenance manuals. Cleaning of the components shall be according to the procedures stated in 5.3.2.1 through 5.3.2.4.

5.3.2.1 The system air side of the intercoolers, aftercoolers, interconnecting air piping, moisture separators, separator collecting traps, blowdown valves, blowdown piping, temperature sensing elements or temperature element wells, cylinder air valves, unloader valves and check valves, with components disassembled as necessary, shall be soaked in a boiling solution of cleaning compound conforming to P-C-437 and fresh water, mixed in the proportion of 1 gallon of water to 4 ounces of compound.

5.3.2.2 The soaking period shall be 1/2 hour followed by scrubbing with suitable brushes (metallic bristle brushes should not be used on critical seating surfaces). This soaking and scrubbing process shall be repeated until the parts are clean.

5.3.2.3 After soaking and scrubbing, the parts shall be adequately rinsed in fresh water and thoroughly dried by means of clean air.