NOTE: MIL-STD-419D has been redesignated as a standard practice. The cover page has been changed for Administrative reasons. There are no other changes to this Document. In addition, all slant sheets associated with this document are hereby designated as standard practice

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(See 6.2)

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

CLEANING, PROTECTING, AND TESTING PIPING, TUBING, AND FITTINGS FOR HYDRAULIC POWER TRASMISSION EQUIPMENT

AMSC N/A FSC 4730

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment

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: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed 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 covers the requirements governing the basic methods of cleaning and protecting nonferrous and ferrous metal and alloyed pipe, tubing, and fittings prior to installation and after hydraulic tests in hydraulic power transmission applications. This standard is applicable to hydraulic components used in systems filled with either petroleum oil, phosphate ester type fluid or water based fluid.

1.2 Applicability. The procedures described in this standard are intended for the use of shipyard or contractor personnel only in accordance with the safety precautions of section 5.

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

O-H-765 - Hydrochloric Acid, Technical.
O-I-501 - Inhibitors, Pickling (For Use with Sulphuric Acid).
O-N-350 - Nitric Acid, Technical.
O-S-571 - Sodium Carbonate, Anhydrous, Technical.
O-S-588 - Sodium Chromate, Anhydrous, Technical.
O-S-595 - Sodium Dichromate, Dihydrate, Technical.
O-S-642 - Sodium Phosphate, Tribasic, Anhydrous; Dodecahydrate; and Monohydrate; Technical.
O-S-809 - Sulfuric Acid, Technical.
P-D-680 - Dry Cleaning Solvent.

MILITARY

MIL-P-116 - Preservation, Methods of.
MIL-C-5501 - Caps and Plugs, Protective, Dust and Moisture Seal General Specification for.
MIL-H-6083 - Hydraulic Fluid, Petroleum Base, For Preservation and Operation.
MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application.
DOD-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (For Ferrous Metals).
MIL-D-16791 - Detergents, General Purpose (Liquid, Nonionic).
MIL-L-17331 - Lubricating Oil, Steam Turbine and Gear, Moderate Service.
MIL-H-17672 - Hydraulic Fluid, Petroleum, Inhibited.
MIL-H-19457 - Hydraulic Fluid, Fire-Resistant, Non-Neurotoxic.
MIL-H-22072 - Hydraulic Fluid, Catapult NATO Code Number H-579.

MILITARY (Continued)

MIL-I-22110 - Inhibitors, Corrosion, Volatile, Crystalline Powder.

MIL-F-24402 - Filters (Hydraulic), Filter Elements (High Efficiency), and Filter Differential Pressure Indicators.

MIL-A-24641 - Acid, Hydrofluoric; Technical.

HANDBOOKS

MILITARY

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

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

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B93.28 - Method for Calibration of Liquid Automatic Particle Counters Using "AC" Fine Test Dust.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 1744 - Standard Test Methods for Water in Liquid Petroleum Products by Karl Fischer Reagant. (DoD adopted)

F 312 - Standard Methods for Microscopical Sizing and Counting Particles from Aerospace Fluids on Membrane Filters.

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

NATIONAL AEROSPACE STANDARD (NAS)

1638 - Cleanliness Requirements of Parts Used in Hydraulic Systems.

(Application for copies should be addressed to the National Standards Association, Inc., 5161 River Road, Bethesda, MD 20816.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

2.3 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 (Not applicable)

4. GENERAL REQUIREMENTS

4.1 Cleanliness. Pipe tubing and fittings related to the hydraulic power transmission equipment shall be thoroughly cleaned and pickled as necessary prior to installation (see 5.2 and 5.3). They shall be free from scale and foreign matter which could be detrimental to operation of hydraulic equipment such as pumps, motors, valves, rams, and accumulators.

4.2 Pipe construction and cleaning. Pipe required to complete a hydraulic installation shall be constructed in a shop where adequate facilities exist. However, shipboard or vehicle construction is allowed, provided adequate provisions exist to allow cleanliness controls and preclude damage to equipment. Subassemblies shall be used to the maximum extent practicable. After construction and bending operations are completed, the constructed and bent pipe, tubing, and fittings shall be cleaned and pickled in accordance with the procedures specified herein (see 5.2). Hydraulic components which may be constructed of materials not compatible with the pickling solution shall not be immersed in the cleaning or pickling baths. Complex components, such as pumps, valves, and rams, which may be compatible with the pickling solution but will require disassembly to remove residual fluids, shall not be immersed in the cleaning or pickling baths. No hydraulic component that is mechanically connected (union, flange) to rigid piping shall be subject to the pickling solution.

4.3 Abrasive blasting. Sand, shot or other abrasive blasting shall not be permitted on any part of the hydraulic system. Unless a separate isolated room is provided in the shop for construction of hydraulic piping, abrasive blasting shall be prohibited in the same building in which an open hydraulic component is housed. Abrasive blasting, chipping, or grinding shall not be permitted in the vicinity of an installation site for an open hydraulic system.

4.4 Sand packing. Hydraulic pipe or tubing shall not be packed with sand during the bending process.

4.5 Wire brushing. The pipe and tubing shall not be wire brushed after pickling.

4.6 Cloth and paper. Cloth or paper material shall not be used in drying operations, nor for capping open ends (see 5.7).

4.7 Corrosion protection. The interior and exterior of the ferrous pipe, tubing and fittings (except corrosion-resistant steel) shall be treated as specified in 5.5 to prevent corrosion.

4.8 Capping. Openings shall be capped and sealed air tight immediately after the cleaning process with a material in accordance with MIL-C-5501 (see 5.7). The openings shall remain capped until immediately before connecting to the equipment for which the pipe is intended.

4.9 Heat treated piping and tubing. Pipe or tubing that has had heat applied at the site of installation to assist in forming shall be returned to the shop or other areas where facilities exist for recleaning, repickling (if necessary), and retesting.

5. DETAILED REQUIREMENTS

5.1 Safety precautions. The contractor or shipyard representative shall ensure that this cleaning is coordinated through the safety superintendent to provide adequate personnel protection from acid and chemical hazards. In general, all chemicals involved are harmful to the eyes and skin. Personal contact with chemicals should be avoided. Obtain medical attention immediately if acid or caustic gets in the eyes. Face shields or goggles shall be worn by personnel involved in chemical cleaning. Avoid breathing mists or vapors over mixing tanks. Rubber overshoes or boots, gloves, aprons, and hats, or other foul weather gear shall be required for personnel who are mixing caustic or acidic cleaning solutions.

5.2 Cleaning. The cleaning and treatment compounds described herein are environmental pollutants if discharged to the water and may be toxic to fresh water and marine organisms. Disposal procedures specified in 5.9 shall be followed. Pickling is not required to clean existing installations during repair or modification unless the pipe or tube has internal oxide scale that cannot be removed by wire brush, water jet, or flushing. If new piping sections have been installed, only the new pipe or tube installed requires pickling. New piping sections do not require pickling if already pickled as specified herein prior to delivery and a clean condition has been maintained during construction. Heat discoloration of piping interior due to welding is not cause for pickling. The following procedure shall be followed in preparation for pickling:

(a) If surfaces are coated with oil or preservatives, the component shall be immersed in the degreasing solution both before and after brushing and air blasting.
(b) Wire-brush entire surface, including interior. Boiler tube brushes or commercial pipe-cleaning apparatus may be used.
(c) Blast thoroughly with air below 30 pounds per square inch (lb/in^2) to remove loose particles. Effective chip guarding and personal protective equipment shall be used during air blasting operations.
(d) Remove grease, oil, and shop dirt by immersing the work in sufficient quantity of the following solution at 160 ± 10 degrees Fahrenheit (°F) for 15 minutes or longer, depending upon the degree of contamination:

Trisodium phosphate monohydrate (in accordance with O-S-642) ..... 7 to 10 ounces.
Detergent, nonionic (polyethylene-glycol monoalkylaryl ether) (in accordance with MIL-D-16791, type I) ..... 1 fluid ounce.
Water ..... 1 gallon.

(e) Rinse thoroughly in warm water (at least 120°F).

(f) If cleaned pipe, tubing and fittings are not pickled immediately, dry with warm, dry, oil-free air which has been filtered through at least 15-micrometer absolute rated filters (hereafter referred to only as clean air) and protect from dust, dirt, oil and moisture.

5.3 Pickling and hydrostatic tests (prior to installation). Pickling and hydrostatic tests shall be in accordance with the procedures specified herein. Caution shall be exercised by the operator during the pickling process insofar as time of immersion in the acid bath is concerned. The assembly shall remain in the bath only long enough to permit adequate pickling (removal of scale), as determined visually. Due to the nature of the pickling process, this caution is necessary to ensure and protect the mechanical properties of the pipe, tubing or fitting. The position of the tubing in the pickling bath shall be changed occasionally to make sure that if gas pockets form they shall not always be at the same location. When hydraulic fluid is used for hydrostatic testing, the assembly shall be degreased just prior to further brazing or welding.

5.3.1 Nonferrous pipe, tubing and fittings (bronze, copper, copper-nickel, and nickel-copper, not aluminum or aluminum alloys). Aluminum and aluminum alloys shall not be pickled.

5.3.1.1 Nonferrous metals other than nickel-copper. The pickling procedure shall be as follows:

(a) Pickle free from scale in a solution of the following composition at 60 to 100°F.

Sulfuric acid, 66 degrees Baume, specific gravity (sp. gr.), 1.83, conforming to type I, class 1 of O-S-809	7 to 14 fluid ounces.
Water	1 gallon.

(Caution: The acid shall always be added carefully with stirring to cooled water. This mixing procedure shall always be followed when adding concentrated sulfuric acid to water.)

Note: If red stains appear, immerse the work briefly in a solution formulated as above but which contains, in addition, 2 to 4 ounces of sodium dichromate (per gallon of water) conforming to O-S-595. This solution shall be maintained at a temperature range of 70 to 120°F.

5.3.1.2 Nickel-copper. The pickling procedure shall be as follows:

(a) Pickle for 20 to 40 minutes in a hot solution (180 ± 10°F) of the following composition:

Hydrochloric acid, 20 degrees Baume, sp. gr. 1.16 (in accordance with O-H-765)	1/2 gallon.
Cupric chloride	4 ounces.
Water	1 gallon.

(b) Rinse in warm water (over 120°F).
(c) Immerse for 5 to 10 minutes in a bath composed as follows (temperature 70 to 100°F).

Sulfuric acid, 66 degrees Baume, sp. gr. 1.83 conforming to type I, class 1 of O-S-809 ..... 13 fluid ounces.
Sodium dichromate (in accordance with O-S-595) ..... 17-1/2 ounces.
Water ..... 1 gallon.

5.3.1.3 Treatment following pickling. The treatment following pickling shall be as follows:

(a) Immediately after pickling, rinse in a clean, warm water bath.
(b) Neutralize traces of acid from the pickling operation by rinsing the work in an alkaline bath containing 4 ounces (per gallon of water) of sodium carbonate conforming to O-S-571.
(c) Rinse thoroughly in fresh, warm water (over 120°F).
(d) If hydrostatic test will not be performed with water (see 5.3.1.4), dry with clean air.

5.3.1.4 Hydrostatic test prior to installation. The piping assembly shall be subjected to the specified test pressure (usually specified in system diagrams) with tap water or with a hydraulic fluid equal to, or compatible with, that normally used in the system. If leaks occur, they shall be repaired and the assembly retested. Following a satisfactory test, the solution shall be drained and all openings capped. If water is used, the assembly shall be blown dry by clean dry air before openings are capped. The piping assembly shall then be installed up to the components (see 4.2).

5.3.2 Ferrous pipe, tubing and fittings (other than corrosion-resistant steel). The pickling procedure shall be as follows (see 5.3):

(a) Pickle free from rust and scale in a hot solution (150 ± 10°F) of the following composition:

Sulfuric acid, 66 degrees Baume, sp. gr. 1.83 conforming to type I, class 1 of O-S-809 ..... 7 to 14 fluid ounces.
Inhibitor (in accordance with O-I-501) ..... Quantity recommended by manufacturer.
Water ..... 1 gallon.

5.3.2.1 Treatment following pickling. The treatment following pickling shall be as follows:

(a) Rinse immediately after pickling in a clean, warm water (over 120°F) bath.
(b) Immerse for several minutes in an alkaline bath containing 4 ounces (per gallon of water), of sodium carbonate conforming to O-S-571.

(c) Rinse by immersing in a clean, warm water (over 120°F) bath.
(d) Immerse in a solution composed of 1 ounce (per gallon of water) of sodium chromate conforming to O-S-588 for at least 2 minutes at room temperature (60 to 100°F).
(e) If the hydrostatic test is to be performed with hydraulic fluid (see 5.3.2.2), rinse the work with clean water, then dry with clean air.

5.3.2.2 Hydrostatic test prior to installation. The piping assembly shall be subjected to the specified test pressure using a sodium chromate solution (1 ounce sodium chromate per gallon of water) or with a hydraulic fluid equal to, or compatible with, that normally used in the system. If leaks occur, they shall be repaired and the assembly treated and retested as specified herein. Following a satisfactory test, the fluid shall be drained and all openings capped. If a water solution has been used, the assembly shall be blown dry with clean dry air before openings are capped. The piping assembly shall then be installed up to the components (see 4.2).

5.3.3 Corrosion-resistant steel pipe, tubing and fittings. The pickling operation shall be as follows (see 5.3):

(a) Immerse work for 10 to 15 minutes in a hot solution (130 ± 10°F) of the following composition:

Nitric acid (in accordance with O-N-350)	13 to 20 fluid ounces.
Hydrofluoric acid (60 percent) (in accordance with MIL-A-24641)	1 to 2 fluid ounces.
Water	1 gallon.

(b) Rinse in a clean, warm water (over 120°F) bath.
(c) If hydrostatic test will not be performed with water (see 5.3.1.4), dry the piping assembly with clean air.

5.3.3.1 Hydrostatic test prior to installation. The piping assembly shall be subjected to the test specified in 5.3.1.4.

5.4 Flush of installed system for removal of brazing fluxes. The entire piping system, after installation up to, but not including, the components shall be flushed to remove brazing fluxes. Flushing blocks and other jumpers shall be used to connect piping around components not being flushed. Before filling the system with water, a low pressure air test (up to 100 lb/in^2) shall be applied to the piping to check for leaks. Any one of the three following procedures shall be conducted. (The hot flush and hot circulation methods are preferred.) Flush water containing flux residues may be discharged to a sanitary sewer system or overboard if connection to a sewer is not feasible.

(a) Hot flush soak with nonrecirculating fresh water for 1 hour while ensuring that the temperature at any part of the system does not go below 110°F.
(b) As an alternative to the hot flush procedure, a hot recirculating procedure with fresh water may be conducted for a period of 1 hour for systems where such an arrangement is feasible.

The system temperature shall be monitored so that no part of the system falls below 110°F. Following the recirculating procedure, the system shall be flushed with fresh water for 15 minutes at a minimum temperature of 60°F.

(c) Cold soak the system for 12 hours using fresh water at a minimum temperature of 60°F. At the completion of the 12-hour soak, systems shall be flushed with nonrecirculating fresh water at a minimum temperature of 60°F for 4 hours.

Under all of the above flux removal procedures, the system shall be full of water so that joints are completely submerged at all times. The minimum flow rate in gallons per minute (gal/min) required for removal of residual brazing flux in piping systems shall be 1.5 times the internal pipe diameter (id) in inches. Upon completion of the flux removal procedure, completely drain the system and dry with air.

5.5 Hydrostatic test after installation. The entire piping system, after installation up to the components, shall be subjected to the specified test pressure with tap water or with a hydraulic fluid equal to, or compatible with, the fluid normally used in the system. If water has been used, the system shall be drained completely after the test and blown dry with clean air. Components and piping assemblies which passed a hydrostatic test prior to installation need not be retested.

5.5.1 Hydraulic systems and components which are subject to corrosion shall be preserved in accordance with MIL-P-116. Prior to assembly, all oil films and preservatives shall be removed from those sections which shall be subjected to welding or brazing operations. Assembled systems which have been protected by a preservative fluid (see 5.5.1.1) shall be thoroughly drained and blown down before adding the system fluid. (See 5.9 for disposal instructions for these fluids.) If the assembled system has not been thoroughly cleaned prior to adding protective fluids, a complete flush (see 5.6) shall be required before putting the system into operation.

5.5.1.1 Assembled systems. Hydraulic systems which are to be left inactive for 6 months or less shall be protected by filling with the system fluid. Those systems which are to be left inactive for an extended period (6 months or more) shall be filled with a suitable preservative fluid. For systems containing petroleum base fluids, the preservative fluid shall conform to MIL-H-6083. For systems containing phosphate ester base hydraulic fluids such as MIL-H-19457 fluids, the preservative fluid shall conform to MIL-H-19457 with addition of a vapor phase inhibitor conforming to MIL-I-22110 in accordance with manufacturer's instructions. For water based systems, the preservative fluids shall be the system fluid as specified in MIL-H-22072. Adequate vents and tanks shall be provided to compensate for the expanding and contracting fluid and minor system leaks. When the system is preserved with other than the normal system fluid, tags with the following information shall be conspicuously attached:

> "This system has been filled with preservative fluid to (specification) on (date). This fluid shall be completely drained and blown down before adding system fluid."

5.5.1.2 Components. If system components are not to be installed immediately, preservation shall be in accordance with the requirements specified in 5.5.1.2.1 through 5.5.1.2.3.

5.5.1.2.1 Short term (internal surfaces). For petroleum oil system components, short term preservation of internal surfaces shall be accomplished with fluids conforming to MIL-H-6083. For phosphate-ester system components, internal surfaces shall be preserved with fluids conforming to MIL-H-19457 with addition of vapor space inhibitor conforming to MIL-I-22110, in accordance with the inhibitor manufacturer's instructions. Water based fluid system components in long term storage shall require annual treatments with the system fluid, as specified in MIL-H-22072. Preservation with coatings in accordance with MIL-H-6083 or MIL-H-19457 fluids is satisfactory for 1 year, after which recoating is required. Since these fluids, in small quantities, are compatible with the system operating fluids, draining of residual fluid prior to installation will provide adequate removal of the preservatives. (See 5.9 for disposal instructions for these fluids.) (See 5.6.1 for definition of acceptable liquid contamination.) Complete removal and degreasing is required when brazing or welding is necessary to reassemble the system. A tag with the following information shall be attached to the assembly:

> "The interior of this item has been (filled, coated) with corrosion preventive fluid to (specification) on (date). Coatings require replacement 1 year from date. Prior to assembly, complete removal and degreasing is required if brazing or welding is necessary to assemble components."

5.5.1.2.2 Long term (internal surfaces). For petroleum oil system components, which are expected to be in storage for considerably longer than 1 year, and are easily disassembled and cleaned, the internal surfaces shall be treated with preservative in accordance with MIL-P-116, type P-2 (MIL-C-16173, grade 2). A tag with the following information shall be attached to the assembly:

> "The interior of this item is coated with corrosion preventive compound, grade 2 of MIL-C-16173. This compound shall be removed just prior to installation."

Phosphate ester system components in long term storage will require annual treatments with fluid conforming to MIL-H-19457 with addition of vapor space inhibitor conforming to MIL-I-22110. The assembly shall be tagged as specified in 5.5.1.2.1.

5.5.1.2.3 External surfaces. For external surfaces of petroleum oil and phosphate ester fluid system components requiring preservation, coatings in accordance with MIL-P-116, type P-1 (MIL-C-16173, grade 1) or type P-19 (MIL-C-16173, grade 4) shall be applied where the preservative will not have to be removed for system operation, or where preservative removal by scraping or solvent action would not damage the part or equipment. Where removal of the

preservative will be required, such as when the preservative would otherwise be in contact with the system fluid, a coating conforming to MIL-P-116, type P-2 or type P-19 shall be applied. A tag with the following information shall be attached to the assembly:

> "The exterior of this item has been coated with corrosion preventive compound to (specification), (coating type or grade). Removal of this compound (is, is not) necessary prior to installation."

5.5.1.3 Preservative removal. The coatings in accordance with MIL-P-116, type P-2 and P-19 and fluid films in accordance with MIL-H-6083 may be removed with dry cleaning solvent conforming to P-D-680, type II. Surfaces cleaned with solvent will be left unprotected and shall be immediately wetted with the system fluid unless welding or brazing will be required to reassemble the system. For preserved petroleum system components which will not require degreasing, the system oil may be used to remove the preservative. When solvent conforming to P-D-680 is used to remove protective coatings, complete removal of the solvent is required to avoid subsequent contamination of the system operating fluid. (See 5.9 for disposal instructions for these fluids.)

5.6 System flushing. Installed piping shall be flushed before being put into operation. Flushing fluid shall be limited to the system operating fluid. Flow rates shall be sufficient to maintain the Reynolds number specified in 5.6.1. Flushing shall be performed on the entire system, but may be accomplished piecemeal on those circuits which can be independently cleaned and isolated. Complex systems may be divided into parts in order to assure the required flow rate in every part of the system during flushing. Hydraulic pumps, motors, complex valves and devices that restrict flow or could be damaged by contaminants dislodged during flushing shall be removed from the circuit; and temporary pipe, flushing blocks, tube, or hose substituted in their place. A temporary filter, conforming to MIL-F-24402, or equal, shall be installed in the circuit being flushed and clean filter elements installed as necessary to keep the pressure drop across the filter within the specified limits. Filter bypass valves shall not be used. The flushing fluid shall be filtered through a filter conforming to MIL-F-24402 or equal as the system is filled. Flushing shall be performed in the same direction as the normal fluid flow during system operation. When the normal system flow may be in either direction, such as in actuator lines, flushing these lines in both directions shall be required. Circuits having a rise in the direction of flow shall require reversing the direction of the flush to ensure that the system is clean in both directions. When flushing is done in both directions, flushing in the direction of normal flow shall be done last. Components such as reservoirs, accumulators, and cylinders shall be flush rinsed with a high velocity jet stream or wiped as required to attain the specified cleanliness. Pistons shall be removed from cylinders and accumulators for shop cleaning. Where wiping is necessary, lint-free toweling shall be used. Components cleaned in the shop prior to installation and properly preserved, sealed, and stored may be connected to the piping, after the pipe is flushed, without further cleaning (see 5.5.1.2). Reasonable technical competence shall be exercised in planning the flushing of a system. (MIL-HDBK-407 is recommended for background information.) Unless otherwise specified by the contracting officer or the ship supervisor, flushing

shall continue until the fluid indicates that the class 9 cleanliness requirement of NAS 1638 has been achieved. Prior to termination of flushing the system piping, the water content of the flushing fluid shall be determined when the flushing fluid is not water based. The water content shall not exceed 0.05 percent for any single sample. The average of the samples taken prior to terminating the flush shall not exceed 0.03 percent for any system or circuit thereof. After flushing and reassembly, the system shall be filled with clean water-free fluid which meets the applicable fluid specification and has been final filtered through a filter in accordance with MIL-F-24402, or equal.

5.6.1 Procedure for system operating fluid flush. Flushing with system operating fluid or a fluid compatible with system fluid as approved by the acquiring activity shall be performed. For systems utilizing MIL-F-17331 or MIL-H-17672 fluids, flushing may be conducted with lower viscosity MIL-H-17672 fluids. For each pipe size, the fluid, flow rate, and fluid temperature shall be defined to achieve a Reynolds number of at least 4000. In small diameter lines, such as 1/4 and 3/8 inch, when piping cannot be reasonably flushed in short enough sections to stay with the pressure limits of the piping (and system), the Reynolds number shall not drop below 2000. Upon completion of flushing with fluids other than the system operating fluid, the system shall be completely drained and blown free of flushing fluid, and the system refilled with operating fluid. Depending upon the complexity of the system and the amount of flushing oil left behind, a second or third drain-and-fill sequence may be required to provide minimal acceptable liquid (not solid) contamination. Acceptable liquid contamination shall be that amount which could be tolerated in a fluid without causing failure of the fluid in any of the tests required by the applicable fluid specification.

5.6.2 Flushing fluid samples. Unless otherwise specified by the contracting officer or ship supervisor, samples shall be taken from the bottom side of the pipe within 5 feet of the inlet of the flushing filter during full flow. The size of each sample drawn shall not exceed 1 liter and shall include the fluid and contaminants trapped by the valve and adapter during the preceding 5-minute flushing period. (Open the valve to draw an amount greater than the volume of branch pipe and valve, close the valve and wait 5 minutes and draw the sample.) The entrance to the sampling port shall be flush with the inner circumference of the pipe, and the valve connector (adapter) shall not extend into the pipe beyond the inner surface of the pipe. For taking samples from the system during flushing, diaphragm (packless) valves are recommended. Where the hydraulic system is equipped with sampling valves, samples may be taken from those valves, in lieu of the location specified above.

5.6.2.1 Sample analyses. The test method for determination of particulate contamination shall be in accordance with ASTM F 312 or an automatic particle counter calibrated in accordance with ANSI B93.28. Directions in the manual for the respective instrument shall be followed. Water content shall be determined in accordance with ASTM D 1744, or with commercially available automatic water-analyzing equipment that shall accurately determine water content down to 0.01 percent.

5.7 Capping and sealing open ends. Open ends shall be capped or sealed to preserve cleanliness of assemblies for stowage, transit, or installation operations. Caps shall have the same grade of cleanliness as the pipe or

assembly to be sealed. The use of electrical plastic tape, or other compatible tape is allowed to hold caps in place. However, the use of any tape as a cap is prohibited. Caps shall be made in accordance with MIL-C-5501, with the following exceptions:

(a) Materials used in the manufacture of protective caps shall be of acceptable quality, compatible with the fluid used in the capped system. Materials conforming to commercial specifications may be used provided they pass the tests specified below and the torque test specified in MIL-C-5501. The use of commercial specifications shall not constitute waiver of inspection. Materials shall not chip or shred during normal usage. Plastics and elastomers may be used provided they pass the tests required herein.

(b) The requirements for durability, repeated assembly test, protection after installation, and drop and sealing tests specified in MIL-C-5501 shall not apply. In lieu thereof the tests specified in (c) and (d) herein shall apply.

(c) Sealing (first article inspection). A fitting, assembled and tested as specified in (d), shall then be immersed in the fluid to be sealed at a temperature of 160 ± 2°F and held for 5 minutes. No leakage shall result.

(d) Sealing (quality conformance inspection). Samples selected shall have the sealing surface wet with the fluid to be sealed, assembled to a fitting connected to an air supply of 2 lb/in^2 minimum air pressure, and immersed in water or other suitable fluid for a period of at least 30 seconds and not more than 1 minute. No leakage shall occur. Applied torque shall be as specified in MIL-C-5501. Test shall be conducted at room temperature. Cloth shall not be used. Wood inserts (plugs) shall not be used: however, wooden blocks bolted over the flanged ends may be used. The open ends shall remain capped until immediately before connecting to the equipment for which pipe is intended. Unthreaded pipe ends shall be capped with unthreaded caps.

5.7.1 In systems using petroleum base hydraulic fluid, plastic or rubber material may be used for caps, with the exception of butyl or ethylene propylene rubber. All other incompatible rubbers shall be prohibited. The pipe end shall be completely covered with sheet plastic or rubber (except butyl) and secured to the pipe outside diameter (od) with electrical plastic tape or some other compatible tape. Nitrile rubber is recommended for caps. These materials may be used for threaded and unthreaded closures.

5.7.2 In systems using phosphate ester type fire-resistant hydraulic fluid, butyl or other compatible rubber and compatible plastics may be used for caps. The pipe end shall be completely covered with compatible sheet plastic or butyl rubber, and secured to the pipe od with a compatible tape.

5.8 Ferrous systems (except corrosion-resistant steel). When specified by the command or agency concerned, ferrous piping, tubing, and fittings shall be phosphate coated, prior to installation, in accordance with the specified type and class of DOD-P-16232.

5.9 Disposal of waste materials used in cleaning. The following materials and solutions containing these materials shall not be discharged overboard. They shall be retained in containers and held for shore disposal:

(a) Sodium chromate.
(b) Sodium dichromate.
(c) Lubricating oil.
(d) Cleaning oil.
(e) Corrosion preventive, solvent cutback, cold application.
(f) Dry cleaning solvent.
(g) Hydraulic fluids.

Other materials shall be disposed of in accordance with local, state, and Federal laws or retained in containers for shore disposal.

6. NOTES

6.1 Subject term (key word) listing.

Hydrostatic test
Pickling test
Long term (internal surfaces)
Short term (internal surfaces)
System flushing

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

Custodians:
Army - ME
Navy - SH

Review activities:
Army - MI
Navy - MS

User activities:
Navy - MC, OS

Preparing activity:
Navy - SH
(Project 4730-0654)

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NAVAL SEA SYSTEMS COMMAND (SEA 55Z3)
DEPARTMENT OF THE NAVY
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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-STD-419D	CLEANING, PROTECTING, AND TESTING PIPING, TUBING, AND FITTINGS FOR HYDRAULIC POWER TRANSMISSION EQUIPMENT

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

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

DD FORM 1426, 82 MAR

PREVIOUS EDITION IS OBSOLETE.