MIL-H-25475B
29 April 1971
SUPERSEDING
MIL-H-25475A
19 January 1961

MILITARY SPECIFICATION

HYDRAULIC SYSTEMS, MISSILE, DESIGN, INSTALLATION AND TESTS, GENERAL REQUIREMENTS FOR

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the design, installation, and testing of missile hydraulic systems.

1.2 Classification. Missile hydraulic systems shall be of the following types and class, as specified:

Type I	-	-65° to +160°F temperature range
Type II	-	-65° to +275°F temperature range
Type III	-	-65° to +450°F temperature range
Type IV	-	Temperature ranges extending above +450°F
Class	-	3,000 pounds per square inch (psi), where the cutout pressure at the main pressure controlling device is 3,000 psi

2. APPLICABLE DOCUMENTS

* 2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

WW-T-700/4	Tube, Aluminum Alloy, Drawn, Seamless, 5052

Military

MIL-B-5087	Bonding, Electrical, and Lightning Protection, for Aerospace Systems
MIL-A-5498	Accumulators, Aircraft Hydropneumatic Pressure
MIL-F-5509	Fittings, Flared Tube, Fluid Connection
MIL-P-5510	Packing, Preformed, Straight Thread Tube Fitting Boss
MIL-J-5513	Joints, Hydraulic Swivel

MIL-G-5514	Gland Design; Packings, Hydraulic, General Requirements for
MIL-P-5516	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160°F
MIL-V-5523	Valve; Relief, Hydraulic Pressure
MIL-H-5606	Hydraulic Fluid, Petroleum Base: Aircraft, Missile, and Ordnance
MIL-H-6083	Hydraulic Fluid, Petroleum Base, for Preservation and Testing
MIL-T-6845	Tubing, Steel, Corrosion-Resistant (304), Aerospace Vehicle Hydraulic System 1/8 Hard Condition
MIL-T-7081	Tube, Aluminum Alloy, Seamless, Round, Drawn, 6061, Aircraft Hydraulic Quality
MIL-M-7997	Motors, Aircraft Hydraulic, Constant Displacement
MIL-W-8160	Wiring, Guided Missile, Installation of, General Specification for
MIL-G-8348	Gage Assemblies, Air Pressure, Dial Indicating Chuck Type, Self-Contained
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 Systems
MIL-F-18280	Fittings, Flareless Tube, Fluid Connection
MIL-C-25427	Coupling Assembly, Hydraulic, Self-Sealing, Quick Disconnect
MIL-H-25579	Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure
MIL-P-25732	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 275°F
MIL-H-38360	Hose Assembly, Tetrafluoroethylene, High Temperature, High Pressure, Hydraulic and Pneumatic

STANDARDS

Military

MIL-STD-100	Engineering Drawing Practices
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-1247	Markings, Functions and Hazard Designations of Hose, Pipe, and Tube Lines for Aircraft, Missile, and Space Systems
MS21919	Clamp, Cushioned, Support, Loop-Type, Aircraft
MS24333	Coupling Assembly, Hydraulic, Self-Sealing, Quick Disconnect, Flared Fitting to Internal Thread Boss
MS24334	Coupling Assembly, Hydraulic, Self-Sealing, Flareless Fitting to Internal Thread Boss
MS33566	Fittings, Installation of Flareless Tube, Straight-Threaded Connectors
MS33583	Tubing End - Double Flare, Standard Dimensions for
MS33584	Tubing End - Standard Dimensions for Flared

MS33611	Tube Bend Radii
MS33620	Chart, Hose Selection
MS33656	Fitting End, Standard Dimensions for Flared Tube Connection and Gasket Seal
MS33657	Fitting End, Standard Dimensions for Bulkhead Flared Tube Connection

Air Force-Navy Aeronautical

AN929	Cap Assembly, Pressure Seal Flared Tube Fitting
AND10064	Fittings - Installation of Flared Tube, Straight Threaded Connectors

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

* 2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Society of Automotive Engineers, Inc.

Aerospace Recommended Practice

ARP 584	Coiled Tubing

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Two Pennsylvania Plaza, New York, New York 10001.)

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

3. REQUIREMENTS

3.1 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified herein shall be selected in accordance with procedures established by the procuring activity.

3.2 Materials. Materials used in the manufacture of hydraulic systems in military missiles shall be of high quality, suitable for the purpose, and shall conform to applicable Government specifications and standards. Materials conforming to the contractor's specifications may be used provided it can be clearly demonstrated that they are at least equivalent to Government specifications with respect to operating characteristics and that a savings in weight or

cost can be accomplished. Contractor's specifications must be satisfactory to the Government and contain provisions for adequate tests. The use of contractor's specifications will not constitute waiver of Government inspection.

3.3 Fluids

* 3.3.1 Fluids - types I and II systems. If compatible with the system requirements, only fluids conforming to MIL-H-5606 or MIL-H-6083 shall be used in the types I and II hydraulic systems or in test stands used for ground testing of these hydraulic systems. Alternate fluids may be used when approved by the procuring activity. All components shall be flushed with the operational fluid prior to installation. If components are to be shipped in a filled condition, they shall be filled with fluids conforming to the system fluid specification.

3.3.2 Fluids - types III and IV systems. Only fluids acceptable to the procuring activity shall be used in types III and IV hydraulic systems or in test stands used for ground testing of these hydraulic systems.

* 3.3.3 Filtering. All hydraulic fluid shall be filtered through a 5-micron absolute, or finer, filter before installation in military missiles.

* 3.4 Hydraulic system design submittal and approval. Hydraulic system design data shall be furnished in accordance with appropriate line items of the Contractor Data Requirements List (DD Form 1423). As a guide for the type of information desired, refer to 6.3.

3.5 General system design. Hydraulic systems shall be as simple and foolproof as possible with respect to design, operation, inspection, and maintenance

3.5.1 System temperature limitations (based on 100°F outside air temperature at sea level)

3.5.1.1 Fluid temperature - type I systems. The fluid temperature shall not exceed 160°F in any portion of the hydraulic systems.

3.5.1.2 Fluid temperature - type II systems. The fluid temperature shall not exceed 275°F in any portion of the hydraulic systems.

3.5.1.3 Fluid temperature - type III systems. The fluid temperature shall not exceed 450°F in any portion of the hydraulic systems.

3.5.1.4 Fluid temperature - type IV systems. The fluid temperature shall be within the range specified in the missile detail specification.

3.5.2 Climatic and environmental conditions

3.5.2.1 Storage temperatures. The hydraulic system shall be capable of safe storage without impairment of its capabilities from the effect of temperature under the following conditions:

(a) Lower limit: -80°F for periods of 3 days duration

(b) Upper limit: +125°F plus the full impact of solar radiation, 360 BTU/sq ft/hr, for periods of 4 hours per day or 160°F with no solar radiation for periods of 4 hours per day, whichever is greater.

* 3.5.2.2 Launching and flight temperatures. The hydraulic system shall be capable of satisfactory performance during preflight testing, launching, and flight at any condition to be found with ground air temperature from -65°F without benefit of solar radiation to +125°F plus full impact of solar radiation (360 BTU/sq ft/hr). If the missile prelaunch environment is controlled, as in a silo or launch tube, the controlled prelaunch conditions shall apply in lieu of the above for the preflight testing and launching periods. The system shall be designed to operate with the nozzle radiation and hot gas recirculation that will occur during flight.

3.5.3 Fire hazards. The hydraulic system shall be integrated with other missile systems in such a manner that, prior to launch, no fire can result from one failure in any system.

3.5.4 Strength

* 3.5.4.1 Additional loads. During operation of the missile, all hydraulic systems and components which are subjected to structural or other loads which are not of hydraulic origin shall withstand such loads, when applied simultaneously with appropriate proof pressure as specified in table I, without exceeding the yield point at the maximum operating temperature.

* 3.5.4.2 Accelerated loads. Actuating cylinders and other components and their attaching lines and fittings which are subject to accelerated loads shall be designed and tested at the maximum operating temperature with a pressure equal to 100 percent of the maximum pressure that will be developed, regardless of relief valve setting, without exceeding the yield point.

3.5.5 Pressure limitations

* 3.5.5.1 System pressure. Main system operating pressure shall be 3,000 psi. Other pressures may be used provided they are approved by the procuring activity. Peak pressure transients lasting longer than 10 milliseconds and resulting from any phase of the system operation shall not exceed 135 percent of the supply system operating pressure.

TABLE I. Operating Pressures

Characteristics	Nominal operating pressure (psi) class 3,000	Percent of nominal operating pressure if other than 3,000 psi	Remarks standard system pressure
Proof pressure (minimum)			
(a) Lines and fittings	6,000	200	Hose proof pressure to be in accordance with applicable detail specification
(b) Hose	6,000	200	
(c) Units under gas and oil pressure	5,000	166	MIL-A-5498
(d) Units normally under oil pressure only	4,500	150	
(e) Parts of system under atmospheric pressure or suction	50	--	Except reservoir and pump seal chambers
(f) Parts of system subject to back pressure only	150 percent of actual maximum pressure	--	Except hose which shall be 250 percent of actual maximum pressure
Burst pressure (minimum)			
(a) Lines, hoses, and fittings	12,000	400	Hose burst pressure to be in accordance with applicable detail specification
(b) Units containing gas and oil under pressure	7,500	250	
(c) Units normally under oil pressure only	7,500	250	
(d) Parts of system subject to back pressure only	300 percent of actual maximum pressure	--	Except hose which shall be 600 percent of actual maximum pressure
Collapse pressure of parts subject to suction	50 external		
Automatic pressure regulator - accumulator system (closed center)			
(a) Regulator cutout pressure	3,000	--	System design pressure
(b) Upper limit of operating pressure for all units (regulator cut-in pressure)	2,600	--	System design pressure
(c) Maximum system relief valve setting, at maximum system flow	3,850	--	MIL-V-8813 or MIL-V-5523 units
Open-center-type system (constant delivery pump)			
(a) System design pressure	3,000	--	Relief valve full-flow setting
(b) Upper limit for full-flow operating pressure	2,700	--	Relief valve full-flow setting
(c) System relief valve setting, at maximum system flow	3,000	--	MIL-V-5523 or MIL-V-8813 units
Closed- or open-center system (variable volume pump)			
(a) Pump unloading pressure	3,000	--	System design pressure
(b) Maximum limit of full-flow system pressure	2,950	--	System design pressure
(c) Maximum system relief valve setting, at maximum system flow	3,850	--	MIL-V-5523 or MIL-V-8813 units
Thermal relief valve setting (maximum)			
(a) Equal to system relief valve maximum setting plus values noted	150		

3.5.5.2 Back pressure. The system shall be so designed that proper functioning of any unit shall not be adversely affected by the back pressure in the system.

3.5.6 System pressurization. In type I systems requiring pump inlet pressurization, the reservoirs may be of the gas-oil in contact or the gasless type. Types II, III, and IV systems shall be so designed that air, or any other gas, does not come into contact with the fluid during the normal functioning of the system or any subsystem, unless it can be demonstrated that gas-oil reservoirs will give satisfactory operation.

3.5.7 Fluid velocity limitations. Tubing size and maximum fluid velocity for each system shall be determined using at least the following criteria:

(a) Provide minimum required servo response at peak flow with minimum operating temperature

(b) Prevent pressure surges exceeding the limits defined in 3.5.5.1

(c) Prevent pump case overpressure surges lasting longer than 10 milliseconds and exceeding 135 percent of case operating pressure

(d) Prevent reservoir overpressure surges lasting longer than 10 milliseconds and exceeding 135 percent of reservoir operating pressure

(e) Prevent pump inlet cavitation during starting and operating conditions at minimum operating temperature.

3.5.7.1 Acceleration effects. System and component operation shall not be adversely affected by the maximum g loading obtainable with the missile. Consideration shall be given to the effect of g on each component, the mechanisms within the component with and without pressure, the actuated service, the fluid columns, other large fluid masses, the mass of the operating controls, and any other unit or subsystems that could be affected by the g capabilities of the missile.

3.5.8 Ground test provisions

* 3.5.8.1 Ground test connections. A set of self-sealing, quick-disconnect coupling halves, in accordance with the applicable specifications and standards listed in the appendix to this specification, consisting of bulkhead halves, and protective caps, if necessary, shall be provided at a location in the missile that is convenient and readily accessible during ground checkout and prelaunch operation. The set shall consist of connection for pressure and suction line in either of the following combinations: (-4 pressure and -6 suction), (-8 pressure and -12 suction), or (-12 pressure and -16 suction). Disconnects used as pump disconnects or elsewhere in the system may be used for this purpose provided the above conditions are met. A check valve shall be installed between

the pump outlet and the ground test high-pressure connection to prevent pump motoring during proof pressure tests and systems operation from a ground source. Reservoir supercharging disconnects shall be provided where necessary. The contractor shall furnish evidence or demonstrate to the procuring activity that ground stand or missile pump pressure cannot be coupled to the missile return or suction circuit.

* 3.5.8.2 Ground test data. The following data shall be attached in a permanent manner on the missile near the ground test connections:

Set Ground Test Reservoir Gas Pressurizing Valve to_____PSI. 1/
Set Ground Test Stand Relief Valve to_____PSI. 1/
Set Ground Test Stand Volume Output to_____GPM. 1/
Set Ground Test Stand Pressure Compensator to_____PSI. 1/
Use Hydraulic Fluid Conforming to Specification_____. 1/
(Any other precautions or information considered necessary)

1/ Missile contractor shall fill in required information.

* 3.5.8.2.1 If the ground test data is too extensive to place on a placard near the ground test connections, the following information shall be shown in place of the ground test data:

See Operating Procedures _____ for Ground Test Information and Precautions. 1/

1/ Missile contractor shall fill in required information.

3.5.9 Special tools. Hydraulic systems shall be so designed that special tools will not be required for installation or removal of components, unless it can be shown that use of special tools is unavoidable. In such cases, the contractor shall submit to the procuring activity for approval Van Dyke copies of drawings of the tools with substantiating evidence justifying use of the special tools.

3.5.10 Service-contractor conference. The contractors shall confer with the hydraulic engineers of the applicable Service on the proposed hydraulic systems during the early stages of design, in order to take advantage of exchange of information and to coordinate development programs. The first conference shall take place at the time when the preliminary schematic diagram is established for the missile. Other conferences shall take place during the appropriate development phases of the missile.

* 3.6 Hydraulic system design

* 3.6.1 The hydraulic system may include those functions necessary for operation of any missile service and for maintaining the magnitude and direction of the velocity vector in a stable manner through all phases of flight.

* 3.6.2 Power sources. In the case of turbine drives (or other devices which can exceed safe operating speed when the unit is unloaded), precautions, such as incorporation of a flow limiter in the pump outlet, shall be taken to prevent operating conditions hazardous to personnel. When using expendable-type power sources, means shall be provided to power the system externally during prelaunch or ground-handling operations.

* 3.6.2.1 Supply pressure. Hydraulic fluid shall be supplied to the system at the system designed operating pressure, within specified limits, under all flow rates required during all phases of flight. If utility services are included in the system, their operation shall not adversely affect those services provided for flight control.

3.6.2.2 Return pressure. The hydraulic system shall maintain the required back pressure, within specified limits, at the return ports of servo valves in the flight control system.

* 3.6.3 Unitized systems. Unitized systems (integrated packages which are hydraulic systems within themselves) shall be designed in such a manner that they can be installed on and removed from the missile without breaking any hydraulic connections. If practicable, the electrical connection to the vehicle shall be through a single electrical connector. The number of adjustments required when the system is installed shall be held to a minimum. The package shall contain an accessible provision to replenish the hydraulic fluid. If different unitized packages are used on the same vehicle, it shall not be possible to install the packages in incorrect locations. In addition, the following requirements shall apply to unitized systems:

(a) Minimize external seals. This includes high and low pressure, static and dynamic type.

(b) Wherever practicable, high-pressure seals shall vent to low pressure cavities.

(c) Means shall be provided to allow instrumentation of the unit to verify performance.

(d) Pump shaft seal leakage should be inspectable.

(e) Means shall be provided to allow determination of the reservoir fluid level. The refill level shall be indicated on the unit.

(f) Operating life shall be specified in the detail specification.

* 3.6.4 Redundancy. The number of redundant components shall be held to a minimum consistent with the missile requirements. If two separate systems

are used, and if practicable, the design shall be such that no single failure will cause loss of more than one system or allow transfer of fluid from one system to another. On dual systems utilizing a switching scheme, switching shall not occur as a result of normal system operation or normal transients. Switching shall be such that a complete switch is normally assured. Redundant systems or components shall be provided with means to permit checkout of each redundant part or subsystem individually.

* 3.6.5 Long term storage. In designing missile systems, consideration shall be given to the storage requirements of the missile. Insofar as practicable, the design of the hydraulic system shall be such that periodic checkouts are not required. The reservoir shall contain sufficient makeup fluid to compensate for normal fluid loss. The system should be designed to avoid ingestion of air or moisture and to minimize external leakage during storage and operation.

3.7 Component design

3.7.1 Military specifications and standards. All hydraulic system components shall comply with the applicable specifications and standards as listed in the appendix to this specification.

3.7.2 Standard components. Standard components shall be used in preference to nonstandard components wherever they will perform the function required by the system operating needs. Unless all qualified sources will operate satisfactorily in the application, the applicable drawings shall specify the manufacturer's part number and not the standard part number, and the installed component shall not carry the standard part number. Where no applicable AN or MS standard component exists, a minimum size envelope compatible with minimum weight requirements, performance, installation, inspection, and maintenance requirements shall be used. AN or MS standard hydraulic components must be used wherever applicable.

* 3.7.3 Nonstandard components. Nonstandard components shall be designed and tested in accordance with the missile manufacturer's specifications. The contractor shall determine the number of cycles of operation to which nonstandard components may be subjected including cycles during component and missile checkout and periodic exercises. The estimated number of cycles shall be multiplied by a factor of at least four to determine the endurance requirement. For types II, III, and IV components, the contractor shall determine the percentage of the cycles anticipated at the elevated temperatures and shall subject the component to elevated temperature endurance for the same percentage of cycles.

* 3.7.4 Orifices. All orifices smaller than 0.070 inch in diameter, the clogging of which could cause malfunction of the system, shall be protected by a filter element having a screened opening of 0.012 maximum. The filter element screen opening size shall be selected to assure adequate protection of the

associated orifice from system contamination. Orifices and filter elements must be strong enough to absorb system design flow and pressure without rupture or excessive deformation.

3.7.5 Hydraulic components

* 3.7.5.1 Servo valves. Electrically controlled servo valves shall meter the flow of hydraulic fluid to hydraulic actuators. Design criteria for servo valves shall be as covered by the missile flight control system and detail specification.

3.7.5.2 Actuators. Design criteria for flight control actuators shall be as covered by the missile flight control system and detail specifications.

3.7.6 Packings. MIL-G-5514 shall be used as a guide for packing installations.

3.7.6.1 Packings and gaskets - type I systems. All packings and gaskets for type I systems shall conform to MIL-P-5516 or MIL-P-5510. Packings conforming to MIL-P-25732 may also be used.

* 3.7.6.2 Packings - type II systems. Packings conforming to MIL-P-25732 shall be used within the performance constraints reflected by qualification requirements and tests of MIL-P-25732. The major performance constraints are summarized as follows:

* 3.7.6.2.1 If the maximum system temperature does not exceed 225°F, the standard seal is suitable for the normal life reflected by endurance test "B" of MIL-P-25732.

* 3.7.6.2.2 If the maximum system temperature is between 225°and 275°F, the life expectancy of the standard seal shall be reduced proportionally from the normal life reflected by endurance test "B" of MIL-P-25732 to the reduced life reflected by endurance test "A" of MIL-P-25732. (The total accumulated time of exposure to 275°F during qualification tests is approximately 80 hours.) The reduced life expectancy shall be clearly defined in all appropriate publications.

3.7.6.3 Packings and gaskets - types III and IV systems. Only packings and gaskets approved by the procuring activity shall be installed in types III and IV hydraulic systems.

3.8 Component installation

3.8.1 Design practice and installation. The hydraulic system component installation requirements stated below are considered to be representative of good design practice. However, it is recognized that variations from these

practices will, in many cases, be necessary because of specific installation exigencies. Installation of standard parts or components shall be designed to accommodate the worst dimensional and operational conditions permitted in the applicable part or component specification or AN or MS standard. All components shall be installed and mounted to withstand all expected acceleration loads, wrench loads, vibration effects, etc.

* 3.8.1.1 Reverse installation. Components which could inadvertently be installed reversed, without the condition being certain of discovery by a routine system check (as specified in the technical order or handbook of maintenance instructions applicable to the missile), shall be so designed that they cannot be installed reversed. Nonstandard components may be used, if necessary, to conform to this requirement. Irreversible components shall be used where system damage due to reversed installation could occur without positive discovery.

* 3.8.1.2 Placards for reversible components. For components which can be inadvertently reversed during installation, a permanent placard shall be installed on adjacent equipment or structures, visible with component installed, to indicate the correct direction of installation. Arrows on connection lines are not sufficient for this purpose.

3.8.2 Accumulators. Accumulators for type I systems shall be in accordance with MIL-A-5498 and the standards listed therein. Types II, III, and IV accumulators shall be approved by the procuring activity.

3.8.2.1 Accumulator accessibility. In all accumulator installations, space shall be provided around the air charging valve for use of the MIL-G-8348 high-pressure, air-testing gage assembly, and for standard fitting connections to charge accumulators.

* 3.8.2.2 Accumulator instructions. Instructions for servicing the accumulator with gas pressure, with the accumulator oil chamber discharged, shall be provided immediately adjacent to the accumulator. Adequate information shall be included to indicate the proper gas preload pressure throughout the temperature range for which the accumulator will be serviced. If the servicing data is too extensive to be displayed, the following information shall be shown in place of the servicing data:

> See Servicing Procedure_____for Accumulator Servicing Instructions and Precautions. 1/
>
> 1/ Missile contractor shall fill in required information.

3.8.2.3 Quantity of accumulators. The number of accumulators used in the hydraulic system shall be kept to a minimum.

* 3.8.2.4 Gas. For type I systems, accumulators may be charged with air or inert gases, such as nitrogen. Nitrogen or inert gases are preferred to minimize oxidation of the hydraulic fluid, reduce fire hazard, and reduce the possibility of "dieseling action." For types II, III, and IV systems, accumulators shall be charged with inert gases only.

3.8.3 Actuating cylinders. Hydraulic actuating cylinders shall be so installed that they are readily accessible for maintenance and inspection and do not interfere with the adjacent structure.

* 3.8.4 Bleeder valves. Where required, bleeder valves shall be so located that they can be operated without removing other components. Such installations shall permit attachment of a flexible hose so that fluid bled off may be directed into a container. Disconnection of lines or loosening of tubing nuts shall not be used for system bleeding.

3.8.5 Check valves. The direction of flow in the lines leading to and from each check valve shall be clearly indicated on each line or, if the lines are not visible, a permanent marking on the structure immediately adjacent to the check valve shall be provided indicating direction of flow through the line for proper installation.

3.8.6 Directional control valves. The installation of directional control valves shall be compatible with the control valve performance so that the system operation will not be affected by pressure, interflow, pressure surges, etc, which might tend to cause the valves to open or move from their setting, or cause them to bypass fluid in other than the intended manner.

3.8.6.1 Multiple control valve systems. In systems which incorporate two or more directional control valves, provision shall be made to prevent fluid from being transferred inadvertently, at any possible valve setting, from the cylinder ports of one valve into the cylinder ports of another valve.

* 3.8.6.2 Manually actuated valves for ground operations. All mechanically controlled valves shall have a means to insure against accidental switching during flight. These valves shall be designed to prevent partial switching. It shall not be possible to leave in a checkout mode where it would result in a flight failure unless such a condition would be detectible during prelaunch check.

3.8.6.3 Control valve wiring. Electrically operated control valves shall be wired in accordance with MIL-W-8160.

* 3.8.7 Unloading valves. Unloading valves are normally used in conjunction with fixed displacement-type pumps. When used, the return line from the unloading valve to the reservoir shall be as short as possible. The tubing connecting the unloading valve shall be so designed and installed that the

pressure surges in the system will not affect the operation of the unloading valve at any flow rate of the system. In addition, provisions shall be made in the system to eliminate any harmful shocks caused by pressure surges due to the operation of the unloading valve.

* 3.8.8 Filters. Five-micron (absolute) filters shall be used to filter all of the circulating fluid in the system. All vent openings or fluid exposed to breathing action through vents shall be protected by filters. Line filters installed in the missile system in proximity to an accumulator shall be installed, if practicable, before the accumulator. Filters shall be so installed that the pressure-drop indicator button is readily visible to servicing personnel. All hydraulic fluid shall be filtered through a 5-micron (absolute) or finer filter before use in the hydraulic system. In cases where a finer degree of filtration is required for specific missiles, it shall be so specified in the servicing instructions for that missile and shall be subject to the approval of the procuring activity.

* 3.8.8.1 Filter location. As a minimum requirement, 5-micron (absolute) nonbypass type, disposable element filters shall be provided as specified in 3.8.8.1.1 and 3.8.8.1.2.

* 3.8.8.1.1 Pressure line. Location shall be such as to provide protection to all major components in the pressure circuit and shall filter all fluid entering the system from the ground test pressure connection.

* 3.8.8.1.2 Return line. Location shall be such as to filter all fluid returning to the reservoir and pump inlet line and all fluid entering the system from the reservoir filling connection.

* 3.8.8.2 Magnetic filters. When magnetic fields exist in portions of the missile hydraulic system such that aggregations of micronic ferromagnetic materials may form and injure system operation, magnetic filters shall be provided. In lieu of magnetic filters, fine micronic filters may be used if test data is available to prove that adequate protection is obtained therewith.

* 3.8.9 Fittings. Removable components shall accept fittings conforming to MIL-F-5509 or MIL-18280. They shall be connected and assembled in accordance with AND10064 or MS33566. Permanently joined tube fittings employing no screw threads shall be used at all joints possible. All nonstandard fittings shall require approval of the procuring activity. Unless specifically approved by the procuring activity, no thread lubricant other than hydraulic fluid shall be used on straight threaded fittings.

* 3.8.10 Hoses. In order that there will be no tendency for the connecting fittings to loosen, hose assemblies may be installed between two points of relative motion but shall not be subjected to torsional deflection (twisting) under any condition of operation. No hose-clamp-type installations shall be

used in hydraulic systems. Wherever practicable, metal coiled tubing in accordance with ARP 584 shall be used in lieu of hoses. Medium- and high-pressure hose assemblies shall conform to MIL-H-25579 and MIL-H-38360, respectively. Hose selections shall be made from MS33620.

3.8.10.1 Hose support. The support of a flexible line shall be such that it will never tend to cause deflection of the rigid lines under any possible relative motion that may occur. Flexible hose between two rigid connections may have excessive motion restrained where necessary but shall never be rigidly supported as by a tight rigid clamp around the outside diameter of the flexible hose.

* 3.8.10.2 Hose bend radii. The minimum radius of bend of hose assemblies shall be as specified in MIL-H-25579 or MIL-H-38360, as applicable.

3.8.10.3 Hose protection. Hose shall be suitably protected against chafing where necessary.

3.8.10.4 Provision for hose elongation and contraction. Hose assemblies shall be so selected and installed that elongation and contraction under pressures within the hose specification limits will not be detrimental to the installation either by causing strains on the end fittings or excessive binding or chafing of the hose.

* 3.8.11 Lock valves. With the approval of the procuring activity, lock valves may be installed in subsystems to hydraulically lock the actuating cylinders, provided the lock is not required for subsystems where the unit must remain closed through extreme changes in temperature unless other means are provided for fluid expansion or contraction. When several actuating cylinders are mechanically tied together, only one lock valve shall be used to hydraulically lock all actuators. Mechanical locks should be used instead of hydraulic shutoff valves in cases where accurate locked position control is required under loading and vibration environments. Such mechanical locks may be hydraulically operated.

3.8.12 Motors. All hydraulic motors shall be in accordance with MIL-M-7997. All motors shall be accessible for maintenance and inspection and shall be located in an appropriately cool or warm space, depending upon their service. Proper case overflow connections to the reservoir shall be provided. Shaft seal drains shall be vented overboard.

3.8.13 Relief valves

3.8.13.1 System relief valves. Provisions shall be made to insure that pressures in any part of the power system will not exceed a safe limit above the cutout pressure of the hydraulic system. Pressure relief valves, as specified

herein, shall be located in the hydraulic system wherever necessary to accomplish this pressure relief (see table I). The system relief valve shall have a capacity equal to or greater than the rated flow of one pump when variable volume pumps with a common pressure line are used.

3.8.13.2 Thermal expansion relief valves. Relief valves, as specified herein, shall be installed in the system wherever necessary to accomplish thermal expansion relief (see table I).

3.8.14 Reservoirs. Reservoirs shall be suitably protected to prevent failure or damage when rapid discharge into the reservoir is encountered.

3.8.14.1 Reservoir location. It is desired that the reservoir shall be so located that the following conditions will be obtained:

(a) A static head of fluid will be supplied to the pumps in all normal flight attitudes of the missile

(b) The length of suction line to the pump is a minimum.

* 3.8.14.2 Reservoir filling provisions. The reservoir shall be filled by a suitable pressure replenishment method through a check valve with an MS33656-6 or MS33657-6 fitting connection and shall be provided with an AN929A6S cap assembly. The cap assembly shall include a suitable safety chain to prevent loss.

3.8.14.3 Reservoir venting. If a vent is provided in the reservoir, it shall be so arranged that loss of fluid will not occur through the vent during flight maneuvers or ground operations of the missile. A filter shall be incorporated into the vent line.

* 3.8.14.4 Pressurized reservoirs - gas-oil in contact. Reservoirs with gas and oil in contact shall not be used without the permission of the procuring activity.

* 3.8.14.5 Pressurized reservoirs - gas-oil separated. The reservoir pressurization shall be effected by any suitable medium with the exception of a gas in contact with the fluid. Operation of the system shall not introduce gas into the hydraulic fluid, and provisions shall be made to entrap entrained gas which may have entered the system during servicing and prevent its recirculation. Adequate instructions shall be provided adjacent to the filling provisions to insure proper bleeding when servicing.

* 3.8.14.6 Reservoir gas pressurization line filter. A filtration device shall be provided in all reservoir gas pressurization circuits and so located as to protect the pressure regulation equipment.

3.8.15 Restrictor valves. Adjustable orifice restrictor valves shall not be used. The directions of restricted and unrestricted flow shall be indicated on restrictor valves and adjacent structure.

3.8.16 Self-sealing couplings. Self-sealing couplings conforming to MIL-C-25427 and MS24333 or MS24334 may be provided at all points in the system, where convenient, to facilitate maintenance. Sufficient clearance shall be provided around the couplings to permit connection and disconnection. Self-sealing couplings installed adjacent to each other shall be of different size or be otherwise designed so that inadvertent cross connection of the lines cannot occur.

3.8.17 Snubbers. Snubbers shall be used with all Bourdon-type pressure transmitters, pressure switches, and pressure gages, except air-pressure gages.

3.8.18 Suction line

3.8.18.1 Suction-line cold starting. The suction line shall be so designed that regardless of ambient temperatures (see MIL-STD-210), the hydraulic system can be started wherever required and will be fully operational in a time period consistent with the mission response time. Use of artificial heating to meet this requirement shall be subject to approval of the procuring activity.

3.8.18.2 Suction line, pressure drop. The pressure drop from the reservoir to the pump intake port under the conditions of temperature and altitude commensurate with the missile mission profile shall be such that the pressure at the inlet port will be adequate to prevent cavitation of the pump.

3.8.18.3 Suction-line filters. Filters shall not be installed in the suction line to power-driven pumps.

* 3.8.19 Swivel joints. Swivel joints may be used where relative motion exists between two points and if other methods, such as coiled metal tubing or flexible hose, are impractical. Design shall be in accordance with MIL-J-5513. Life test data shall be submitted to the procuring activity for approval. Where lines or fittings are used to drive swivel joints, they shall be adequately supported and shall be of sufficient strength to insure a satisfactory operating installation.

3.8.20 Tubing

3.8.20.1 Tubing materials. Tubing shall be either corrosion-resistant steel conforming to MIL-T-6845 or MIL-T-8504, or an aluminum alloy conforming to temper 0 of WW-T-700/4 or condition T6 of MIL-T-7081. Higher strength-to-weight ratio steel or titanium tubing may be used with the approval of the procuring activity.

3.8.20.2 Tubing bends. Bends shall be uniform (without kinks or scratches), and the radius of bend for the tubing shall be not less than that specified in MS33611. Radii of bends for nonstandard tubing shall be subject to approval of the procuring activity.

* 3.8.20.3 Designed motion in tubing. Looped or straight aluminum-alloy tubing shall not be used between two connections where relative motion exists. Coiled tube and torsion tube installations of corrosion-resistant steel tubing shall be designed and installed in accordance with ARP 584. Titanium tubing may be used if approved by the procuring activity.

3.8.20.4 Straight tube lines. The use of straight tube lines installed between two rigid connections shall be avoided wherever possible. Where such straight lines are necessary, provisions shall be made in the mounting of the units or in the rigid connections to insure that no excessive strains will be applied to the tubing and fittings. Semiloops may be provided in the tubing, as necessary, to insure proper alignment on installation and to take care of vibratory motion.

* 3.8.20.5 Tubing and fitting identification. All hydraulic oil lines shall be permanently marked in accordance with MIL-STD-1247. A sufficient number of hydraulic lines shall be marked in conspicuous locations throughout the missile in order that each run of line may be traced. This marking shall indicate the unit operated. These markings shall be repeated as often as necessary, particularly on lines entering and emerging from closed compartments, to facilitate maintenance work. Where fittings are located in members such as bulkheads, webs, etc, each fitting location shall be identified (placard) as to system function, using the same terminology as on its connecting line.

3.8.20.6 Tubing supports. All hydraulic tubing shall be supported from rigid structure by tube clamps conforming to MS21919 or by suitable multiple block-type clamps. Where system temperatures make the MS21919 clamp unsatisfactory, clamps suitable for the temperature involved shall be used as approved by the procuring activity. Supports shall be placed as near as practicable to bends to minimize overhang of the tube. Recommended spacings between supports are shown in table II, except that where tubes support fittings, such as unions, tees, etc, spacings should be reduced approximately 20 percent. Where tubes of different diameters are connected together, an average spacing distance may be used. In any event, the requirements of 3.8.24 shall be met. Provisions shall be made in the support location to accommodate change in tubing length caused by expansion and contraction. In order to facilitate inspection and repair, tubing shall not be bundled together.

TABLE II. Hydraulic Line Support Spacings

Nominal tube OD (inches)	Maximum length between support centers (measured along tube)	
	Aluminum alloy (inches)	Steel (inches)
1/8	9-1/2	11-1/2
3/16	12	14
1/4	13-1/2	16
5/16	15	18
3/8	16-1/2	20
1/2	19	23
5/8	22	25-1/2
3/4	24	27-1/2
1	26-1/2	30
1-1/4	28-1/2	31-1/2
1-1/2	29-1/2	32-1/2

* 3.8.20.7 Location of hydraulic tubing. Hydraulic lines shall be protected from sources of extreme heat which could cause excessive oil or component temperatures. To prevent fire from line leakage, hydraulic lines should be located so that leakage does not fall directly on sources of extreme heat. Insofar as possible, hydraulic lines shall not be grouped with lines carrying flammable fluids. Hydraulic drain and vent lines shall exhaust in areas where the fluid will not be blown into the missile, collect in pools in the structure, or be blown onto or near exhaust stacks, manifolds, or other sources of heat. Components and lines shall be so located that easy accessibility for inspection, adjustment, and repair is possible.

3.8.20.8 Design of line installations

* 3.8.20.8.1 Component lines. Where two or more lines are attached to a hydraulic component and incorrect connection of lines to the component is possible, the two lines shall be sufficiently different, such as a variation in size, length, or diameter, to prevent such an occurrence.

3.8.20.8.2 Drain lines. Drain or vent lines coming from the pump, reservoir, or other hydraulic components shall not be connected to any other line of any other fluid system in the missile in such manner as to permit mixture of the fluids at any of the components being drained or vented.

* 3.8.20.9 Tubing flares and assembly. Tube flares when used shall conform to MS33584 or MS33583. Aluminum-alloy tubing conforming to temper 0 of WW-T-700/4 3/8-inch outside diameter and smaller shall be double flared. When installing tube connections, care should be exercised to keep the wrench torque used within the limits specified in AND10064.

3.8.20.10 Tubing clearance. Where tubing is supported by structure or other rigid members, a minimum clearance of 1/16 inch shall be maintained with such member. A minimum clearance of 1/4 inch shall be maintained with adjacent rigid structure or units. In areas where relative motion of adjoining components exists, a minimum clearance of 1/4 inch shall be maintained under the most adverse conditions that will be encountered.

3.8.21 Mounting lightweight components. Standard lightweight components such as check valves, etc, which are not supplied with mounting holes and which do not require adjustment after installation, may be supported by the tubing, provided a tube clamp is used as close as practicable on each side of the component. Nonstandard components of similar weight and usage may be mounted in the same manner.

3.8.22 Pressure testing

3.8.22.1 Proof pressure. No part of a hydraulic system shall fail, take any permanent set, or be damaged in any manner, when subjected to applicable proof pressure. All hydraulic systems shall satisfy this requirement when subjected to the appropriate proof pressure as listed in table I.

* 3.8.22.2 Burst pressure. No part of a hydraulic system shall rupture when subjected to applicable burst pressure. All hydraulic systems shall satisfy this requirement when subjected to the applicable burst pressure listed in table I.

3.8.23 Bonding. The missile hydraulic system components and lines shall be bonded to the missile in accordance with MIL-B-5087.

3.8.24 Vibration. The hydraulic system, its components and their supports, shall be so designed and vibration tested as to demonstrate that they will function properly for adequate life under any condition of vibration to which they may be subjected in the missile (see 4.2.1).

* 3.8.25 Cleaning of parts and systems. All parts of hydraulic system units shall be thoroughly cleaned prior to assembly or installation of the particular unit.

* 3.9 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. Where changes in the contractor's drawings are required, such changes shall conform to MIL-STD-100.

3.10 Identification of product. Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130.

3.11 Workmanship. Workmanship shall be high grade throughout to insure proper operation and service life. The systems shall be designed to provide maximum protection to personnel and accessibility for overhaul of components.

4. QUALITY ASSURANCE PROVISIONS

* 4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Inspection. The hydraulic system installation of one of the first complete experimental and production missiles shall be subject to inspection for conformance to this specification by engineering representatives of the procuring activity. It is expected that this inspection will be performed at the contractor's plant concurrently with similar engineering inspections of other systems of the missile. Detailed arrangements for the inspection will be the subject of correspondence between the procuring activity and the contractor.

* 4.2.1 Hydraulic lines, hydraulic units, and their supports shall be inspected visually for evidence of destructive vibration after the missile is fired statically, or when some other satisfactory means of excitation is utilized.

4.3 Cleaning of parts and systems. To assure that the hydraulic system is free of contamination, each new hydraulic system shall be operated at least 10 times in order to insure infiltration of all circulating fluid. Ground equipment which is used for this cleaning process shall be provided with filters of the same degree of filtration, or finer, as that used in the missile system. Dead-end lines in the system shall be properly connected with jumpers to completely clean such lines during actuation of the system. If the filter element in the hydraulic system is used during this operation, it shall be replaced.

4.4 Ground and flight tests. Ground and flight tests shall be conducted as specified in the contract and shall include at least one of the first experimental missiles and one of each subsequent model if there are significant differences.

4.4.1 Ground tests

4.4.1.1 Preparation. A test stand shall be connected to the missile system in a suitable manner which will closely approximate the actual power system in the missile. All special test equipment shall be installed, and approved system modifications, if any, completed. The hydraulic system shall be adequately bled of entrapped air, and the system and reservoir(s) filled to their specified level with applicable hydraulic fluid. All accumulators shall be properly serviced and the entire system, components, and attached linkages and mechanisms properly adjusted. The missile shall be suitably elevated and safely anchored in place to permit full operation of all hydraulically operated services or units.

* 4.4.1.2 Test procedure. Nominal system pressure shall be applied to the whole installation, and each selector and control valve shall be operated for at least two complete cycles of the corresponding service. In addition, each control unit shall be operated through an incomplete half cycle, followed by a complete reversal of direction. (A cycle is interpreted to mean the full travel of a service from down (closed) to up (open) and return to original down (closed).

4.4.1.2.1 This test procedure shall be accomplished through both directions of operation. During the operations, inspection shall be made to determine whether:

(a) The various functions are accomplished satisfactorily in accordance with specification requirements

(b) The movement of all components and surfaces is smooth and positive

(c) All tubing and fitting joints and component external seals are free from leaks

(d) The clearance for all moving parts throughout the entire range of movement is such that fouling of adjacent parts cannot occur. Particular attention shall be given to flexible connections to insure that pinching or stretching does not occur.

(e) Peak pressures shall be in accordance with 3.5.5.1.

* 4.4.1.2.2 A series of control operations, simulating extreme and normal flight operating conditions, including aerodynamic loads and airborne temperatures, shall be conducted to determine any malfunctioning which could be encountered.

* 4.4.1.2.3 Values of operating temperature (if applicable) and ambient temperature shall be noted.

4.4.1.2.4 Low fluid level. The oil in the reservoir(s) shall be set to the lowest permissible indicated level. The controls shall then be operated at

least once through the normal sequence of operations. The control valves shall be set to simulate normal flight operation, whereby the minimum amount of fluid is returned to the reservoir. The reservoir power pump suction line shall be checked for any indication that air has been introduced into the system. Reservoir pressurization, if applicable, shall be set to the low limit of the normal pressurization range during this test. Cavitation of the pump(s) shall not occur.

4.4.2 Flight tests. The missile shall be instrumented to measure and record all necessary data as specified herein. The data should cover pressures (operating peak or surge, as applicable), ambient air and system temperatures, time of operation, and other data as may be required on any individual system. The system(s) shall be properly serviced for adjustments, normal fluid level, bleeding of air, etc. All necessary special components, bypass circuits, etc, as required, shall be installed and checked for proper and safe function.

4.4.2.1 Instrumentation

4.4.2.1.1 Telemetering. When possible, telemetering facilities shall be provided to monitor hydraulic pressure and temperature at critical points in the system, in order to have a record of hydraulic system operation in the event of system failure. Telemetering of any specific pressure need not be continuous. However, if the time interval between telemetering signals for any pressure or temperature is sufficiently small and recording facilities are available on the ground, integral recording facilities need not be provided in the missile to record these data.

4.4.2.1.2 Recoverable recording equipment. When telemetering is not utilized for the recording of data, recoverable recording equipment shall be utilized for the recording of data. Recording need not be continuous under the conditions of 4.4.2.1.1.

4.4.2.1.3 Choice of equipment. The telemetering and recording equipment selected shall have characteristics that are compatible with the telemetering and instrumentation facilities of the Service's test range where the missile system is to be flight tested.

4.4.2.2 Data. Data that will assist in determining the cause of hydraulic malfunction in the event of flight failure shall be recorded or telemetered. Also, the most critical hydraulic fluid temperatures shall be recorded or telemetered.

4.4.2.3 Flight conditions. Data shall be obtained for all extremes of flight attitude, altitude, ambient temperature, speed, and acceleration to be encountered during operation of the missile. These data may be obtained during flight tests designed to evaluate other portions of the missile.

4.5 Environmental and climatic tests. Environmental and climatic tests shall be conducted to show conformance to this specification.

* 4.6 Mockup testing. Mockup testing shall be performed on a hydraulic system to demonstrate that the system has an operational capability equal to the required number of flights plus operation equivalent to the expected number of hours of hydraulic system operation during normal missile testing, confidence checks, and maintenance. Pending the availability of production components, prototype components or suitable laboratory models may be used. One test on the simulator shall simulate a typical mission profile so as to duplicate, within practical limitations, an actual missile flight. Items shall operate in sequence for a check on unusual back pressure, surges, temperatures, etc. Redundant systems shall be tested with simulated failures. The functional mockups shall be used to determine the performance of the hydraulic system prior to the first flight of the missile and to evaluate any significant changes as they are made to the sytem during production of the missile.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

6.1 Intended use. This specification is intended for use in the design, installation, and testing of missile hydraulic systems.

* 6.2 Coiled tubing design notes. Design criteria for coiled tubing installations are given in ARP 584.

* 6.3 Hydraulic system design submittal data

* 6.3.1 To obtain approval of the missile hydraulic system, data as indicated in the following subparagraphs should be included when submitting data as specified in 3.4.

* 6.3.1.1 System studies data. The following data should be submitted to the procuring activity for approval:

(a) Hydraulic system schematic diagram including a system block diagram

(b) Hydraulic flow versus time curves for typical missions

(c) Hydraulic fluid peak temperature versus time curves for typical missions

(d) Description of the hydraulic system.

* 6.3.1.2 Prototype design selection data. The following data should be submitted for evaluation for purposes of selecting a preliminary missile hydraulic system design for continuation into the detailed development phase:

(a) Hydraulic system schematic diagram in accordance with this specification

(b) Hydraulic flow versus time curves for typical missions

(c) Hydraulic fluid peak temperature versus time curves

(d) Revised description of the hydraulic system, including a discussion of those areas that will present problems and will require considerable development effort

(e) Hydraulic system design selection report. This report should present a simplified analysis verifying that the hydraulic system selected will conform to the weapon system.

* 6.3.1.3 Developmental data. The following data should be submitted during the development phase of the hydraulic system and should be suitable for use as production procurement data:

(a) If it is determined by the preliminary service-contractor conference (see 3.5.10) that MIL-H-8775 is not adequate for a specific missile, the contractor should prepare and submit for approval a general specification for components similar to MIL-H-8775. This document should specify the performance, design, and testing requirements for all components in the hydraulic system and also will be the controlling document for components not otherwise covered by an applicable component specification.

(b) If it is determined by the preliminary service-contractor conference (see 3.5.10) that this specification is not adequate for a specific missile application, the contractor should prepare and submit for approval a system specification similar to this specification.

(c) Hydraulic system schematic diagram in accordance with 6.3.1.5 should be submitted for approval.

(d) Hydraulic system design report in accordance with 6.3.1.6 should be submitted for approval.

(e) Hydraulic system ground and flight test report in accordance with MIL-T-5522 should be submitted for approval.

(f) Detail specifications and test reports for the following components should be submitted for technical review and approval. Test reports should include analysis of failures and malfunctions affecting performance and safety.

(1) Pumps and motors

(2) Flight control actuators and servos

(3) Flexible connectors, including hoses (if nonstandard)

(4) Packings and packing installations (if nonstandard)

(5) Fluids (if nonstandard)

(6) Fittings (if nonstandard)

Note: Other components that may require surveillance, in view of the criticalness of the particular item to the proper functioning of the weapon system, may be specified after the hydraulic system schematic diagrams have been reviewed. The list of surveillance items will be established during the service-contractor conference (see 3.5.10).

(g) Cross-sectional assembly drawings, in accordance with 6.3.1.7, of all nonstandard hydraulic components should be submitted for information.

(h) Reliability data should be as required in the contractor's system specification.

* 6.3.1.3.1 The following data need not be submitted for technical review and approval:

(a) Component specifications and test reports other than those specified in 6.3.1.3(f)

(b) System and component detail installation drawings.

* 6.3.1.3.2 The following procedure should be adopted by the contractor in lieu of submitting the data specified in 6.3.1.3.1:

(a) The contractor should certify, upon completion of validating tests, that the hydraulic component conforms to the applicable military- or contractor-prepared specifications approved by the procuring activity and is satisfactory for use in the particular missile weapon hydraulic system.

(b) The test reports as well as the specifications and other applicable engineering data covering the hydraulic system components, other than those specified in 6.3.1.3(f), should be retained by the contractor and should be available to the procuring activity upon request, with the exception that all the cross-sectional assembly drawings should be submitted for information.

(c) The contractor should list in a status of equipment list those components that are contractor certified for data availability and compliance with the applicable Government-approved specifications.

* 6.3.1.4 Production data. Where changes have been made in the hydraulic system over the development hydraulic system, the developmental data required in 6.3.1.3 should be submitted.

6.3.1.4.1 A specification specifying the necessary functional tests of the hydraulic system of production missiles should be submitted to the procuring activity for approval.

* 6.3.1.5 Schematic diagram. The schematic diagrams should consist of one copy of the conventional size and one copy approximately 11 inches in height. The arrangement of the schematic diagram should be such as to present the system in a clear and easily readable form, with complete subsystems grouped and labeled accordingly. Emphasis should be placed on simplicity and clarity of presentation, with location in the missile being of secondary importance. Nomenclature of each unit should be included adjacent to or in the vicinity of each unit. In addition, the schematic diagram should contain the following information:

(a) Operating pressure of all systems and subsystems, including prelaunch auxiliary systems used on the launcher or in the launching missile.

(b) All relief valve cracking and full flow pressures.

(c) Initial gas pressure of accumulators and their nominal capacities.

(d) Pressure settings of pressure regulators and sequence valves.

(e) Diameter, wall thickness, and material of tubing.

(f) Total and reserve fluid capacities of reservoir(s) and the system.

(g) Displacement of fluid in cubic inches of each actuating cylinder for both extension and retraction.

(h) Actuating cylinder piston head diameter, rod diameter, effective piston area, and total and working stroke of each cylinder.

(i) Motor displacement per revolution and number of required revolutions of hydraulic motors for each half-cycle of operation and the torque load required for each unit.

(j) Type of power-driven pump and displacement, including flow-rate curve showing pump rpm for all phases of flight.

(k) Indicated flow of fluid through all hydraulic lines.

(l) Reservoir pressurizing system source, operating pressure, and schematic diagram of plumbing.

(m) Simple schematic diagram of linkages showing mechanical disconnects, downlocks, and uplocks, and other data to tie the mechanical system to the hydraulic system for analysis. This should include mechanical feedback devices and mechanical instrumentation elements (such as filter Δ P indicators).

(n) A simple schematic wiring diagram of the electrical portion of the hydraulic system giving current loads and describing functions in accordance with MIL-E-8189. Electrical feedback elements and electrical instrumentation elements

3.6.4 Bleeder valves. Where required, bleeder valves shall be so located that

should be shown on this schematic including reference to direction of operation (i.e., piston extend, increasing pressure, etc). (This diagram and data may be on a separate drawing.)

(o) Name and part number of all units. Standard part numbers should be indicated, where applicable. Nonstandard units should also include name of manufacturer and the manufacturer's part number.

(p) Connections for testing with auxiliary or ground test power systems should be indicated.

(q) Tubing and hose lines should be identified in accordance with MIL-STD-17.

(r) All hydraulic components should be shown in schematic, typical cutaway views, with adequate data to show flow directions for the various operating conditions of the unit. Symbols in accordance with MIL-STD-17 may be used where the flow path is obvious.

(s) Normal system temperature (estimated).

(t) Maximum system temperature (estimated).

(u) Length of time in minutes and in percentage of total flight time that the hydraulic system will be at or near maximum temperature.

(v) Compartment temperatures (estimated).

(w) Valve types (solenoid, servo, squib operated, etc) and rated flow.

* 6.3.1.6 Hydraulic system design report. The hydraulic system design report should be submitted prior to or with the final schematic diagram and should incorporate sufficient design calculations and data to demonstrate that the design requirements of the hydraulic system have been met. A hydraulic system temperature survey should be included considering the location of the hydraulic system in the missile. An estimate of the bulk oil and hotspot temperatures should be made. The length of time in minutes and in percentage of total flight time that the hydraulic system will be at or near maximum temperature should be included. Compartment temperatures should be indicated. The system peak and average flow rates and the power spectrum should be shown. Duration of peak and average flow rates should also be indicated. The minimum temperature at which full performance occurs should be included.

* 6.3.1.7 Hydraulic system nonstandard component cross-sectional assembly drawings. The cross-sectional assembly drawings for each nonstandard hydraulic component should contain sufficient information in order that an evaluation of the unit can be made. Such information should include the applicable specification, the material protective finish of each part, and bearing data. This information may appear as a written addition to the drawing. Reason for the use of a nonstandard component, where a standard exists, should be submitted with the component drawing.

6.4 The margins of this specification are marked with an asterisk to indicate where changes from the previous issue were made. This was done as a convenience only, and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notation and relationship to the last previous issue.

Custodians:
Army - MI
Navy - AS
Air Force - 11

Review activities:
Army - MI
Navy - AS
Air Force - 70

Preparing activity:
Air Force - 11

Project No. 1410-0061

APPENDIX

10. SCOPE

* 10.1 This appendix covers documents applicable to MIL-H-25475B not cited therein.

SPECIFICATIONS

Military

MIL-S-5049	Scrapers, Piston Rod
MIL-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-C-5503	Cylinders; Aeronautical, Hydraulic Actuating, General Requirements for
MIL-P-5517	Plastic Parts in Aircraft Hydraulic Equipment; General Tests for
MIL-V-5519	Valves, Aircraft Hydraulic Unloading
MIL-R-5520	Reservoirs: Aircraft, Hydraulic, Non-Separated Type
MIL-W-5521	Washer, Aircraft Hydraulic Packing Back-Up
MIL-T-5522	Test Procedure for Aircraft Hydraulic and Pneumatic Systems, General
MIL-V-5529	Valves, Hydraulic Directional Control
MIL-V-5530	Valves, Aircraft Hydraulic Shuttle
MIL-C-5541	Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys
MIL-H-5593	Hose, Aircraft, Low Pressure, Flexible
MIL-P-5954	Pump Unit, Hydraulic, Electric Motor Driven Fixed Displacement
MIL-P-5994	Pump, Hydraulic, Electric-Motor-Driven, Variable Delivery
MIL-V-6164	Valve; Aircraft, Air, High-Pressure
MIL-I-6866	Inspection, Penetrant Method of
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-I-7084	Indicator, Pressure, Hydraulic, 0-4000 PSI
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series: General Specification for
MIL-P-7858	Pump, Hydraulic, Power Driven, Fixed Displacement
MIL-V-7915	Valves; Hydraulic, Directional Control, Slide Selector
MIL-E-8189	Electronic Equipment, Missiles, Boosters and Allied Vehicles, General Specification for
MIL-H-8446	Hydraulic Fluid, Nonpetroleum Base, Aircraft
MIL-V-8566	Valves; Aircraft Hydraulic Flow Regulator
MIL-C-8603	Clamps, Tube Support, Loop Type
MIL-H-8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
MIL-H-8788	Hose, Hydraulic, High Pressure
MIL-F-8789	Fitting End, Attachable Hydraulic High-Pressure Hose
MIL-H-8790	Hose Assemblies, Rubber, Hydraulic, High Pressure (3,000 PSI)

MIL-R-8791	Retainer, Packing, Hydraulic, and Pneumatic, Tetrafluoroethylene Resin
MIL-H-8794	Hose, Rubber, Hydraulic, Fuel, and Oil Resistant
MIL-H-8795	Hose Assemblies, Rubber, Hydraulic, Fuel and Oil Resistant
MIL-H-8890	Hydraulic Components, Type III (-65° to +450°F), General Specification for
MIL-F-9490	Flight Control Systems - Design, Installation and Test of, Piloted Aircraft, General Specification for
MIL-V-19067	Valves, Check, Controllable, Hydraulic, Aircraft, Type II Systems
MIL-V-19068	Valves, Shuttle, Hydraulic, Aircraft, Type II Systems
MIL-V-19069	Valves, Check, Hydraulic, Aircraft, Type II Systems
MIL-P-19692	Pumps, Hydraulic, Variable Delivery, General Specification for
MIL-G-25308	Gage, Pressure, Dial Indicating, Hydraulic, Type ME-1
MIL-V-25675	Valves, Check, Miniature, Hydraulic, Aircraft and Missiles
MIL-G-25867	Gage, Pressure, Dial Indicating, Pneumatic
MIL-G-25987	Gages, Pressure, Dial Indicating, General Purpose, Aircraft

STANDARDS

Military

MIL-STD-17	Mechanical Symbols
MIL-STD-889	Dissimilar Metals
MS20995	Wire, Safety or Lock
MS21902	Union, Flareless Tube
MS21904	Elbow, Flareless Tube, 90°
MS21905	Tee, Flareless Tube
MS21906	Cross, Flareless Tube
MS21907	Elbow, Bulkhead Universal, 45°, Flareless Tube
MS21908	Elbow, Bulkhead Universal 90°, Flareless Tube
MS21909	Tee, Bulkhead and Universal, Flareless Tube
MS21910	Tee, Bulkhead, Flareless Tube, Internal Thread on Side
MS21911	Tee, Bulkhead, Flareless Tube, Internal Thread on Run
MS21912	Tee, Flareless Tube with Bulkhead on Run
MS21913	Plug, Flareless Tube
MS21914	Cap, Pressure Seal, Flareless Tube Fitting
MS21915	Bushing, Screw-Thread Expander, Flareless Tube Connection
MS21916	Reducer, External Thread, Flareless Tube
MS21917	Nut - Sleeve Coupling, Flareless
MS21924	Union, Flareless Tube, Bulkhead and Universal
MS24335	Flange, Bulkhead Mounting, Hydraulic, Self-Sealing Coupling
MS24352	Valve, Aircraft Hydraulic Restrictor, One-Way, Filtered
MS24353	Valve, Aircraft Hydraulic Restrictor, Two-Way, Filtered
MS24478	Gage, Single 1 Inch Dial, Pneumatic Pressure
MS24512	Gages, Pressure, Dial Indicating, General Purpose, Aircraft
MS27252	Plate, Identification

MS28016	Valve - Hydraulic Dual Thermal Expansion Relief
MS28061	Gages, Pressure, Engine and Utility, 2 Inch Flange-Mounted, Back Ports
MS28063	Gages, Pressure, Engine and Utility, 2-Inch, Flange- or Port-Mounted, Bottom Port
MS28700	Accumulator - Cylindrical, 3,000 PSI
MS28720	Filter, Aircraft Hydraulic Line Type, 3,000 PSI
MS28741	Hose Assembly, Detachable End Fitting, Medium Pressure
MS28759	Hose Assembly, Rubber, Hydraulic (3,000 PSI), Flared Tube
MS28760	Adapter, Straight, Tube to Hose
MS28761	Fitting End, Attachable, Hydraulic High Pressure Hose (3,000 PSI), Flareless Tube
MS28762	Hose Assembly, Hydraulic High Pressure (3,000 PSI) Flareless Tube
MS28764	Valve, Check, Controllable, Rotary-Action, Hydraulic, 3,000 PSI Type II Systems
MS28765	Valve, Check, Hydraulic, Internal Ports, 3000 PSI, Type II Systems
MS28766	Valve, Shuttle, Hydraulic, Direct Mounting, 3,000 PSI, Type II Systems
MS28767	Valve, Shuttle, Hydraulic, Internal-Thread, Tube Fitting Outlet, 3,000 PSI, Type II Systems
MS28768	Valve, Check, Controllable, Plunger-Type, Hydraulic, 3,000 PSI, Type II Systems
MS28771	Valve, Check, Hydraulic, Flared 3000 PSI, Type II Systems
MS28774	Retainer, Packing Backup, Single Turn, Tetrafluoroethylene
MS28775	Packing, Preformed, Hydraulic, +275°F ("O" Ring)
MS28776	Scraper, Piston Rod
MS28777	Washer, Aircraft Hydraulic Packing Back-Up
MS28778	Packing, Preformed, Straight Thread Tube Fitting Boss
MS28782	Retainer, Packing, Back-Up, Teflon
MS28783	Ring, Gasket, Back-Up, Teflon
MS28880	Valve - Controllable Hydraulic Check, Rotating Action, 3000 PSI
MS28881	Valve - Hydraulic, Directional Control, Slide Selector 4 Way, 3000 PSI
MS28886	Valve, Aircraft Hydraulic Flow Regulator
MS28889	Valve, Air, High-Pressure Charging
MS28892	Valve, 3,000 PSI Hydraulic Check, Flareless, Type II Systems
MS28893	Valve, Hydraulic Relief, Cylindrical, Type II Systems
MS28895	Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style A, By Pass, 275°F
MS28896	Filter, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Micron, Style B, Non By Pass, 275°F
MS28897	Filter Element, Fluid, Pressure, Hydraulic Line, 3000 PSI, Absolute 15 Microns, -65°F to +275°F
MS28932	Felt Strip, Packing Gland

MS33514	Fitting End, Standard Dimensions for Flareless Tube Connection and Gasket Seal
MS33515	Fitting End, Standard Dimensions for Bulkhead Flareless Tube Connections
MS33524	Recommended Port Sizes for Hydraulic Pumps (Aircraft)
MS33540	Safety Wiring and Cotter Pinning, General Practices for
MS33649	Bosses, Fluid Connection - Internal Straight Thread
MS33675	Scraper, Installation, Packing Gland Ring

Air Force-Navy Aeronautical

AN742	Clamp, Plain, Support, Loop-Type, Aircraft
AN814	Plug and Bleeder - Screw Thread
AN871	Flange - Straight Thread Boss Welding
AN893	Bushing - Screw Thread Reducer
AN901	Gasket - Metal Tube Connection Seal
AN924	Nut, Plain Hexagon, Tube, Bulkhead and Universal Fitting
AN937	Cross - Internal Screw Thread
AN938	Tee - Internal Screw Thread
AN939	Elbow - Internal Screw Thread, 90°
AN941	Elbow - Internal Screw Thread, 45°
AN6204	Valve, Hydraulic Bleeder
AN6227	Packing, "O" Ring Hydraulic
AN6230	Gasket, "O" Ring Hydraulic
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 Element Vent Type
AN6245	Valve-Hydraulic Thermal Expansion Relief
AN6247	Valve, Controllable Hydraulic Check (Rotating Action)
AN6280	Valve - 3000 PSI Hydraulic Check Internal Ports
AN6289	Nut - Flared Tube Universal Fitting
AN6293	Valve, 4-Way Rotary Selector, 3,000 PSI, Non-Interflow
AN6294	Valve, 4-Way Rotary Selector, 3,000 PSI, Interflow
AN6295	Regulator - 10 GPM Hydraulic Pressure
AN6296	Valve, Controllable Check, Plunger-Type, 3,000 PSI
AND10067	Valve Installation - Hydraulic Bleeder (Standard Dimensions for)
AND10074	Boss Spacing - Hydraulic
AND10104	Tubing, Steel, Corrosion-Resistant, Round, Standard Dimensions for
AND10313	Relief Valve Installation Clearance - Hydraulic

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 22-R255

INSTRUCTIONS: This sheet is to be filled out by personnel, either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments and suggestions submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or serve to amend contractual requirements.

SPECIFICATION

ORGANIZATION

CITY AND STATE

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO *(If "yes", in what way?)*

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity - Optional)*

DATE

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