



AEROSPACE RECOMMENDED PRACTICE

ARP4943™**REV. A**

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Superseding ARP4943

(R) Ground Support Equipment Hydraulic Systems,
Design and Installation, Recommended Practices for

RATIONALE

ARP4943 has been updated to Revision A for the following reasons:

- a. Minor technical changes have been made;
- b. Applicable Document references have been updated;
- c. Editorial changes have been made to improve the readability of the document.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) covers the design and installation requirements for hydraulic systems (up to 8000 psig [56 MPa]) for ground support equipment (GSE). This ARP is derived from AS5440, which provides hydraulic system requirements for aircraft. The recommendations herein are primarily intended for GSE that exchange hydraulic fluid with the aircraft, such as hydraulic service carts, rather than GSE with non-interfacing hydraulic systems. The GSE may be mobile, portable, or stationary.

1.1 Classification

The hydraulic systems defined by this document shall be capable of servicing aircraft systems and components of all types and classes defined in AS5440. The terminology, Class XXXX, where XXXX is the GSE system pressure, is utilized within this document.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS3384	Rubber, Fluorocarbon Elastomer (FKM), 70 to 80 Hardness, Low Temperature Sealing Tg -22 °F (-30 °C), for Elastomeric Shapes or Parts in Gas Turbine Engine Oil, Fuel, and Hydraulic Systems
AMS4081	Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T4), Solution Heat Treated and Naturally Aged
AMS4083	Aluminum Alloy Tubing, Hydraulic, Seamless, Drawn, Round, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061-T6), Solution and Precipitation Heat Treated
AMS5561	Steel, Corrosion- and Heat-Resistant, Welded and Drawn or Seamless and Drawn Tubing, 9.0Mn - 20Cr - 6.5Ni - 0.28N, High-Pressure Hydraulic
AMS5566	Steel, Corrosion-Resistant, Seamless or Welded Hydraulic Tubing, 19Cr - 10Ni (304), High Pressure, Cold Drawn
AMS-P-83461	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275 °F (135 °C)
AIR1657	Handbook of Hydraulic Metric Calculations
AIR1922	Aerospace - System Integration Factors That Affect Hydraulic Pump Life
ARP584	Coiled Tubing - Corrosion-Resistant Steel, Hydraulic Applications, Aerospace
ARP994	Design of Tubing Installations for Aerospace Hydraulic Systems
ARP4835	Aerospace Fluid Power - Hydraulic Thermal Expansion Relief Valves
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

AS4059	Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids
AS4157	Coupling Assemblies, Hydraulic, Self-Sealing, Quick Disconnect, 8000 Pounds per Square Inch, Gage
AS4330	Tubing, Flared, Standard, Dimensions for, Design Standard
AS4395	Fitting End, Flared, Tube Connection, Design Standard
AS4396	Fitting End, Bulkhead, Flared, Tube Connection, Design Standard
AS4716	Gland Design, O-Ring and Other Seals
AS5440	Hydraulic Systems, Military Aircraft, Design and Installation, Requirements for
AS5781	Retainers (Backup Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Single Turn, Scarf-Cut, for Use in AS4716 Glands
AS5782	Retainers (Backup Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Solid, Un-Cut, for Use in AS4716 Glands
AS5857	Gland Design, O-Ring and Other Elastomeric Seals, Static Applications
AS5860	Retainers (Backup Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Single Turn, Scarf-Cut, for Use in AS5857 Static Glands
AS5861	Retainers, (Backup Rings), Hydraulic and Pneumatic, Polytetrafluoroethylene Resin, Solid, Un-Cut, for Use in Static Glands to AS5857
AS6235	Face Seal Gland Design, Static, O-Ring and Other Seals, for Aerospace Hydraulic and Pneumatic Applications
AS8791	Hydraulic and Pneumatic Retainers (Backup Rings), Polytetrafluoroethylene (PTFE) Resin
AS33514	Fitting End, Standard Dimensions for Flareless Tube Connection and Gasket Seal
AS33515	Fitting End, Standard Dimension for Bulkhead Flared and Tube Connections
AS33583	Tubing End, Double Flare, Standard Dimensions for
AS33611	Tube Bend Radii
AS85421	Fittings, Tube, Fluid Systems, Separable, Beam Seal, 3000/4000 psi, General Specification for
AS85720	Fittings, Tube, Fluid Systems, Separable, High-Pressure Beam Seal, 5000/8000 psi, General Specification for
SAE J1926/1	Specification for Straight Thread O-Ring Boss Port

2.1.2 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

AN 929	Cap Assembly, Pressure Seal Flared Tube Fitting
MIL-DTL-9395	Switches, Pressure
MIL-DTL-25427	Coupling Assembly, Hydraulic, Self-Sealing, Quick Disconnect
MIL-DTL-81940	Valve, Sampling and Bleed, Hydraulic
MIL-F-8815	Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 5 and 15 Micron Absolute, Type II Systems
MIL-G-5514	Gland Design, Packings, Hydraulic, General Requirements for
MIL-HDBK-470	Maintainability Program for Systems and Equipment
MIL-HDBK-502	Logistics Support Analysis
MIL-HDBK-781	Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production
MIL-P-24691	Pipe and Tube, Carbon Alloy and Stainless, Seamless and Welded, General Specification
MIL-PRF-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile and Ordnance
MIL-PRF-28800	Test Equipment for Use with Electrical and Electronic Equipment
MIL-PRF-81836	Filter, Fluid, Pressure, Hydraulic, 5000/8000 psi, 3 Micron, Style A, Mechanical Indicator
MIL-PRF-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft
MIL-PRF-87257	Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base Aircraft and Missile
MIL-STD-882	System Safety Program Requirements
MIL-STD-889	Dissimilar Metals
MIL-STD-1247	Marking, Functions and Hazard Designation of Hose, Pipe, and Tube Lines for Aircraft, Missile and Space Systems
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
MIL-T-8504	Tubing, Steel, Corrosion Resistant 304, Aerospace Vehicle Hydraulic Systems, Annealed, Seamless and Welded
MIL-V-8813	Valves, Aircraft, Hydraulic Pressure Relief, Type II System
MS21344	Fittings, Installation of Flared Tube, Straight Thread
WD ASTM PS93	Resin, Polyamide, Hot-Pressed or Pressed and Sintered

2.1.3 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A312 Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

ASTM A376 Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes, High Temperature

2.2 Acronyms and Abbreviations

The procurement activity will define any peculiar abbreviations and acronyms used for clarity and understanding.

2.3 Definitions

The procurement activity will provide any nonstandard definitions.

3. REQUIREMENTS

3.1 Materials

Materials used in the manufacture of GSE hydraulic systems shall be high quality, industrial components suitable for the purpose and shall conform to applicable standards identified herein. Where no standard is specified, and the procuring activity has not specified one, materials conforming to contractor's specifications may be used, provided that they are equivalent to the industrial standards.

3.1.1 Dissimilar Metals

Unless protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in MIL-STD-889.

3.2 Design

The hydraulic systems and components thereof shall be designed to operate satisfactorily under all conditions that the GSE may encounter within the structural limitations of the GSE, including forces or conditions caused by specified acceleration or deceleration rates.

3.3 Fluid

Fluid shall be as specified by the procurement activity. Fluid conforming to MIL-PRF-83282 or MIL-PRF-87257 is preferred for ground support equipment systems rated at 4000 psig (28 MPa) or greater. Other fluids may be utilized where applicable at operating pressures below 4000 psig (28 MPa). Fire retardant fluids such as those conforming to AS1241 require special care and handling and may pose safety hazards to the operator. Preservative fluids may be utilized, but only with the approval of the procurement activity.

3.4 Seals

Seal materials shall be compatible with the specified fluid. To maximize utilization, consider materials mutually compatible with several fluids, such as MIL-PRF-5606, MIL-PRF-83282, and MIL-PRF-87257. For static applications, O-ring packing squeeze shall be a minimum of 10% at the most adverse tolerance conditions. O-ring packings with cross section widths of 0.070 inch (1.8 mm) or less are not recommended for dynamic applications.

3.4.1 Gland Design

Seal gland dimensions shall conform to the requirements of AS4716, AS5857, or AS6235, except for specialized proprietary packings. Nonstandard glands shall be used only with the specific approval of the procurement activity. Care shall be taken to prevent binding and interference at the most adverse temperature extremes. Standard clearance may be used for system pressure levels greater than 3000 psig (21 MPa) and the seal life improved by using proprietary type packings, shapes and high modulus backup ring materials.

3.4.2 Packings

O-ring packings shall conform to AMS-P-83461 series, AMS3384, or made from other compounds compatible with the specified fluid in the AMS3300 and AMS7200 series. Packing configurations other than O-rings may be used in standard glands with the approval of the procurement activity.

3.4.3 Backup Rings

Backup rings shall conform to AMS, AS8791. Nonstandard backup rings may be used for systems with pressure level greater than class 3000, subject to the approval of the procurement activity.

3.5 General System Design

Hydraulic systems shall be as simple and fool-proof as possible and in accordance with design, operation, inspection, and maintenance objectives.

3.5.1 Fluid Temperature Limitations

3.5.1.1 Nonoperating/Storage

The hydraulic system shall be able to withstand temperatures of -65 to +275 °F (-54 to 135 °C) with relative humidity (condensing) ranging up to 100%.

3.5.1.2 Operating

The hydraulic system shall be capable of operating within temperatures of -40 to +240 °F (-40 to 116 °C) with relative humidity (noncondensing) ranging up to 95%. The system shall have an overtemperature shutdown capability to prevent damage to aircraft systems, where applicable.

3.5.2 Fluid System Temperature

Unless otherwise specified by the procurement activity, it is recommended that fluid system temperature be controllable between +80 °F (27 °C) (or ambient if higher) and +160 °F (71 °C) as measured at the outlet of the GSE. The temperature controller shall be capable of maintaining set temperature at ± 5 °F (± 3 °C) in the manual mode (operator selected set temperature) of operation or ± 5 °F (± 3 °C) in the automatic mode of operation. See 3.7.11.3 for fluid operating limitations.

3.5.3 Fire Hazards

The hydraulic system shall be so designed and installed with other systems that it will eliminate or isolate the system(s) from fire hazards caused by proximity of combustible gases, heat sources, or electrical ignition sources. Hydraulic lines and equipment located in the vicinity of heat and ignition sources that may cause spontaneous ignition or sustained fire of hydraulic leakage from these lines or equipment shall be protected by devices such as firewalls, shrouds, or equivalent means that will prevent fluid ignition. When electric motors, switches and other sources of sparks are installed in the same compartment as hydraulic equipment, the electrical equipment shall be above the hydraulic equipment.

3.5.4 Loads

The installation of hydraulic systems and components shall be designed to withstand 1.5 times the operational static and dynamic loads which are not of hydraulic nature. The installation shall be designed to withstand such loads when applied simultaneously with the appropriate hydraulic pressure requirements identified in 3.5.5.