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# SURFACE VEHICLE INFORMATION REPORT

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## Specifications and Standards for Marine Hydraulic Systems and Components

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***1.*** ***Scope***—This document lists military and industry specifications and standards that are considered to be of particular interest to designers of marine vehicle hydraulic systems. SAE AIR737 lists additional aerospace hydraulic documents which occasionally may have application in marine hydraulic systems (see 4.2.1).

**1.1** **Purpose**—This report is intended to assist marine hydraulic system designers in identifying military and industry specifications and standards that are suitable for use in marine hydraulic systems. The documents are listed according to specific categories and components. Documents that can be identified with more than one category are listed accordingly. The user is cautioned to use the latest revision of each document and to review the document carefully to determine the suitability of the document for the particular application.

***2.*** ***References***—See following sections.

***3.*** ***Document Sources***

**3.1 Industry Publications**

3.1.1 SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) PUBLICATIONS—SAE Aerospace Standards (AS), Aerospace Recommended Practices (ARP), Aerospace Information Reports (AIR), Hydrospace Information Reports (HIR), and Hydrospace Recommended Practices (HRP) are available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

3.1.2 AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) PUBLICATIONS—ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

3.1.3 AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. (AIA) PUBLICATIONS—National Aerospace Standards (NAS) are available from the Aerospace Industries Association of America, Inc., 1250 Eye Street, NW, Washington, DC 20005.

3.1.4 AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) PUBLICATIONS—ANSI publications are available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

3.1.5 INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) PUBLICATIONS—ISO publications are available from the International Organization for Standardization, 1 rue de Varembe, 1211 Geneva 20, Switzerland.

3.1.6 NATIONAL FLUID POWER ASSOCIATION (NFPA) PUBLICATIONS—NFPA publications are available from the National Fluid Power Association, Inc., 3333 North Mayfair Road, Milwaukee, WI 53222.

**3.2** **U.S. Government Publications**—Military specifications, standards, and handbooks can be obtained from the Standardization Documents Order Desk, Building 4D, 400 Robbins Avenue, Philadelphia, PA 19111-5094. Industry standards that have been adopted by the Department of Defense (DOD) can be ordered by DOD activities only from this address.

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## *4. Document List*

### 4.1 Accumulators

#### 4.1.1 Industry Publications

| | |
|---|---|
| SAE ARP763 | Accumulators, Ground, Hydropneumatic Pressure |
| NFPA B93.78M | Hydraulic Fluid Power, Gas Loaded Accumulators with Separators, Range of Pressures and Volumes, Characteristic Quantities and Identification (Technically identical to ISO 5596) (Metric only) (ANSI approved) |

#### 4.1.2 Military Specifications and Standards

| | |
|---|---|
| MIL-A-5498 | Accumulators, Hydraulic, Cylindrical, 3000 PSI Aircraft (QPL-5498) |
| MIL-A-8897 | Accumulators, Hydraulic, Cylindrical, 3000 PSI, Aircraft, Type II Systems |
| MS28700 | Accumulator - Cylindrical, 3000 PSI (associated procurement spec: MIL-A-5498) |

### 4.2 Communication (Drawings, Symbols, and Nomenclature)

#### 4.2.1 Industry Publications

| | |
|---|---|
| SAE ARP485 | Temperature Measuring Devices Nomenclature |
| SAE AIR737 | Aerospace Hydraulic and Pneumatic Specifications and Standards (ANSI approved) |
| SAE AS1290 | Graphic Symbols for Aircraft Hydraulic and Pneumatic Systems (DoD adopted, ANSI approved) |
| SAE AIR1916 | Aerospace Fluid Power and Control Actuation System Glossary (ANSI approved) |
| SAE HRP4382 | Diagrams and Associated Tables for Hydraulic Systems of Marine Vehicles |
| SAE ARP4386 | Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies |
| SAE J916 | Rules for SAE Use of SI (Metric) Units, Recommended Practice (ANSI approved) |
| ASTM E 380 | Standard Practice for Use of the International System of Units (SI), the Modernized Metric System |
| ANSI B93.2 | Fluid Power Systems and Products - Glossary (NFPA T3.27.1, NFPA T3.10.3) |
| ANSI Y14.5M | Dimensioning and Tolerancing (DoD adopted) |
| ANSI Y32.10 | Graphic Symbols for Fluid Power Diagrams |
| ANSI Z35.1 | Accident Prevention Signs, Specifications for ISO 5598 Fluid Power Systems and Components - Vocabulary |
| NFPA T3.10.4M | Graphic Symbols for Hydraulic Fluid Power Filters and Separators for Use in Fluid Power Diagrams |

#### 4.2.2 Military Specifications and Standards

| | |
|---|---|
| MIL-STD-12 | Abbreviations for Use on Drawings, and in Specifications, Standards, and Technical-Type Publications |
| MIL-STD-100 | Engineering Drawing Practices |
| MIL-STD-970 | Standards and Specifications, Order of Preference for the Selection of |
| DOD-D-1000 | Drawings, Engineering and Associated Lists |
| MS18282 | Relief Valve Operating Characteristics Versus Maximum Operating Pressure for Liquid Service |
| MS18284 | Regulating and Control Valves Accuracy of Regulation Equipment |

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## 4.3 Contamination Control and Cleanliness

### 4.3.1 Industry Publications

| | |
|---|---|
| SAE ARP598 | Determination of Particulate Contamination in Liquids by the Particle Count Method (DoD adopted, ANSI approved) |
| SAE ARP599 | Dynamic Test Method for Determining the Degree of Cleanliness of the Downstream Side of Filter Elements |
| SAE ARP1192 | Procedure for Calibration and Verification of Liquidborne Particle Counter: An Absolute Standard (ANSI approved) |
| SAE AS4059 | Aerospace-Cleanliness Classification for Hydraulic Fluids |
| SAE ARP4268 | Aerospace - Hydraulic System Fluid Contamination - Location of Sampling Points |
| ASTM D 95 | Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation (API MPMS Chapter 10.5) (British Standard 4385) (AASHTO No. T 55) (DoD adopted, ANSI approved) |
| ASTM D 1744 | Standard Test Method for Water in Liquid Petroleum Products by Karl Fischer Reagent (DoD adopted, ANSI approved) |
| ASTM D 4174 | Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems, Standard Practice for (ANSI approved) |
| ASTM F 303 | Standard Practice for Sampling Aerospace Fluids from Components |
| AIA NAS 1638 | Cleanliness Requirements of Parts Used in Hydraulic Systems |
| ANSI B93.19M | Hydraulic Fluid Power - Particulate Contamination Analysis - Extraction of Fluid Samples from Lines of an Operating System (Technically Identical to ISO 4021) (NFPA T2.9.1) Metric Only |
| ISO 4402 | Hydraulic Fluid Power - Calibration of Automatic-Count Instruments for Particles Suspended in Liquids - Method Using Classified AC Fine Test Dust |
| ISO 4406 | Hydraulic Fluid Power - Fluids - Method for Coding Level of Contamination by Solid Particles [Note: The ISO 4406 coding method is more versatile than SAE AS 4059 and NAS 1638.] |
| NFPA B93.20M | Procedure for Qualifying and Controlling Cleaning Methods for Hydraulic Fluid Power Fluid Sample Containers (Technically Identical to ISO 3722) (NFPA T2.9.2) (ANSI approved) |
| NFPA T2.9.6 | Hydraulic Fluid Power - Calibration Method for Liquid Automatic Particle Counters Using Latex Spheres (Revision and Redesignation of ANSI B93.28) (ANSI approved) |
| NFPA T2.9.14 | Hydraulic Fluid Power - Fluid Contaminant - Determination of Solid Contaminant Level by the Gravimetric Method |
| NFPA T3.9.18 | Method of Establishing the Flow Degradation of Fixed Displacement Hydraulic Fluid Power Pumps When Exposed to Particulate Contaminant |

### 4.3.2 Military Handbooks

| | |
|---|---|
| MIL-HDBK-201 | Petroleum Operations |
| MIL-HDBK-407 | Contamination Control Technology Precision Cleaning Methods and Procedures |

### 4.3.3 Military Specifications

| | |
|---|---|
| MIL-C-5501 | Caps and Plugs, Protective, Dust and Moisture Seal (Associated Specification Sheets 1 through 30 according to mating connection) |

### 4.3.4 Military Standards

| | |
|---|---|
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Hydraulic Power Transmission Equipment |
| MIL-STD-1246 | Product Cleanliness Levels and Contamination Control Program |

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## 4.4 Cylinders and Other Actuators

### 4.4.1 Industry Publications

| | |
|---|---|
| SAE J214 | Hydraulic Cylinder Test Procedure, Recommended Practice (ANSI approved) |
| SAE J1195 | Cylinder Rod Wiper Seal Ingression Test, Recommended Practice (ANSI approved) |
| SAE J1334 | Hydraulic Cylinder Integrity Test, Recommended Practice |
| SAE J1336 | Hydraulic Cylinder Leakage Test, Recommended Practice |
| SAE J1374 | Hydraulic Cylinder Rod Seal Endurance Test Procedure, Recommended Practice |
| NFPA B93.1 | Dimension Identification Code for Fluid Power Cylinders; Appendices I and II (ANSI approved) |
| NFPA B93.3 | Fluid Power Systems and Products - Cylinder Bores and Piston Rod Diameters - Inch Series (NFPA T3.6.1) (ANSI approved) |
| NFPA B93.8 | Bore and Rod Size Combinations and Rod End Configurations for Cataloged Square Head Industrial Fluid Power Cylinders (NFPA T3.6.4) (ANSI approved) |
| NFPA B93.15 | Fluid Power Systems and Products - Square Head Industrial Cylinders - Mounting Dimensions (NFPA T3.6.7) (ANSI approved) |
| NFPA B93.52M | Fluid Power System and Products - Cylinder Bores and Piston Rod Diameters - Metric Series (NFPA T3.6.33M) (Technically Identical to ISO 3320) (ANSI approved) |
| NFPA B93.75M | Hydraulic Fluid Power, Cylinder Ports, SAE Straight Thread O-Ring and 4-Bolt Flange Ports, Heavy Duty and Light Duty Cylinders (NFPA T3.6.54M) (ANSI approved) |
| NFPA B93.84M | Fluid Power Systems and Components - Cylinders - Identification Code for Mounting Dimensions and Mounting Types (Technically Identical to ISO 6099) Metric Only (ANSI approved) |
| NFPA B93.92M | Hydraulic Fluid Power, Cylinders, Bore and Rod Area Ratios (Technically Identical to ISO 7181) Metric Only (ANSI approved) |
| NFPA B93.104M | Hydraulic Fluid Power, Single Rod Cylinders, 160 Bar (16 MPa) Medium and 250 Bar (25 MPa) Series, Mounting Dimensions for Accessories (Technically Identical to ISO 8136) Metric Only (ANSI approved) |

### 4.4.2 Military Specifications

| | |
|---|---|
| MIL-A-24533 | Actuators, Rotary, Hydraulic |
| MIL-A-47312 | Actuator, Hydraulic |
| MIL-R-52411 | Rams, Hydraulic, 10,000 PSI |

## 4.5 Fasteners

### 4.5.1 Industry Publications

| | |
|---|---|
| AIA NAS 1351 | Screw, Cap, Socket Head - Undrilled and Drilled, Plain and Self-Locking, Alloy Steel and Corrosion-Resisting Steel UNRF-3A (DoD adopted) |

### 4.5.2 Military Specifications

| | |
|---|---|
| MIL-I-8846 | Inserts, Screw-Thread, Helical Coil |
| MIL-F-18240 | Fastener Element, Self-Locking, Threaded Fastener, 250 Deg. F Maximum (QPL-18240) |
| MIL-N-25027 | Nut, Self-Locking, 250 Deg. F, 450 Deg. F, 800 Deg. F (QPL-25027) |
| MIL-N-25027/1 | Nut, Self-Locking, Heavy Hex, (Non-Metallic Insert) 250 Deg. F, UNJC-3B, 1/4 through 2-1/2 Inch Nominal Diameters, Nickel-Copper Alloy |
| MIL-I-45910 | Insert, Screw Thread-Locked In and Ring Locked, Serrated, General Specification for |
| MIL-I-45932 | Insert, Screw Thread, Thin Wall, Locked In: General Specification for |
| MIL-I-45932/1 | Insert, Screw Thread - Thin Wall, Locked In |
| MIL-I-45932/2 | Insert, Screw Thread - Thin Wall, Locked In |

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4.5.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-1251 | Screws and Bolts, Preferred for Design, Listing of |
| MIL-STD-1515 | Fastener Systems for Aerospace Applications |
| MIL-STD-1754 | Fastening Devices Preferred for Design, Listing of |
| MIL-STD-1759 | Rivets and Rivet Type Fasteners Preferred for Design, Listing of |
| MIL-STD-1764 | Washers, Preferred for Design, Listing of |
| MIL-STD-1903 | Nuts, Preferred for Design, Listing of |
| MS20995 | Wire, Safety or Lock |
| MS33540 | Safety Wiring and Cotter Pinning, General Practices for |
| MS33547 | Pins, Spring, Functional Limitations of |

## 4.6 Filters

4.6.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE AIR887 | Liquid Filter Ratings, Parameters and Tests (ANSI approved) |
| SAE AIR901 | Bubble-Point Test Method |
| NFPA T3.10.8.4M | Method for Determining the Fabrication Integrity of a Hydraulic Fluid Power Filter Element |
| NFPA T3.10.8.5M | Hydraulic Fluid Power - Filter Elements - Verification of Collapse/Burst Resistance |
| NFPA T3.10.8.6M | Hydraulic Fluid Power - Filter Elements - Verification of Material Compatibility with Fluids |
| NFPA T3.10.8.7M | Method for Verifying the Flow Fatigue Characteristics of a Hydraulic Power Filter Element |
| NFPA T3.10.8.8 | Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance, First Edition (Revision and Redesignation of ANSI B93.31) |
| NFPA T3.10.18M | Multi-Pass Method for Evaluating the Filtration Performance of a Coarse Hydraulic Fluid Power Filter Element |

4.6.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-F-5504 | Filters and Filter Elements, Fluid Pressure, Hydraulic Micronic Type (QPL-5504) |
| MIL-F-8815 | Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems (QPL-8815) |
| MIL-F-8815/1 | Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style A, Bypass, -65 DEG. to +275 DEG. F |
| MIL-F-8515/2 | Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style B, Non Bypass, -65 DEG. to +275 DEG. F. |
| MIL-F-8815/3 | Filter Element, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, -65 DEG. F to +275 DEG. F |
| MIL-F-24402 | Filters (Hydraulic), Filter Elements (High Efficiency), and Filter Differential Pressure Indicators, General Specification for (QPL-24402) |
| MIL-F-24402/1 | Filter Housings, Hydraulic, Single Element |
| MIL-F-24402/2 | Filter Housings, Hydraulic, Duplex |
| MIL-F-24402/3 | Filter Housings, Hydraulic, Three Elements |
| MIL-F-24402/4 | Filter Elements, Hydraulic, Disposable |
| MIL-F-24402/5 | Filter Indicators, Differential Pressure, Hydraulic |
| MIL-F-24702 | Filter Elements, Hydraulic, Disposable, General Specification for (Metric) (QPL-24702) |
| MIL-F-24702/1 | Filter Elements, Hydraulic, Disposable (Metric) |
| MIL-F-24724 | Filter Housings (Hydraulic) and Differential Pressure Indicators, General Specification for |
| MIL-F-24724/1 | Filter Housings (Hydraulic) and Differential Pressure Indicators, (1, 2, 3 Elements) MIL-F-24724/2Filter Housings (Hydraulic) and Differential Pressure Indicators, (4 and 6 Elements) |
| MIL-F-27656 | Filter Unit, Fluid, Pressure, MXU-408/M, Absolute, 5 Micron, Hydraulic |

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4.6.3 MILITARY STANDARDS

| | |
|---|---|
| AN6235 | Filter Element - Hydraulic Replaceable Micronic Line Type |
| AN6236 | Filter Element - Hydraulic Replaceable Micronic Reservoir Type |
| AN6237 | Filter Element - Hydraulic Replaceable Micronic Vent Type |
| AN6238 | Gasket - Hydraulic Replaceable Reservoir Type Filter Element |
| AN6240 | Filter - Hydraulic Replaceable Vent Type |
| MS28720 | Filter, Aircraft Hydraulic Line Type |

4.6.4 OTHER PUBLICATIONS—Wilcox, Wayne K., "Selection Parameters for Hydraulic System Filters with a Comparison of Aircraft and Marine Applications," Naval Engineers Journal, Sept. 1987, Vol. 99, No. 5, pp. 62-70

## 4.7 Fluids

4.7.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE AIR81 | Hydraulic Fluid Characteristics |
| SAE AIR1116 | Fluid Properties |
| SAE HIR1149 | Hydraulic Fluids for Marine Vehicles |
| SAE AIR1362 | Physical Properties of Hydraulic Fluids |
| ASTM D 92 | Standard Test Method for Flash and Fire Points by Cleveland Open Cup (AASHTO No. T48) (DIN 51 376) (ANSI approved) |
| ASTM D 445 | Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (And the Calculation of Dynamic Viscosity) (British Standard 4708) (IP Designation: 71/84) (ANSI approved) |
| ASTM D 664 | Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration (British Standard 4457) (IP 177/83) (ANSI approved) |
| ASTM D 974 | Standard Test Method for Acid and Base Number by Color-Indicator Titration (British Standard 2634) (IP 139/86) (ANSI approved) |
| ASTM D 2272 | Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Bomb (ANSI approved) |

4.7.2 MILITARY HANDBOOKS

| | |
|---|---|
| MIL-HDBK-200 | Quality Surveillance Handbook for Fuels, Lubricants, and Related Products |
| MIL-HDBK-267 | Guide for Selection of Lubricants and Hydraulic Fluids for Use in Shipboard Equipment |
| MIL-HDBK-290 | Packaging of Petroleum and Related Products |

4.7.3 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-H-5559 | Hydraulic Fluid, Arresting Gear |
| MIL-H-5606 | Hydraulic Fluid, Petroleum Base: Aircraft, Missile, and Ordnance (QPL-5606) |
| MIL-H-6083 | Hydraulic Fluid, Petroleum Base, for Preservation and Operation (QPL-6083) |
| MIL-F-17111 | Fluid, Power Transmission (QPL-17111) |
| MIL-L-17331 | Lubricating Oil, Steam Turbine and Gear, Moderate Service (QPL-17331) |
| MIL-H-17672 | Hydraulic Fluid, Petroleum, Inhibited (QPL-17672) |
| MIL-H-19457 | Hydraulic Fluid, Fire Resistant, Non-Neurotoxic (QPL-19457) |
| MIL-H-22072 | Hydraulic Fluid, Catapult, NATO Code Number H-579 (QPL-22072) |
| MIL-S-81087 | Silicone Fluid, Chlorinated Phenyl Methyl Polysiloxane, NATO Code Number H-536 (QPL-81087) |
| MIL-H-83282 | Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon (QPL-83282) |

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## 4.8 Hoses and Hose Fittings

### 4.8.1 Industry Publications

| | |
|---|---|
| SAE ARP603 | Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies (DoD adopted, ANSI approved) |
| SAE AS604 | Hose Assembly, Tetrafluoroethylene, 400 Degrees F, 3000 psi, Hydraulic, Heavyweight (ANSI approved) |
| SAE AS614 | Hose Assembly, Tetrafluoroethylene, Heavy Duty, High Pressure, 4000 psi (27,580 kPa) Hydraulic and Pneumatic (DoD adopted) |
| SAE AS620 | High Temperature Hose Assembly, Convoluted Tetrafluoroethylene, for Aircraft |
| SAE AS1339 | Hose Assembly, Tetrafluoroethylene, 400°F, 3000 psi Hydraulic, Lightweight (DoD adopted) |
| SAE AS1624 | Hose, Polytetrafluoroethylene (TFE), Lightweight 3000 psi, High Temperature, Hydraulic and Pneumatic |
| SAE J516 | Hydraulic Hose Fittings, Standard (ANSI approved) |
| SAE J517 | Hydraulic Hose, Standard (ANSI approved) |
| SAE J1273 | Selection, Installation, and Maintenance of Hose and Hose Assemblies, Recommended Practice (ANSI approved) |
| SAE J1475 | Hydraulic Hose Fittings for Marine Application, Standard (ANSI approved) |
| SAE J1927 | Cummulative Damage Analysis for Hydraulic Hose Assemblies, Information Report |
| SAE J1942 | Hose and Hose Assemblies for Marine Application, Standard (ANSI approved) |
| NFPA B93.100M | Hydraulic Fluid Power - Hose Assemblies - Method of Test (Technically Identical to ISO 6605) Metric Only (ANSI approved) |

### 4.8.2 Federal Standards

| | |
|---|---|
| FED-STD-162 | Hose Rubber, Visual Inspection Guide For |

### 4.8.3 Military Specifications

| | |
|---|---|
| MIL-H-24135 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, General Specification for (QPL-24135) |
| MIL-H-24135/1 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid or Two-Spiral and One-Wire Braid, High Pressure, Sizes -4 through -32) |
| MIL-H-24135/2 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, (Four Plies, Spiral-Wrapped or Two Plies, Spiral-Wrapped and One Ply, Braided High Pressure, Sizes-6 through -16) |
| MIL-H-24135/3 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Spiral-Wrapped, Braided High Pressure, Sizes -16 through -32) |
| MIL-H-24135/4 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid for Medium Pressure, Sizes -40, -48 and -64) |
| MIL-H-24135/5 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid, Perforated Cover for High Pressure Air, Sizes -4 through -32) |
| MIL-H-24135/6 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid or Two-Sprial and One Wire Braid, High Pressure, Sizes -4 through -32, for Phosphate-Ester Base Hydraulic Fluids) |
| MIL-H-24135/7 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Heavy Spiral Wire for High Pressure Phosphate Ester, Sizes -20, -24 and -32) |

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| | |
|---|---|
| MIL-H-24135/8 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Spiral Wrapped Wire, High Pressure, for Phosphate Ester Base Fluids, Sizes -6 through -16) |
| MIL-H-24135/9 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Heavy Spiral Wrapped Wire, High Pressure, Sizes -8 through -32) |
| MIL-H-24135/10 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Single or Double Wire Braid, Medium Pressure Sizes -4 through -48) |
| MIL-H-24136 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, General Specification for (QPL-24136) |
| MIL-H-24136/2 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (High Pressure, Sizes -4 through -32) |
| MIL-H-24136/3 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Low Pressure, Sizes -4 through -32) |
| MIL-H-24136/4 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Low Pressure, Sizes -40, -48 and -64) and Adaptors |
| MIL-H-24239 | Hose Assemblies, Hydraulic, Nonmagnetic, for Minesweeping Tensiometers |
| MIL-H-24592 | Hose Assembly, Tetrafluoroethylene Tube, Non-collapsible, High Temperature |
| MIL-H-24595 | Hose, Wire Reinforced Large-Diameter with Reuseable End Fittings for Flexible Connections |
| MIL-H-25579 | Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure (QPL-25579) |
| MIL-H-27267 | Hose, Tetrafluoroethylene, High Temperature, Medium Pressure (QPL-27267) |

4.8.4 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-438 | Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarines |
| MIL-STD-777 | Schedule of Piping, Valves, Fittings and Associated Piping Components for Surface Ships |

## 4.9 Materials and Coatings

4.9.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE HIR1694 | Materials for Fluid Systems of Marine Vehicles |

[Provides guidance on materials suitable for use in sea water and the general marine environment]

| | |
|---|---|
| ASTM E 208 | Standard Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels |
| ANSI B46.1 | Surface Texture, Surface Roughness, Waviness and Lay (DoD adopted) |

4.9.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-S-81733 | Sealing and Coating Compound, Corrosion Inhibitive (QPL-81733) |
| MIL-C-83982 | Compound, Sealing, Fluid Resistant (QPL-83982) |

4.9.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-889 | Dissimilar Metals |
| MIL-STD-1516 | Unified Code for Coatings and Finishes for DoD Materiel |
| MIL-STD-2193 | Hydraulic System Components, Ship [Provides guidance on material selection and coatings for corrosion resistance] |

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## 4.10 Miscellaneous Components

### 4.10.1 Military Specifications

| | |
|---|---|
| MIL-S-9395 | Switches, Pressure, (Absolute, Gage, and Differential), General Specification for (QPL-9395 and associated specification sheets 1 through 48 according to switch type and amperes) |
| MIL-C-15730 | Coolers, Fluid, Naval Shipboard: Lubricating Oil, Hydraulic Oil, and Fresh Water |
| MIL-I-17244 | Indicators, Temperature, Direct-Reading, Bimetallic (3-inch and 5-inch dial) |
| MIL-M-17508 | Mounts, Resilient, Types 6E2000, 6E900, 6E900BB, 7E450, 7E450BB, 6E150, and 6E100 (QPL-17508) |
| MIL-G-18997 | Gauge, Pressure, Dial Indicating |
| MIL-A-24533 | Actuators, Rotary, Hydraulic |

### 4.10.2 Military Standards

| | |
|---|---|
| MIL-STD-1762 | Bearings and Bushings, Plain, Preferred for Design, Listing of |
| MIL-STD-2193 | Hydraulic System Components, Ship |

## 4.11 Piping and Tubing

### 4.11.1 Industry Publications

| | |
|---|---|
| SAE AMS 4943 | Titanium Alloy Tubing, Seamless, Hydraulic, 3.0 Al - 2.5V Annealed |
| SAE AMS 4944 | Titanium Alloy Tubing, Seamless, Hydraulic, 3.0 Al - 2.5V Cold Worked, Stress Relieved |
| SAE AMS 4945 | Titanium Alloy Tubing, Seamless, Hydraulic, 3 Al - 2.5V, Texture Controlled, 105,000 psi (724 MPa) Yield Strength |
| SAE AMS 5561 | Steel Tubing, Welded and Drawn, Corrosion and Heat Resistant 9.0 Mn - 20 Cr - 6.5 Ni - 0.28N High Pressure Hydraulic (DoD adopted) |
| SAE ARP584 | Coiled Tubing, Corrosion Resistant Steel, Hydraulic Applications (ANSI approved) |
| SAE ARP994 | Recommended Practice for the Design of Tubing Installations for Aerospace Fluid Power Systems (DoD adopted) |
| SAE ARP4146 | Coiled Tubing - Titanium Alloy, Hydraulic Applications |
| SAE J1065 | Pressure Ratings for Hydraulic Tubing and Fittings, Information Report |
| ASTM A 312 /A312M | Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes (DoD adopted) |
| NFPA B93.4M | Hydraulic Fluid Power - Line Tubing - Electric Resistance Welded, Mandrel Drawn (NFPA T3.6.1) (ANSI approved) |
| NFPA B93.59M | Fluid Power Systems and Products - Connectors and Associated Components - Outside Diameters of Tubes and Inside Diameters of Hoses, Appendix (NFPA T3.8.22M) (Technically Identical to ISO 4397) Metric Only (ANSI approved) |

### 4.11.2 Military Specifications

| | |
|---|---|
| MIL-T-1368 | Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded |
| MIL-T-16420 | Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Number 715 and 706) |
| MIL-T-24107 | Tube, Copper (Seamless) (Copper Alloy Numbers C10100, C10200, C10300, C10800, C12000, C12200, and C14200) |
| MIL-P-24691 | Pipe and Tube, Carbon, Alloy and Stainless Steel, Seamless and Welded, General Specification for |
| MIL-P-24691/1 | Pipe and Tube, Carbon Steel, Seamless |
| MIL-P-24691/2 | Pipe and Tube, Chromium-Molybdenum Steel, Seamless |
| MIL-P-24691/3 | Pipe and Tube, Corrosion Resistant, Stainless Steel, Seamless or Welded |

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4.11.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-278 | Welding and Casting Standard |
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment |
| MIL-STD-438 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service |
| MIL-STD-777 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships |
| MIL-STD-798 | Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI-Shock Test Requirements for Piping System Components for Naval Shipboard Use |
| MIL-STD-1627 | Bending of Pipe or Tube for Ship Piping Systems |

## 4.12 Piping and Tubing Fittings

4.12.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE J514 | Hydraulic Tube Fittings, Standard (DoD adopted, ANSI approved) |
| SAE J518 | Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Bolt Split Flange Type, Standard (DoD adopted, ANSI approved) |
| SAE J1065 | Pressure Ratings for Hydraulic Tubing and Fittings, Information Report |
| SAE J1453 | Fitting O-Ring Face Seal, Standard |
| SAE J1926 | Specification for Straight Thread, O-Ring Boss Port, Standard |
| SAE MA2012 | Port Connection Internal, Straight Thread, Metric |
| ANSI B16.5 | Pipe Flanges and Flanged Fittings (DoD adopted) (ASME copyrighted) |
| ANSI B16.9 | Factory-Made Wrought Steel Buttwelding Fittings (DoD adopted) (ASME copyrighted) |
| ANSI B16.11 | Forged Steel Fittings, Socket-Welding and Threaded (DoD adopted) (ASME copyrighted) |

4.12.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-F-1183 | Fittings, Pipe, Cast Bronze, Silver-Brazing, General Specification for (associated specification sheets 1 through 12 according to pipe configuration) |
| MIL-F-18280 | Fittings, Flareless Tube, Fluid Connection (QPL-18280) |
| MIL-F-18866 | Fittings, Hydraulic Tube, Flared, 37 Degree and Flareless, Steel |
| MIL-F-20236 | Fittings, Tube and Pipe, Butt-Welding, 300 PSI and 775 Deg. F Maximum |
| MIL-F-24202 | Fittings, Butt Welding, Seamless or Welded, 70-30 Copper - Nickel Alloy, 700 PSI, 200 Deg. F (QPL has been cancelled) |
| MIL-F-24227 | Fittings and Flanges, Cast Bronze, Silver Brazing Suitable for Ultrasonic Inspection |
| MIL-F-24704 | Flanges, Four Bolt Square, Hydraulic, General Specification for |
| MIL-F-24704/1 | Flanges, Four Bolt Square, Socket Weld for Hydraulic Systems |
| MIL-F-24704/2 | Flanges, Four Bolt Square, Butt Weld for Hydraulic Systems |
| MIL-F-24704/4 | Flanges, Four Bolt Square, Blind for Hydraulic Systems |
| MIL-F-24704/5 | Flanges, Four Bolt, Insert Rings for Hydraulic Systems |
| MIL-C-24714 | Connector Tubes, Hydraulic Component, General Specification for |
| MIL-C-24714/1 | Connector Tubes, Preferred Sizes, Valves and Subplates |
| MIL-C-25427 | Couplings, Assembly, Hydraulic, Self-Sealing Quick Disconnect (QPL-25427) |

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4.12.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-278 | Welding and Casting Standard |
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment |
| MIL-STD-438 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service |
| MIL-STD-777 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships |
| MIL-STD-798 | Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI-Shock Test Requirements for Piping System Components for Naval Shipboard Use |
| MS21344 | Fittings - Installation of Flared Tube, Straight Threaded Connectors, Design Standard for |
| MS24391 | Plug - Bleeder, Tube Precision Type |

## 4.13 Pumps and Motors

4.13.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE HIR1514 | Design and Specification Guide for Hydraulic Pumps Used on Advanced Surface Craft and Submersible Vehicles |
| SAE J745 | Hydraulic Power Pump Test Procedure, Standard (ANSI approved) |
| SAE J746 | Hydraulic Motor Test Procedure, Recommended Practice (ANSI approved) |
| NFPA B93.6M | Dimensions and Identification Code for Mounting Flanges and Shafts for Positive Displacement Hydraulic Fluid Power Pumps and Motors (NFPA T3.9.2) (ANSI approved) |
| NFPA T3.9.13 | Hydraulic Fluid Power - Pumps and Motors - Glossary |
| NFPA T3.9.17 | Hydraulic Fluid Power - Positive Displacement Pumps - Method of Testing and Presenting Basic Performance Data First Edition (Revision and Redesignation of ANSI B93.27) (ANSI approved) |
| NFPA T3.9.18M | Method of Establishing the Flow Degradaton of Fixed Displacement Hydraulic Fluid Power Pumps when Exposed to Particulate Contaminant |
| NFPA T3.9.25M | Method of Establishing the Speed Degradation of Hydraulic Fluid Power Motors when Exposed to Particulate Contaminant |

4.13.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-P-5515 | Pump, Hydraulic, Ram, Hand Driven (QPL-5515) (Shipboard Use) |
| MIL-P-17869 | Pumps and Motors, Power Oil Hydraulic (Naval Shipboard Use) (QPL-17869) |

4.13.3 MILITARY STANDARDS

| | |
|---|---|
| AN6201 | Pump, Hydraulic Hand |
| AN6248 | Pump, Hydraulic Hand, Type 3000 |

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## 4.14 Seals, Gaskets, Packings, and Glands

### 4.14.1 Industry Standards

| | |
|---|---|
| SAE AS568 | Aerospace Size Standard for O-Rings (DoD adopted, ANSI approved) |
| SAE HIR1149 | Hydraulic Fluids for Marine Vehicles [Identifies seal compatibility with hydraulic fluids] |
| SAE ARP1231 | Gland Design, Elastomeric O-Ring Seals, General Considerations |
| SAE ARP1232 | Gland Design, Elastomeric O-Ring Seals, Static Radial |
| SAE ARP1233 | Gland Design, Elastomeric O-Ring Seals, Dynamic Radial, 1500 PSI MAX. |
| SAE AIR1243 | Anti-Blow-By Design Practice for Cap Strip Seals |
| SAE ARP1802 | Selection and Application of PTFE or TFE Back-up Rings for Hydraulic and Pneumatic Fluid Power Applications |
| SAE AS4088 | Rod Scraper Gland Design Standard (ANSI approved) |
| SAE J1926 | Specification for Straight Thread O-Ring Boss Port, Standard |
| SAE MA2010 | Packing, Preformed - O-Ring Seal Standard Sizes and Size Codes, Metric (DoD adopted, ANSI approved) |
| SAE MA2012 | Port Connection Internal, Straight Thread, Metric |
| SAE MA3352 | Packing, Preformed O-Ring Seal (AMS 7276) Metric (DoD adopted, ANSI approved) |
| SAE MA3445 | Packing, Preformed O-Ring Seal, Fluorocarbon (MIL-R-83485, Type I) Metric (DoD adopted, ANSI approved) |
| SAE MAP3439 | O-Ring Groove Design for Packing Preformed, Elastomeric O-Ring Seals, Static Axial Compression, Metric |
| SAE MAP3440 | O-Ring Groove Design for Packing Preformed, Elastomeric O-Ring Seals, Static Radial Squeeze, Metric |
| AIA NAS 1611 | Packing, Preformed, O-Ring, Phosphate Ester Resistant (-65 Deg F to +160 Deg F) |
| AIA NAS 1612 | Packing, Preformed, Straight Thread Tube Fitting Boss (-65 Deg F to +160 Deg F) |
| AIA NAS 1613 | Packing, O-Ring, Phosphate Ester Resistant |
| ISO 3601/1 | Fluid Systems - Sealing Devices - O-Rings Part 1: Inside Diameters, Cross-Sections, Tolerances and Size Identification Code Part 2: Design Criteria for O-Ring Housings |
| NFPA B93.17 | Fluid Power Systems and Components - Multiple Lip Packing Sets - Methods for Measuring Stack Heights (Technically Identical to ISO 3939) (NFPA T3.19.5) (ANSI approved) |

### 4.14.2 Military Handbooks

| | |
|---|---|
| MIL-HDBK-149 | Rubber and Rubber-Like Materials |
| MIL-HDBK-695 | Rubber Products: Recommended Shelf Life |

### 4.14.3 Military Specifications

| | |
|---|---|
| MIL-R-5049 | Ring, Wiper, Piston Rod (QPL-5049) |
| MIL-P-5510 | Packing, Preformed Straight Thread Tube Fitting Boss, Type I Hydraulic (-65 to 160 deg F) (QPL-5510) |
| MIL-G-5514 | Gland Design; Packings, Hydraulic, General Requirements for |
| MIL-W-5521 | Washer, Aircraft, Hydraulic Back-up (QPL-5521) |
| MIL-R-8791 | Retainer, Packing, Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, (Single Turn), General Specification for |
| MIL-R-8791/1 | Retainer, Packing, Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, (Single Turn) |
| DOD-G-24508 | Grease, High Performance, Multipurpose (Metric) (QPL-24508) [used for o-ring installation] |
| MIL-S-45180 | Sealing Compound, Gasket, Hydrocarbon Fluid and Water Resistant |

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| | |
|---|---|
| MIL-G-27617 | Grease, Aircraft and Instrument, Fuel and Oxidizer Resistant (QPL-27617) |
| MIL-R-83248 | Rubber Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant, General Specification for |
| MIL-R-83248/1 | Rubber Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant (O-Rings, Class 1, 75 Hardness) |
| MIL-R-83248/2 | Rubber Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant (O-Rings, Class 2, 90 Hardness) |
| MIL-R-83485 | Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures |
| MIL-R-83485/1 | Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures, O-Ring Sizes and Tolerances |

#### 4.14.4 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-190 | Identification Marking of Rubber Products |
| AN6226 | Packing - U-Cup Hydraulic |
| AN6228 | Adapter - V-Ring Female Hydraulic Packing |
| AN6229 | Adapter - V-Ring Male Hydraulic Packing |
| MS9058 | Ring - Back-up Boss Connection (SAE AMS 3651) |
| MS27595 | Retainer, Packing Backup, Continuous Ring Tetrafluoroethylene |
| MS28773 | Retainer, Packing Backup, Tetrafluoroethylene, Straight Thread Tube Fitting Boss |
| MS28776 | Scraper, Piston Rod |
| MS28777 | Washer, Flat, Aircraft Hydraulic Backup |
| MS28778 | Packing, Preformed, Straight Thread Tube Fitting Boss |
| MS28782 | Retainer, Packing, Back-up, Teflon |
| MS28783 | Ring, Gasket, Back-up, Teflon |
| MS28932 | Felt Strip, Packing Gland |
| MS33675 | Scraper, Installation, Packing Gland Ring |
| MS35803 | Washer, Aircraft, Hydraulic Packing Back-up |
| MS51917 | Seal, Plain Encased: Single Felt Sealing Member, Internal Type |

### 4.15 System Design

#### 4.15.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP24 | Determination of Hydraulic Pressure Drop (DoD adopted) |
| SAE HIR1063 | General Environmental Considerations for Marine Vehicles (DoD adopted) |
| SAE HIR1415 | Design Guide for Hydraulic Systems for Submersible Vehicles (DoD adopted, ANSI approved) |
| SAE HIR1496 | Hydraulic System Design Criteria for Advanced Marine Surface Vehicles (DoD adopted) |
| SAE HIR1622 | Noise Control in Fluid Power Systems of Marine Vehicles (DoD adopted, ANSI approved) |
| SAE AIR1657 | Handbook of Hydraulic Metric Calculations |
| SAE HIR1694 | Materials for Fluid Systems of Marine Vehicles (DoD adopted, ANSI approved) |
| SAE ARP4268 | Aerospace - Hydraulic System Fluid Contamination - Location Sampling Points |
| SAE J916 | Rules for SAE Use of SI (Metric) Units Recommended Practice (ANSI approved) |
| ANSI/B93.18M | Non-Integral Industrial Fluid Power Hydraulic Reservoirs (Technically identical to NFPA T3.16.2M) |
| ANSI/(NFPA/JIC) T2.24.1 | Hydraulic fluid power - Systems standard for stationary industrial machinery |
| NFPA T2.6.1 | Method for Verifying the Fatigue and Establishing the Burst Pressure Ratings of the Pressure Containing Envelope of a Metal Fluid Power Component (Supplements 1 through 9 address requirements for specific hydraulic components.) |

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4.15.2 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-167-1 | Mechanical Vibrations of Shipboard Equipment (Type I -Environmental and Type II - Internally Excited) |
| MIL-STD-210 | Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment |
| MIL-STD-470 | Maintainability Program for Systems and Equipment |
| MIL-STD-740-1 | Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment |
| MIL-STD-740-2 | Structureborne Vibratory Acceleration Measurements and Criteria of Shipboard Equipment |
| MIL-STD-785 | Reliability Program for Systems and Equipment Development and Production |
| MIL-STD-810 | Environmental Test Methods and Engineering Guidelines |
| MIL-STD-882 | System Safety Program Requirements |
| MIL-STD-889 | Dissimilar Metals |
| DOD-STD-1399 | Interface Standard for Shipboard Systems (DOD-STD-1399 is divided into sections according to type of equipment, system, or environment) |
| MIL-STD-1472 | Human Engineering Design Criteria for Military Systems, Equipment and Facilities |
| MIL-STD-2193 | Hydraulic System Components, Ship |

## 4.16 Testing

4.16.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP24 | Determination of Hydraulic Pressure Drop (DoD adopted) |
| SAE ARP598 | Determination of Particulate Contamination in Liquids by the Particle Count Method (DoD adopted, ANSI approved) |
| SAE ARP599 | Dynamic Test Method for Determining the Degree of Cleanliness of the Downstream Side of Filter Elements |
| SAE ARP603 | Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies (DoD adopted, ANSI approved) |
| SAE ARP785 | Procedure for the Determination of Particulate Contamination in Hydraulic Fluids by the Control Filter Gravimetric Procedure (DoD adopted, ANSI approved) |
| SAE AIR887 | Liquid Filter Ratings, Parameters and Tests (ANSI approved) |
| SAE AIR901 | Bubble-Point Test Method |
| SAE ARP1192 | Procedure for Calibration and Verification of Liquidborne Particle Counter: An Absolute Standard (ANSI approved) |
| SAE ARP1383 | Impulse Testing of Hydraulic Actuators, Valves, Pressure Containers and Similar Fluid System Components (DoD adopted) |
| SAE J214 | Hydraulic Cylinder Test Procedure, Recommended Practice (ANSI approved) |
| SAE J745 | Hydraulic Power Pump Test Procedure, Standard (ANSI approved) |
| SAE J746 | Hydraulic Motor Test Procedure, Recommended Practice (ANSI approved) |
| SAE J1195 | Cylinder Rod Wiper Seal Ingression Test, Recommended Practice (ANSI approved) |
| SAE J1334 | Hydraulic Cylinder Integrity Test, Recommended Practice |
| SAE J1336 | Hydraulic Cylinder Leakage Test, Recommended Practice |
| SAE J1374 | Hydraulic Cylinder Rod Seal Endurance Test Procedure, Recommended Practice |
| ASTM D 92 | Standard Test Method for Flash and Fire Points by Cleveland Open Cup (DIN 51 376) (ANSI approved) |
| ASTM D 95 | Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation (API MPMS Chapter 10.5) (British Standard 4385) (AASHTO No. T 55) (DoD adopted, ANSI approved) |
| ASTM D 445 | Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (And the Calculation of Dynamic Viscosity) (British Standard 4708) (IP Designation: 71/84) (ANSI approved) |

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| | |
|---|---|
| ASTM D 664 | Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration (British Standard 4457) (IP 177/83) (ANSI approved) |
| ASTM D 974 | Standard Test Method for Acid and Base Number by Color-Indicator Titration (British Standard 2634) (IP 139/86) (ANSI approved) |
| ASTM D 1744 | Standard Test Method for Water in Liquid Petroleum Products by Karl Fischer Reagent (DoD adopted, ANSI approved) |
| ASTM D 2272 | Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Bomb (ANSI approved) |
| ASTM E 208 | Standard Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels |
| ASTM F 303 | Standard Practice for Sampling Aerospace Fluids from Components |
| ANSI B93.19M | Hydraulic Fluid Power - Particulate Contamination Analysis - Extraction of Fluid Samples from Lines of an Operating System (Technically Identical to ISO 4021) (NFPA T2.9.1) Metric Only |
| NFPA B93.20M | Procedure for Qualifying and Controlling Cleaning Methods for Hydraulic Fluid Power Fluid Sample Containers (Technically Identical to ISO 3722) (NFPA T2.9.2) (ANSI approved) |
| NFPA B93.99M | Hydraulic Fluid Power - Servovalves - Test Methods (Technically Identical to ISO 6404) Metric Only (ANSI approved) |
| NFPA B93.112M | Hydraulic Fluid Power - Valves - Method for Determining the Internal Leakage Characteristics (NFPA T3.5.15M) (ANSI approved) |
| NFPA T2.6.1 | Method for Verifying the Fatigue and Establishing the Burst Pressure Ratings of the Pressure Containing Envelope of a Metal Fluid Power Component (Supplements 1 through 9 address requirements for specific hydraulic components.) |
| NFPA T2.9.6 | Hydraulic Fluid Power - Calibration Method for Liquid Automatic Particle Counters Using Latex Spheres (Revision and Redesignation of ANSI B93.28) (ANSI approved) |
| NFPA T3.9.17 | Hydraulic Fluid Power - Positive Displacement Pumps - Method of Testing and Presenting Basic Performance Data First Edition (Revision and Redesignation of ANSI B93.27) (ANSI approved) |
| NFPA T3.9.18M | Method of Establishing the Flow Degradaton of Fixed Displacement Hydraulic Fluid Power Pumps when Exposed to Particulate Contaminant |
| NFPA T3.10.8.4M | Method for Determining the Fabrication Integrity of a Hydraulic Fluid Power Filter Element |
| NFPA T3.10.8.5M | Hydraulic Fluid Power - Filter Elements - Verification of Collapse/Burst Resistance |
| NFPA T3.10.8.6M | Hydraulic Fluid Power - Filter Elements - Verification of Material Compatibility with Fluids |
| NFPA T3.10.8.7M | Method for Verifying the Flow Fatigue Characteristics of a Hydraulic Power Filter Element |
| NFPA T3.10.8.8 | Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance, First Edition (Revision and Redesignation of ANSI B93.31) |
| NFPA T3.10.18M | Multi-Pass Method for Evaluating the Filtration Performance of a Coarse Hydraulic Fluid Power Filter Element |

4.16.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-S-901 | Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for |

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4.16.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-210 | Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment |
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment |
| MIL-STD-798 | Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI-Shock Test Requirements for Piping System Components for Naval Shipboard Use |
| MIL-STD-810 | Environmental Test Methods and Engineering Guidelines |
| MIL-STD-2193 | Hydraulic System Components, Ship |

## 4.17 Valves

4.17.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP490 | Electrohydraulic Flow-Control Servovalves (ANSI approved) |
| ANSI B16.5 | Pipe Flanges and Flanged Fittings (DoD adopted, ASME copyrighted) |
| ISO 4401 | Hydraulic Fluid Power - Four-port directional control valves - Mounting surfaces |
| ISO 6952 | 2-Pin Electrical Connector Characteristics and Requirements |
| NFPA B93.7M | Hydraulic Fluid Power - Valves - Mounting Interfaces (NFPA T3.5.1M) (ANSI approved) |
| NFPA B93.9M | Symbols for Marking Electric Leads and Ports on Fluid Power Valves (NFPA T3.5.2) (ANSI approved) |
| NFPA B93.55M | Hydraulic Fluid Power - Solenoid Piloted Industrial Valves - Interface Dimensions for Electrical Connectors; Appendix (NFPA T3.5.29M) (ANSI approved) |
| NFPA B93.94 | Fluid Power Systems and Components - Three-Pin Electrical Plug Connector - Characteristics and Requirements (Technically Identical to ISO 4400) Metric Only (ANSI approved) |
| NFPA B93.99M | Hydraulic Fluid Power - Servovalves - Test Methods (Technically Identical to ISO 6404) Metric Only (ANSI approved) |
| NFPA B93.112M | Hydraulic Fluid Power - Valves - Method for Determining the Internal Leakage Characteristics (NFPA T3.5.15M) (ANSI approved) |

4.17.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-V-868 | Valves, Hydraulic Directional Control, General Specification for |
| MIL-V-868/1 | Valves, Hydraulic Directional Control, Four-Way, 0-12 GPM |
| MIL-V-868/2 | Valves, Hydraulic Directional Control, Four-Way, 3-25 GPM |
| MIL-V-868/3 | Valves, Hydraulic Directional Control, Four-Way, 10-50 GPM |
| MIL-V-5519 | Valves, Regulating Fluid Pressure |
| MIL-V-5523 | Valve, Safety Relief |
| MIL-V-5524 | Valves, Check, Hydraulic, Aircraft Type I Systems (QPL-5524) |
| MIL-V-5527 | Valves, Aircraft, Hydraulic Thermal Expansion Relief (QPL-5527) |
| MIL-V-5529 | Valves, Hydraulic Directional Control, Rotary Selector |
| MIL-V-5530 | Valves, Aircraft Hydraulic Shuttle (QPL-5530) |
| MIL-V-8813 | Valves: Aircraft, Hydraulic Pressure Relief, Type II Systems (QPL-8813) |
| MIL-V-19067 | Valves, Check, Controllable, Hydraulic, Aircraft, Type II Systems (QPL-19067) |
| MIL-V-19068 | Valves, Shuttle, Hydraulic, Aircraft, Type II Systems (QPL-19068) |
| MIL-V-19069 | Valves, Check, Hydraulic, Aircraft, Type II Systems (QPL-19069) |
| MIL-V-22052 | Valves, Stop and Check, Globe, Angle, and Y Pattern, Cast or Forged Carbon or Alloy Steel, Outside Screw and Yoke (Sizes 2-1/2 Inches and Larger) (QPL-22052) |
| MIL-V-22687 | Valves, Ball, Naval Shipboard, for Air, Nitrogen Helium or Hydraulic Service (Sizes 2-1/2 Inches NPS and Below) |

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| | |
|---|---|
| MIL-V-24109 | Valves, Globe, Angle, Quick Change Cartridge Trim, High Pressure (H.P.) Hydraulic and Pneumatic (Sizes 1/8 - 1-1/4 Inches) (QPL-24109) |
| MIL-V-24332 | Valves, Angle Relief, for Liquid Service (Naval Shipboard) |
| MIL-V-24578 | Valves, Globe, Pressure Instrument, Stem Test Connection, Union End |
| MIL-V-24630 | Valves, Check, In-Line, for Hydraulic Fluid and Lubricating Oil Fluid (QPL-24630) |
| MIL-V-24630/1 | Valves, Check, In-Line, Non-Reversible Installation for Hydraulic Fluid and Lubricating Oil Fluid |
| MIL-V-24694 | Valve, Hydraulic Relief, 1.5 - 35 Bars (22 - 500 Pounds Per Square Inch) Cartridge Type, General Specification for (Metric) |
| MIL-V-24694/1 | Valve, Hydraulic Relief, 1.5 35 Bar, 150 LPM Cartridge Type |
| MIL-V-24694/2 | Valve, Hydraulic Relief, 1.5 - 35 Bar, 10 LPM Cartridge Type |
| MIL-V-24695 | Valve, and Hose Assembly, Vent and Test Hydraulic Service, General Specification for (Metric) |
| MIL-V-24695/1 | Valve, Vent and Test Hydraulic Service |
| MIL-V-24695/2 | Vent and Test Valve Hose Assembly Hydraulic Service |
| MIL-V-24695/3 | Adapter, Vent and Test Valve Hose Assembly |
| MIL-V-24722 | Valve and Subplate, Servo Flow-Control, Electro-hydraulic, General Specification for |
| MIL-V-24722/1 | Valve and Subplate, Servo Flow-Control, Electro-hydraulic for 0 to 50 GPM and 0 to 80 GPM Flow Ranges |
| MIL-V-24722/2 | Valve, Servo Flow-Control, Electrohydraulic for 0 to 10 GPM Flow Range |
| MIL-V-24722/3 | Valve and Subplate, Servo Flow-Control, Electro-hydraulic for 0 to 80 GPM |
| MIL-V-81940 | Valve, Sampling and Bleed, Hydraulic, Type II, Systems (QPL-81940) |
| MIL-V-81940/1 | Valve, Sampling and Bleed, Hydraulic, Type II Systems |
| MIL-V-81940/4 | Valve, Sampling and Bleed, Hydraulic, 3000 psi, Non-Aircraft Applications |

### 4.17.3 Military Standards

| | |
|---|---|
| AN6245 | Valve - Hydraulic Thermal Expansion Relief |
| AN6249 | Valve, 3000 PSI Hydraulic Check |
| MS18282 | Relief Valve Operating Characteristics Versus Maximum Operating Pressure for Liquid Service |
| MS18284 | Regulating and Control Valves Accuracy of Regulation Equipment |
| MS28764 | Valve, Check, Controllable, Rotary-Action, Hydraulic, 3000 PSI, Type II Systems |
| MS28765 | Valve, Check, Hydraulic, Internal Ports, 3000 PSI, Type II Systems |
| MS28766 | Valve, Shuttle, Hydraulic, Direct Mounting, 3000 PSI, Type II Systems |
| MS28767 | Valve, Shuttle, Hydraulic, Internal-Thread, Tube Fitting Outlet, 3000 PSI, Type II Systems |
| MS28768 | Valve, Check, Controllable Plunger-Type, Hydraulic, 3000 PSI, Type II Systems |
| MS28771 | Valve, Check, Hydraulic, Flared, 3000 PSI, Type II Systems |
| MS28881 | Valve - Hydraulic, Directional Control, Slide Selector 4 Way, 3000 PSI |
| MS28886 | Valve, Aircraft Hydraulic Flow Regulator |
| MS28887 | Valve, Relief, Cylindrical, Type II System |
| MS28890 | Valve, Hydraulic Check, 3000 PSI, Flareless, Type I Systems |
| MS28891 | Valve, Shuttle, Hydraulic, 3000 PSI, Direct Mounting |
| MS28892 | Valve, 3000 PSI, Hydraulic Check, Flareless, Type II Systems |
| MS28893 | Valve, Hydraulic Relief, Cylindrical, Type II Systems |

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### 4.18 Vibration, Noise, and Shock

4.18.1 INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE HIR1622 | Noise Control in Fluid Power Systems of Marine Vehicles (DoD adopted, ANSI approved) |
| NFPA T2.7.4M | Hydraulic fluid power - Pumps - Test code for the determination airborne noise levels (Technically similar to ISO 4421/1) |
| NFPA T2.7.5M | Hydraulic fluid power - Motors - Test code for the determination of airborne noise levels (Techncally similar to ISO 4412/2) |

4.18.2 MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-S-901 | Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for |

4.18.3 MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-167-1 | Mechanical Vibrations of Shipboard Equipment (Type I -Environmental and Type II - Internally Excited) |
| MIL-STD-740-1 | Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment |
| MIL-STD-740-2 | Structureborne Vibratory Acceleration Measurements and Criteria of Shipboard Equipment |

## *5. Notes*

**5.1** New documents are continually being developed by the various organizations which prepare standards. If a document reference for the subject of interest is not referenced herein, it is suggested that you review updated lists of standards published by the document sources listed herein.

**5.2** Specific recommendations for additions and deletions to the next revision of this information report are solicited.

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PREPARED BY THE SAE SHIP SYSTEMS AND EQUIPMENT COMMITTEE


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**SAE J1784/HIR4544 Cancelled AUG2000**

**Rationale—**This document was useful but difficult to keep updated . With various standards organization web sites, more curent information is readily available.

**Relationship of SAE Standard to ISO Standard—**Not applicable.

**Application—**This document lists military and industry specifications and standards that are considered to be of particular interest to designers of marine vehicle hydraulic systems. SAE AIR737 lists additional aerospace hydraulic documents which occasionally may have application in marine hydraulic systems (see 4.2.1).

**Reference Section**

**Accumulators**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP763 | Accumulators, Ground, Hydropneumatic Pressure |
| NFPA B93.78M | Hydraulic Fluid Power, Gas Loaded Accumulators with Separators, Range of Pressures and Volumes, Characteristic Quantities and Identification (Technically identical to ISO 5596) (Metric only) (ANSI approved) |

MILITARY SPECIFICATIONS AND STANDARDS

| | |
|---|---|
| MIL-A-5498 | Accumulators, Hydraulic, Cylindrical, 3000 PSI Aircraft (QPL-5498) |
| MIL-A-8897 | Accumulators, Hydraulic, Cylindrical, 3000 PSI, Aircraft, Type II Systems |
| MS28700 | Accumulator - Cylindrical, 3000 PSI (associated procurement spec: MIL-A-5498) |

**Communication (Drawings, Symbols, and Nomenclature)**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP485 | Temperature Measuring Devices Nomenclature |
| SAE AIR737 | Aerospace Hydraulic and Pneumatic Specifications and Standards (ANSI approved) |
| SAE AS1290 | Graphic Symbols for Aircraft Hydraulic and Pneumatic Systems (DoD adopted, ANSI approved) |
| SAE AIR1916 | Aerospace Fluid Power and Control Actuation System Glossary (ANSI approved) |
| SAE HRP4382 | Diagrams and Associated Tables for Hydraulic Systems of Marine Vehicles |
| SAE ARP4386 | Terminology and Definitions for Aerospace Fluid Power, Actuation and Control Technologies |
| SAE J916 | Rules for SAE Use of SI (Metric) Units, Recommended Practice (ANSI approved) |
| ASTM E 380 | Standard Practice for Use of the International System of Units (SI), the Modernized Metric System |
| ANSI B93.2 | Fluid Power Systems and Products - Glossary (NFPA T3.27.1, NFPA T3.10.3) |
| ANSI Y14.5M | Dimensioning and Tolerancing (DoD adopted) |
| ANSI Y32.10 | Graphic Symbols for Fluid Power Diagrams |
| ANSI Z35.1 | Accident Prevention Signs, Specifications forISO 5598Fluid Power Systems and Components - Vocabulary |
| NFPA T3.10.4M | Graphic Symbols for Hydraulic Fluid Power Filters and Separators for Use in Fluid Power Diagrams |

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MILITARY SPECIFICATIONS AND STANDARDS

| | |
|---|---|
| MIL-STD-12 | Abbreviations for Use on Drawings, and in Specifications, Standards, and Technical-Type Publications |
| MIL-STD-100 | Engineering Drawing Practices |
| MIL-STD-970 | Standards and Specifications, Order of Preference for the Selection of |
| DOD-D-1000 | Drawings, Engineering and Associated Lists |
| MS18282 | Relief Valve Operating Characteristics Versus Maximum Operating Pressure for Liquid Service |
| MS18284 | Regulating and Control Valves Accuracy of Regulation Equipment |

**Contamination Control and Cleanliness**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP598 | Determination of Particulate Contamination in Liquids by the Particle Count Method (DoD adopted, ANSI approved) |
| SAE ARP599 | Dynamic Test Method for Determining the Degree of Cleanliness of the Downstream Side of Filter Elements |
| SAE ARP1192 | Procedure for Calibration and Verification of Liquidborne Particle Counter: An Absolute Standard (ANSI approved) |
| SAE AS4059 | Aerospace-Cleanliness Classification for Hydraulic Fluids |
| SAE ARP4268 | Aerospace - Hydraulic System Fluid Contamination - Location of Sampling Points |
| ASTM D 95 | Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation (API MPMS Chapter 10.5) (British Standard 4385) (AASHTO No. T 55) (DoD adopted, ANSI approved) |
| ASTM D 1744 | Standard Test Method for Water in Liquid Petroleum Products by Karl Fischer Reagent (DoD adopted, ANSI approved) |
| ASTM D 4174 | Cleaning, Flushing, and Purification of Petroleum Fluid Hydraulic Systems, Standard Practice for (ANSI approved) |
| ASTM F 303 | Standard Practice for Sampling Aerospace Fluids from Components |
| AIA NAS 1638 | Cleanliness Requirements of Parts Used in Hydraulic Systems |
| ANSI B93.19M | Hydraulic Fluid Power - Particulate Contamination Analysis - Extraction of Fluid Samples from Lines of an Operating System (Technically Identical to ISO 4021) (NFPA T2.9.1) Metric Only |
| ISO 4402 | Hydraulic Fluid Power - Calibration of Automatic-Count Instruments for Particles Suspended in Liquids - Method Using Classified AC Fine Test Dust |
| ISO 4406 | Hydraulic Fluid Power - Fluids - Method for Coding Level of Contamination by Solid Particles [Note: The ISO 4406 coding method is more versatile than SAE AS 4059 and NAS 1638.] |
| NFPA B93.20M | Procedure for Qualifying and Controlling Cleaning Methods for Hydraulic Fluid Power Fluid Sample Containers (Technically Identical to ISO 3722) (NFPA T2.9.2) (ANSI approved) |
| NFPA T2.9.6 | Hydraulic Fluid Power - Calibration Method for Liquid Automatic Particle Counters Using Latex Spheres (Revision and Redesignation of ANSI B93.28) (ANSI approved) |
| NFPA T2.9.14 | Hydraulic fluid power - Fluid contaminant - Determination of solid contaminant level by the gravimetric method |
| NFPA T3.9.18 | Method of Establishing the Flow Degradation of Fixed Displacement Hydraulic Fluid Power Pumps When Exposed to Particulate Contaminant |

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MILITARY HANDBOOKS

| | |
|---|---|
| MIL-HDBK-201 | Petroleum Operations |
| MIL-HDBK-407 | Contamination Control Technology Precision Cleaning Methods and Procedures |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-C-5501 | Caps and Plugs, Protective, Dust and Moisture Seal (Associated Specification Sheets 1 through 30 according to mating connection) |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Hydraulic Power Transmission Equipment |
| MIL-STD-1246 | Product Cleanliness Levels and Contamination Control Program |

**Cylinders and Other Actuators**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE J214 | Hydraulic Cylinder Test Procedure, Recommended Practice (ANSI approved) |
| SAE J1195 | Cylinder Rod Wiper Seal Ingression Test, Recommended Practice (ANSI approved) |
| SAE J1334 | Hydraulic Cylinder Integrity Test, Recommended Practice |
| SAE J1336 | Hydraulic Cylinder Leakage Test, Recommended Practice |
| SAE J1374 | Hydraulic Cylinder Rod Seal Endurance Test Procedure, Recommended Practice |
| NFPA B93.1 | Dimension Identification Code for Fluid Power Cylinders; Appendices I and II (ANSI approved) |
| NFPA B93.3 | Fluid Power Systems and Products - Cylinder Bores and Piston Rod Diameters - Inch Series (NFPA T3.6.1) (ANSI approved) |
| NFPA B93.8 | Bore and Rod Size Combinations and Rod End Configurations for Cataloged Square Head Industrial Fluid Power Cylinders (NFPA T3.6.4) (ANSI approved) |
| NFPA B93.15 | Fluid Power Systems and Products - Square Head Industrial Cylinders - Mounting Dimensions (NFPA T3.6.7) (ANSI approved) |
| NFPA B93.52M | Fluid Power System and Products - Cylinder Bores and Piston Rod Diameters - Metric Series (NFPA T3.6.33M) (Technically Identical to ISO 3320) (ANSI approved) |
| NFPA B93.75M | Hydraulic Fluid Power, Cylinder Ports, SAE Straight Thread O-Ring and 4-Bolt Flange Ports, Heavy Duty and Light Duty Cylinders (NFPA T3.6.54M) (ANSI approved) |
| NFPA B93.84M | Fluid Power Systems and Components - Cylinders - Identification Code for Mounting Dimensions and Mounting Types (Technically Identical to ISO 6099) Metric Only (ANSI approved) |
| NFPA B93.92M | Hydraulic Fluid Power, Cylinders, Bore and Rod Area Ratios (Technically Identical to ISO 7181) Metric Only (ANSI approved) |
| NFPA B93.104M | Hydraulic Fluid Power, Single Rod Cylinders, 160 Bar (16 MPa) Medium and 250 Bar (25 MPa) Series, Mounting Dimensions for Accessories (Technically Identical to ISO 8136) Metric Only (ANSI approved) |

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MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-A-24533 | Actuators, Rotary, Hydraulic |
| MIL-A-47312 | Actuator, Hydraulic |
| MIL-R-52411 | Rams, Hydraulic, 10,000 PSI |

**Fasteners**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| AIA NAS 1351 | Screw, Cap, Socket Head - Undrilled and Drilled, Plain and Self-Locking, Alloy Steel and Corrosion-Resisting Steel UNRF-3A (DoD adopted) |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-I-8846 | Inserts, Screw-Thread, Helical Coil |
| MIL-F-18240 | Fastener Element, Self-Locking, Threaded Fastener, 250 Deg. F Maximum (QPL-18240) |
| MIL-N-25027 | Nut, Self-Locking, 250 Deg. F, 450 Deg. F, 800 Deg. F (QPL-25027) |
| MIL-N-25027/1 | Nut, Self-Locking, Heavy Hex, (Non-Metallic Insert) 250 Deg. F, UNJC-3B, 1/4 through 2-1/2 Inch Nominal Diameters, Nickel-Copper Alloy |
| MIL-I-45910 | Insert, Screw Thread-Locked In and Ring Locked, Serrated, General Specification for |
| MIL-I-45932 | Insert, Screw Thread, Thin Wall, Locked In: General Specification for |
| MIL-I-45932/1 | Insert, Screw Thread - Thin Wall, Locked In |
| MIL-I-45932/2 | Insert, Screw Thread - Thin Wall, Locked In |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-1251 | Screws and Bolts, Preferred for Design, Listing of |
| MIL-STD-1515 | Fastener Systems for Aerospace Applications |
| MIL-STD-1754 | Fastening Devices Preferred for Design, Listing of |
| MIL-STD-1759 | Rivets and Rivet Type Fasteners Preferred for Design, Listing of |
| MIL-STD-1764 | Washers, Preferred for Design, Listing of |
| MIL-STD-1903 | Nuts, Preferred for Design, Listing of |
| MS20995 | Wire, Safety or Lock |
| MS33540 | Safety Wiring and Cotter Pinning, General Practices for |
| MS33547 | Pins, Spring, Functional Limitations of |

**Filters**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE AIR887 | Liquid Filter Ratings, Parameters and Tests (ANSI approved) |
| SAE AIR901 | Bubble-Point Test Method |
| NFPA T3.10.8.4M | Method for Determining the Fabrication Integrity of a Hydraulic Fluid Power Filter Element |
| NFPA T3.10.8.5M | Hydraulic Fluid Power - Filter Elements - Verification of Collapse/Burst Resistance |
| NFPA T3.10.8.6M | Hydraulic Fluid Power - Filter Elements - Verification of Material Compatibility with Fluids |
| NFPA T3.10.8.7M | Method for Verifying the Flow Fatigue Characteristics of a Hydraulic Power Filter Element |

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| | |
|---|---|
| NFPA T3.10.8.8 | Hydraulic Fluid Power - Filters - Multi-Pass Method for Evaluating Filtration Performance, First Edition (Revision and Redesignation of ANSI B93.31) |
| NFPA T3.10.18M | Multi-Pass Method for Evaluating the Filtration Performance of a Coarse Hydraulic Fluid Power Filter Element |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-F-5504 | Filters and Filter Elements, Fluid Pressure, Hydraulic Micronic Type (QPL-5504) |
| MIL-F-8815 | Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and 5 Micron Absolute, Type II Systems (QPL-8815) |
| MIL-F-8815/1 | Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style A, Bypass, -65 DEG. to +275 DEG. F |
| MIL-F-8515/2 | Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style B, Non Bypass, -65 DEG. to +275 DEG. F. |
| MIL-F-8815/3 | Filter Element, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, -65 DEG. F to +275 DEG. F |
| MIL-F-24402 | Filters (Hydraulic), Filter Elements (High Efficiency), and Filter Differential Pressure Indicators, General Specification for (QPL-24402) |
| MIL-F-24402/1 | Filter Housings, Hydraulic, Single Element |
| MIL-F-24402/2 | Filter Housings, Hydraulic, Duplex |
| MIL-F-24402/3 | Filter Housings, Hydraulic, Three Elements |
| MIL-F-24402/4 | Filter Elements, Hydraulic, Disposable |
| MIL-F-24402/5 | Filter Indicators, Differential Pressure, Hydraulic |
| MIL-F-24702 | Filter Elements, Hydraulic, Disposable, General Specification for (Metric) (QPL-24702) |
| MIL-F-24702/1 | Filter Elements, Hydraulic, Disposable (Metric) |
| MIL-F-24724 | Filter Housings (Hydraulic) and Differential Pressure Indicators, General Specification for |
| MIL-F-24724/1 | Filter Housings (Hydraulic) and Differential Pressure Indicators, (1, 2, 3 Elements) |
| MIL-F-24724/2 | Filter Housings (Hydraulic) and Differential Pressure Indicators, (4 and 6 Elements) |
| MIL-F-27656 | Filter Unit, Fluid, Pressure, MXU-408/M, Absolute, 5 Micron, Hydraulic |

MILITARY STANDARDS

| | |
|---|---|
| AN6235 | Filter Element - Hydraulic Replaceable Micronic Line Type |
| AN6236 | Filter Element - Hydraulic Replaceable Micronic Reservoir Type |
| AN6237 | Filter Element - Hydraulic Replaceable Micronic Vent Type |
| AN6238 | Gasket - Hydraulic Replaceable Reservoir Type Filter Element |
| AN6240 | Filter - Hydraulic Replaceable Vent Type |
| MS28720 | Filter, Aircraft Hydraulic Line Type |

OTHER PUBLICATIONS

Wilcox, Wayne K., “Selection Parameters for Hydraulic System Filters with a Comparison of Aircraft and Marine Applications,” Naval Engineers Journal, Sept. 1987, Vol. 99, No. 5, pp. 62-70

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## Fluids

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE AIR81 | Hydraulic Fluid Characteristics |
| SAE AIR1116 | Fluid Properties |
| SAE HIR1149 | Hydraulic Fluids for Marine Vehicles |
| SAE AIR1362 | Physical Properties of Hydraulic Fluids |
| ASTM D 92 | Standard Test Method for Flash and Fire Points by Cleveland Open Cup (AASHTO No. T48) (DIN 51 376) (ANSI approved) |
| ASTM D 445 | Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (And the Calculation of Dynamic Viscosity) (British Standard 4708) (IP Designation: 71/84) (ANSI approved) |
| ASTM D 664 | Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration (British Standard 4457) (IP 177/83) (ANSI approved) |
| ASTM D 974 | Standard Test Method for Acid and Base Number by Color-Indicator Titration (British Standard 2634) (IP 139/86) (ANSI approved) |
| ASTM D 2272 | Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Bomb (ANSI approved) |

MILITARY HANDBOOKS

| | |
|---|---|
| MIL-HDBK-200 | Quality Surveillance Handbook for Fuels, Lubricants, and Related Products |
| MIL-HDBK-267 | Guide for Selection of Lubricants and Hydraulic Fluids for Use in Shipboard Equipment |
| MIL-HDBK-290 | Packaging of Petroleum and Related Products |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-H-5559 | Hydraulic Fluid, Arresting Gear |
| MIL-H-5606 | Hydraulic Fluid, Petroleum Base: Aircraft, Missile, and Ordnance (QPL-5606) |
| MIL-H-6083 | Hydraulic Fluid, Petroleum Base, for Preservation and Operation (QPL-6083) |
| MIL-F-17111 | Fluid, Power Transmission (QPL-17111) |
| MIL-L-17331 | Lubricating Oil, Steam Turbine and Gear, Moderate Service (QPL-17331) |
| MIL-H-17672 | Hydraulic Fluid, Petroleum, Inhibited (QPL-17672) |
| MIL-H-19457 | Hydraulic Fluid, Fire Resistant, Non-Neurotoxic (QPL-19457) |
| MIL-H-22072 | Hydraulic Fluid, Catapult, NATO Code Number H-579 (QPL-22072) |
| MIL-S-81087 | Silicone Fluid, Chlorinated Phenyl Methyl Polysiloxane, NATO Code Number H-536 (QPL-81087) |
| MIL-H-83282 | Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon (QPL-83282) |

## Hoses and Hose Fittings

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE ARP603 | Impulse Testing of Hydraulic Hose, Tubing, and Fitting Assemblies (DoD adopted, ANSI approved) |
| SAE AS604 | Hose Assembly, Tetrafluoroethylene, 400 Degrees F, 3000 psi, Hydraulic, Heavyweight (ANSI approved) |
| SAE AS614 | Hose Assembly, Tetrafluoroethylene, Heavy Duty, High Pressure, 4000 psi (27,580 kPa) Hydraulic and Pneumatic (DoD adopted) |
| SAE AS620 | High Temperature Hose Assembly, Convoluted Tetrafluoroethylene, for Aircraft |
| SAE AS1339 | Hose Assembly, Tetrafluoroethylene, 400°F, 3000 psi Hydraulic, Lightweight (DoD adopted) |

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| | |
|---|---|
| SAE AS1624 | Hose, Polytetrafluoroethylene (TFE), Lightweight 3000 psi, High Temperature, Hydraulic and Pneumatic |
| SAE J516 | Hydraulic Hose Fittings, Standard (ANSI approved) |
| SAE J517 | Hydraulic Hose, Standard (ANSI approved) |
| SAE J1273 | Selection, Installation, and Maintenance of Hose and Hose Assemblies, Recommended Practice (ANSI approved) |
| SAE J1475 | Hydraulic Hose Fittings for Marine Application, Standard (ANSI approved) |
| SAE J1927 | Cummulative Damage Analysis for Hydraulic Hose Assemblies, Information Report |
| SAE J1942 | Hose and Hose Assemblies for Marine Application, Standard (ANSI approved) |
| NFPA B93.100M | Hydraulic Fluid Power - Hose Assemblies - Method of Test (Technically Identical to ISO 6605) Metric Only (ANSI approved) |

FEDERAL STANDARDS

| | |
|---|---|
| FED-STD-162 | Hose Rubber, Visual Inspection Guide For |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-H-24135 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, General Specification for (QPL-24135) |
| MIL-H-24135/1 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid or Two-Spiral and One-Wire Braid, High Pressure, Sizes -4 through -32) |
| MIL-H-24135/2 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, (Four Plies, Spiral-Wrapped or Two Plies, Spiral-Wrapped and One Ply, Braided High Pressure, Sizes-6 through -16) |
| MIL-H-24135/3 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Spiral-Wrapped, Braided High Pressure, Sizes -16 through -32) |
| MIL-H-24135/4 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid for Medium Pressure, Sizes -40, -48 and -64) |
| MIL-H-24135/5 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid, Perforated Cover for High Pressure Air, Sizes -4 through -32) |
| MIL-H-24135/6 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Double-Wire Braid or Two-Sprial and One Wire Braid, High Pressure, Sizes -4 through -32, for Phosphate-Ester Base Hydraulic Fluids) |
| MIL-H-24135/7 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Heavy Spiral Wire for High Pressure Phosphate Ester, Sizes -20, -24 and -32) |
| MIL-H-24135/8 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Spiral Wrapped Wire, High Pressure, for Phosphate Ester Base Fluids, Sizes -6 through -16) |
| MIL-H-24135/9 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Four Plies, Heavy Spiral Wrapped Wire, High Pressure, Sizes -8 through -32) |
| MIL-H-24135/10 | Hose, Synthetic Rubber, Wire Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Single or Double Wire Braid, Medium Pressure Sizes -4 through -48) |
| MIL-H-24136 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies, General Specification for (QPL-24136) |

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|---|---|
| MIL-H-24136/2 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (High Pressure, Sizes -4 through -32) |
| MIL-H-24136/3 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Low Pressure, Sizes -4 through -32) |
| MIL-H-24136/4 | Hose, Synthetic Rubber, Synthetic Fiber Reinforced, and End Fittings, Reusable, for Flexible Hose Assemblies (Low Pressure, Sizes -40, -48 and -64) and Adaptors |
| MIL-H-24239 | Hose Assemblies, Hydraulic, Nonmagnetic, for Minesweeping Tensiometers |
| MIL-H-24592 | Hose Assembly, Tetrafluoroethylene Tube, Non-collapsible, High Temperature |
| MIL-H-24595 | Hose, Wire Reinforced Large-Diameter with Reuseable End Fittings for Flexible Connections |
| MIL-H-25579 | Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure (QPL-25579) |
| MIL-H-27267 | Hose, Tetrafluoroethylene, High Temperature, Medium Pressure (QPL-27267) |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-438 | Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarines |
| MIL-STD-777 | Schedule of Piping, Valves, Fittings and Associated Piping Components for Surface Ships |

**Materials and Coatings**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE HIR1694 | Materials for Fluid Systems of Marine Vehicles<br>[Provides guidance on materials suitable for use in sea water and the general marine environment] |
| ASTM E 208 | Standard Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels |
| ANSI B46.1 | Surface Texture, Surface Roughness, Waviness and Lay (DoD adopted) |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-S-81733 | Sealing and Coating Compound, Corrosion Inhibitive (QPL-81733) |
| MIL-C-83982 | Compound, Sealing, Fluid Resistant (QPL-83982) |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-889 | Dissimilar Metals |
| MIL-STD-1516 | Unified Code for Coatings and Finishes for DoD Materiel |
| MIL-STD-2193 | Hydraulic System Components, Ship [Provides guidance on material selection and coatings for corrosion resistance] |

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## Miscellaneous Components

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-S-9395 | Switches, Pressure, (Absolute, Gage, and Differential), General Specification for (QPL-9395 and associated specification sheets 1 through 48 according to switch type and amperes) |
| MIL-C-15730 | Coolers, Fluid, Naval Shipboard: Lubricating Oil, Hydraulic Oil, and Fresh Water |
| MIL-I-17244 | Indicators, Temperature, Direct-Reading, Bimetallic (3-inch and 5-inch dial) |
| MIL-M-17508 | Mounts, Resilient, Types 6E2000, 6E900, 6E900BB, 7E450, 7E450BB, 6E150, and 6E100 (QPL-17508) |
| MIL-G-18997 | Gauge, Pressure, Dial Indicating |
| MIL-A-24533 | Actuators, Rotary, Hydraulic |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-1762 | Bearings and Bushings, Plain, Preferred for Design, Listing of |
| MIL-STD-2193 | Hydraulic System Components, Ship |

## Piping and Tubing

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE AMS 4943 | Titanium Alloy Tubing, Seamless, Hydraulic, 3.0 Al - 2.5V Annealed |
| SAE AMS 4944 | Titanium Alloy Tubing, Seamless, Hydraulic, 3.0 Al - 2.5V Cold Worked, Stress Relieved |
| SAE AMS 4945 | Titanium Alloy Tubing, Seamless, Hydraulic, 3 Al - 2.5V, Texture Controlled, 105,000 psi (724 MPa) Yield Strength |
| SAE AMS 5561 | Steel Tubing, Welded and Drawn, Corrosion and Heat Resistant 9.0 Mn - 20 Cr - 6.5 Ni - 0.28N High Pressure Hydraulic (DoD adopted) |
| SAE ARP584 | Coiled Tubing, Corrosion Resistant Steel, Hydraulic Applications (ANSI approved) |
| SAE ARP994 | Recommended Practice for the Design of Tubing Installations for Aerospace Fluid Power Systems (DoD adopted) |
| SAE ARP4146 | Coiled Tubing - Titanium Alloy, Hydraulic Applications |
| SAE J1065 | Pressure Ratings for Hydraulic Tubing and Fittings, Information Report |
| ASTM A 312 /A312M | Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes (DoD adopted) |
| NFPA B93.4M | Hydraulic Fluid Power - Line Tubing - Electric Resistance Welded, Mandrel Drawn (NFPA T3.6.1) (ANSI approved) |
| NFPA B93.59M | Fluid Power Systems and Products - Connectors and Associated Components - Outside Diameters of Tubes and Inside Diameters of Hoses, Appendix (NFPA T3.8.22M) (Technically Identical to ISO 4397) Metric Only (ANSI approved) |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-T-1368 | Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded |
| MIL-T-16420 | Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Number 715 and 706) |
| MIL-T-24107 | Tube, Copper (Seamless) (Copper Alloy Numbers C10100, C10200, C10300, C10800, C12000, C12200, and C14200) |
| MIL-P-24691 | Pipe and Tube, Carbon, Alloy and Stainless Steel, Seamless and Welded, General Specification for |
| MIL-P-24691/1 | Pipe and Tube, Carbon Steel, Seamless |

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| MIL-P-24691/2 | Pipe and Tube, Chromium-Molybdenum Steel, Seamless |
| MIL-P-24691/3 | Pipe and Tube, Corrosion Resistant, Stainless Steel, Seamless or Welded |

MILITARY STANDARDS

| | |
|---|---|
| MIL-STD-278 | Welding and Casting Standard |
| MIL-STD-419 | Cleaning, Protecting, and Testing Piping, Tubing, and Fittings for Hydraulic Power Transmission Equipment |
| MIL-STD-438 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service |
| MIL-STD-777 | Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships |
| MIL-STD-798 | Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI-Shock Test Requirements for Piping System Components for Naval Shipboard Use |
| MIL-STD-1627 | Bending of Pipe or Tube for Ship Piping Systems |

**Piping and Tubing Fittings**

INDUSTRY PUBLICATIONS

| | |
|---|---|
| SAE J514 | Hydraulic Tube Fittings, Standard (DoD adopted, ANSI approved) |
| SAE J518 | Hydraulic Flanged Tube, Pipe, and Hose Connections, 4-Bolt Split Flange Type, Standard (DoD adopted, ANSI approved) |
| SAE J1065 | Pressure Ratings for Hydraulic Tubing and Fittings, Information Report |
| SAE J1453 | Fitting O-Ring Face Seal, Standard |
| SAE J1926 | Specification for Straight Thread, O-Ring Boss Port, Standard |
| SAE MA2012 | Port Connection Internal, Straight Thread, Metric |
| ANSI B16.5 | Pipe Flanges and Flanged Fittings (DoD adopted) (ASME copyrighted) |
| ANSI B16.9 | Factory-Made Wrought Steel Buttwelding Fittings (DoD adopted) (ASME copyrighted) |
| ANSI B16.11 | Forged Steel Fittings, Socket-Welding and Threaded (DoD adopted) (ASME copyrighted) |

MILITARY SPECIFICATIONS

| | |
|---|---|
| MIL-F-1183 | Fittings, Pipe, Cast Bronze, Silver-Brazing, General Specification for (associated specification sheets 1 through 12 according to pipe configuration) |
| MIL-F-18280 | Fittings, Flareless Tube, Fluid Connection (QPL-18280) |
| MIL-F-18866 | Fittings, Hydraulic Tube, Flared, 37 Degree and Flareless, Steel |
| MIL-F-20236 | Fittings, Tube and Pipe, Butt-Welding, 300 PSI and 775 Deg. F Maximum |
| MIL-F-24202 | Fittings, Butt Welding, Seamless or Welded, 70-30 Copper - Nickel Alloy, 700 PSI, 200 Deg. F (QPL has been cancelled) |
| MIL-F-24227 | Fittings and Flanges, Cast Bronze, Silver Brazing Suitable for Ultrasonic Inspection |
| MIL-F-24704 | Flanges, Four Bolt Square, Hydraulic, General Specification for |
| MIL-F-24704/1 | Flanges, Four Bolt Square, Socket Weld for Hydraulic Systems |
| MIL-F-24704/2 | Flanges, Four Bolt Square, Butt Weld for Hydraulic Systems |
| MIL-F-24704/4 | Flanges, Four Bolt Square, Blind for Hydraulic Systems |
| MIL-F-24704/5 | Flanges, Four Bolt, Insert Rings for Hydraulic Systems |
| MIL-C-24714 | Connector Tubes, Hydraulic Component, General Specification for |
| MIL-C-24714/1 | Connector Tubes, Preferred Sizes, Valves and Subplates |
| MIL-C-25427 | Couplings, Assembly, Hydraulic, Self-Sealing Quick Disconnect (QPL-25427) |

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