

SURFACE VEHICLE RECOMMENDED PRACTICE

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HYDRAULIC SYSTEM DIAGRAMS AND ASSOCIATED TABLES FOR MARINE VEHICLES

Foreword—This Document has not changed other than to put it into the new SAE Technical Standards Board format.

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1. Scope—This document establishes the requirements for technical content and format of hydraulic system diagrams. This document does not establish configuration requirements, material, or performance requirements for any system or component identified herein.

1.1 Field of Application—The purpose of this document is to specify the minimum technical content of marine and submergence vehicle hydraulic system diagrams and provide a standard format. Diagrams prepared in accordance with this document will be suitable for use in procurement activity, shipboard installation, and technical manuals for use in troubleshooting, operation, and maintenance of the hydraulic system.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

AS1290—Graphic Symbols for Aircraft Hydraulic and Pneumatic Systems

2.1.2 U.S. GOVERNMENT PUBLICATIONS—Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2.1 Military Specifications

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

2.1.2.2 Military Standards

DOD-STD-100—Engineering Drawing Practices

2.1.3 FEDERAL CATALOG SYSTEM PUBLICATIONS—Available from Commander, Defense Logistics Services Center, ATTN: DLSC-JBDA, Battle Creek, MI 49017-3084

Commercial and Government Entity (CAGE) Handbook H4/H8

2.1.4 ANSI PUBLICATIONS—Available from American National Standards Institute, 10 East 46th Street, New York, NY 10017.

ANSI B93.31—Multi-Pass Method for Evaluating the Filtration Performance of a Fine Hydraulic Fluid Power Filter Element

ANSI B93.7—Hydraulic Fluid Power - Valves - Mounting Interfaces

ANSI Y14.1—Drawing Sheet Size and Format

ANSI Y14.2—Line Conventions and Lettering

ANSI Y32.10—Graphic Symbols for Fluid Power Diagrams

3. Definitions

3.1 Commercial And Government Entities Code (Cage Codes)—A five digit code assigned to each manufacturer and supplier doing business with the Federal Government. This code is an abbreviated means of identifying the name, address, and other pertinent informational data of a particular manufacturer or supplier.

3.2 Component Drawing Number—The manufacturer's drawing number of the identified component.

- 3.3 Filtration Ratio**—Used to specify the performance of a filter element, it is defined as the ratio of the number of particles greater than a given size in the influent fluid to the number of particles greater than the same size in the same volume of the effluent fluid.
- 3.4 Hydraulic System Diagram**—A schematic drawing that displays the functional relationship and technical information of a hydraulic system and its components. It is a basis which the supplier and user of the system are dependent upon for information. A hydraulic system diagram also includes explanatory notes and tables to clearly convey information relevant to the schematic.
- 3.5 Pressure, Design**—The pressure used in calculation of piping and piping components minimum section thickness. Within a system there will be at least two system design pressures, "supply" and "return". In some systems, several "supply" and "return" design pressures may apply to various portions of the system.
- 3.6 Pressure, Full Flow Differential**—The maximum pressure differential across a valve due to the characteristics of the valve when it is at rated flow.
- 3.7 Pressure, Hydrostatic Test**—A specific pressure or pressure range used to confirm the integrity of hydraulic system piping (tubing) and components following installation or assembly.
- 3.8 Pressure, Nominal Set**—The upstream or downstream pressure which a pressure control valve is intended to regulate and maintain.
- 3.9 Pressure, Rated Operating**—The maximum safe operating or working pressure of a component as determined by the manufacturer based on an established number of fatigue cycles.
- 3.10 Pressure, Reseat**—The differential pressure across a relief valve at which there is a reduction in flow through the relief valve equal to a predefined leakage rate. This is the pressure at which the relief valve is considered to no longer pass flow.
- 3.11 Service**—The type of system or application for which the identified component or lines are used.
- 3.12 Shock Grade**—The hi-impact shock classification per MIL-S-901 for the identified component or lines, necessary for some military hydraulic system applications.
- 3.13 Temperature, Maximum System**—The highest temperature that can exist in a system or subsystem and for which the system is designed to operate continuously.
- 3.14 Temperature, Minimum Ambient**—The lowest temperature which could exist in a system or subsystem as a result of the surroundings.
- 4. General Requirements for Hydraulic System Diagrams**
- 4.1 Drawing Sheet Size**—Engineering drawing sheet size and format shall be in accordance with ANSI Y14.1. Drawing roll sheet widths and lengths shall not exceed those for ANSI Y14.1 size designation H and segmented match lines shall not exceed 112 cm (44 in).

4.2 Engineering Drawing Practices—Drawing symbols shall be used to indicate a revision or reference a particular feature on the hydraulic system diagram. Line conventions and lettering shall be in accordance with ANSI Y14.2. For military applications, drawing practices on hydraulic diagrams shall conform to DOD-STD-100.

4.3 Hydraulic System References—For hydraulic systems which are defined by more than one diagram, each diagram shall have a unique drawing number and shall reference associated diagrams. References shall be tabulated in a region near the drawing title block.

4.4 Units of Measurement—Hydraulic system diagrams produced in accordance with this document shall be in either the International System of Units (SI) or United States customary (inch-pound) units as determined by the specific contract requirements. Mixture of SI metric units and inch-pound units should be avoided.

4.5 Drawing Sections—A hydraulic system diagram shall consist of the following sections:

- a. Schematic
- b. Notes
- c. Component tables
- d. Line table

A typical hydraulic diagram is shown in Figure 2 for guidance. For complex diagrams, clarity can be obtained by presenting the drawing sections on separate sheets with each section clearly identified as "Schematic," "Notes," "Component Tables," or "Line Table" in bold letters near the title block.

5. Requirements for Specific Sections of the Drawing

5.1 Schematic Drawing Section—The schematic drawing section shall provide the schematic of the hydraulic system. The schematic displays by means of graphic symbols the hydraulic connections and functions of a specific circuit arrangement. A schematic facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

5.1.1 FLUID POWER DIAGRAM DRAFTING PRACTICES—The drafting practices and symbols for boundries, enclosures, envelopes, and fluid flow lines shall comply with SAE AS1290 except where otherwise permitted or required by this document.

5.1.2 GRAPHIC SYMBOLS—All graphic symbols used to describe the hydraulic system components shall comply with ANSI Y32.IO as supplemented by SAE AS1290. Special graphic symbols other than those listed in ANSI Y32.IO or SAE AS1290 shall be identified and defined in a legend for reference. Exceptions to conventional symbols or practices shall also be identified. (Computer software containing SAE AS1290 is available for computer-aided drafting and design (CADD) systems.)

5.1.3 COMPONENT IDENTIFICATION—Each component shall have a unique number that will permit the number to be used to identify a specific valve or component in a technical manual or other written procedures. The diagram tables shall be arranged so that all components in the system can be identified. However, to save space, identical components need not be listed individually in the tables.

For military applications, there are often a number of requirements that must be incorporated in component identification. The component identification system in Figure 1 should be suitable for almost all applications with minor tailoring.

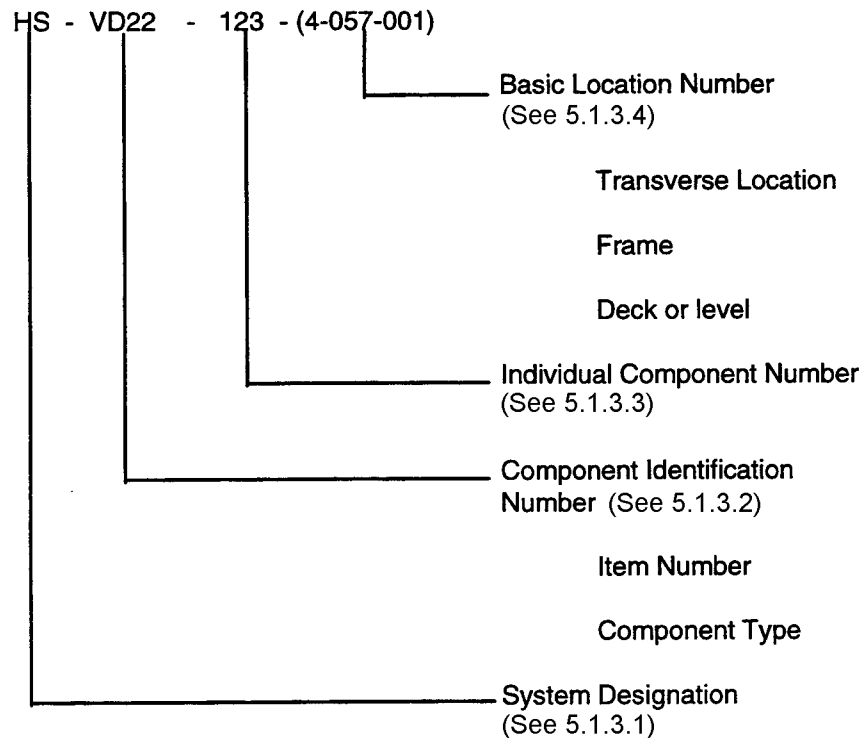


FIGURE 1—COMPONENT IDENTIFICATION SYSTEM

5.1.3.1 System Designation—On many ships there will be more than one hydraulic system. Each system should have a distinct designator. A two or three character designator is suggested, but a single character could be used for one system. For Navy ships, the shipbuilding specification may specify the designators to be used. For example, the following designators have been used for submarine hydraulic systems:

- a. HD -Diving Plane Hydraulic System
- b. HE -External Hydraulic System
- c. HP -Port Side Hydraulic System
- d. HR -Rudder Hydraulic System
- e. HS -Starboard Side Hydraulic System
- f. HPS -Valves and Components common to both Port and Starboard Hydraulic Systems

5.1.3.2 Component Identification Number—The component identification number consists of a component type designation and an item number.

- a. **Component Type:** The component type is designated by one or two character abbreviations. A separate table is used on the diagram for each type component. On a very simple system, all valves could be designated by "V" and a single valve table provided. For more complex systems, it may be desirable to group valves by several types such as "VD" for directional control valves and "VP" for pressure control. The abbreviations used are optional but the abbreviation must be included in the title for each table. The following abbreviations are suggested for identification of specific types of components:

1. AG - Accumulators, Gas-charged
2. CY - Cylinders, Linear Actuator
3. EM - Electric Motors
4. FL - Filters
5. FB - Flasks and Fluid Bottles
6. FH - Flexible Hose
7. GA - Gauges
8. HX - Heat Exchangers, Cooler
9. IR - Instrumentation
10. M - Motors, Hydraulic
11. P - Pumps
12. RA - Rotary Actuators
13. ST - Strainers
14. SD - Surge Dampers
15. TK - Tanks and Reservoirs
16. V - Valves
17. VD - Valves, Directional Control
18. VF - Valves, Flow Control
19. VP - Valves, Pressure Control
20. VM - Valves, Miscellaneous

- b. Item Number: Each different component under a specific type shall be designated with a unique item number. From the previous example, if the same model directional control valve is used in six locations, it could be listed in the tables only once by its type (VD) designation and item number (22). Thus the combined type designation and item number make up a component identification number which is used in the first column of the diagram tables to identify specific components. For drawings in accordance with DOD-STD-100, the component identification number can be used as a find number.

If the item number is not used, then each component must be listed in the tables by its individual component number. (See 5.1.3.3)

5.1.3.3 Individual Component Number—The individual component number is a unique number which provides the capability to identify a specific component in the system. From the previous example, each directional control valve used in six locations in the system may have the same system (HS) and component identification number (VD22). The individual component number (123) allows one to identify the specific valve. An individual component number shall be assigned for each valve. For components other than valves, individual system numbers may be omitted when the component is used only once in the system. Normally, individual system numbers shall be assigned in numerical order. However, a system of odd numbers for starboard locations and even numbers for port locations may be used when a basic location is not required.

5.1.3.4 Basic Location Number—The basic location number is a series of three numbers, separated by hyphens, designating (in the following sequence) the vertical, longitudinal, and transverse location of a component in the ship.

- a. Vertical Level: The first number shall indicate the vertical level at which the component is normally accessible by deck or platform number.
- b. Longitudinal Location: The second number shall indicate the longitudinal location of a component by frame number. If the component is not on a frame, the next forward frame number shall be used, unless that frame is outside the compartment in which the component is located; in this case the next frame number aft shall be used.

- c. **Transverse Location:** The third number shall indicate the transverse location by assigning of consecutive odd numbers for starboard locations and consecutive even numbers for port locations. The numerical "1" shall indicate the lowest centerline (or centermost starboard) component. Consecutive odd or even numbers shall be assigned to components from forward to next aft frame, and then outboard of the preceding component, as they would be observed as being from above.

Basic location numbers are required on some Navy surface ships. On other ships the use of the basic location number is optional.

- 5.1.4 **LINE IDENTIFICATION**—Piping and tubing between all junctions or nodes shall be labeled with an item number which corresponds to the line table. The suggested two letter abbreviation to be used for identification numbers associated with piping and tubing is "LN." For rapid identification of line size, the nominal size of the line can be inserted between the "LN" designation and the item number. System designation, individual component numbers, and basic location numbers are not required for piping/tubing.
- 5.1.5 **SET PRESSURES**—Where a single pressure is shown next to a relief valve in the schematic section, it shall be the nominal set (cracking) pressure. (See 5.3.2.17). The preferred notation is the maximum full flow differential pressure and the minimum reseal pressure being shown next to the relief valve.
- 5.1.6 **LINE FLOW CONDITIONS**—If line flow conditions are shown on the diagram, they shall be placed in three rectangular boxes in the format shown below and located adjacent to major piping runs. Define units used.

For example,

a	b	c
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indicates conditions where

a = Flow velocity in meters per second (or feet per second)

b = Flow rate in liters per minute (or gallons per minute)

c = Pressure drop in pascals at 40°C per meter of pipe (or pounds per square inch at 104°F per foot of pipe)

- 5.2 **Notes Drawing Section**—The notes drawing section shall provide technical information pertaining to the hydraulic systems requirements tests and procedures. Its function is to consolidate technical information which would otherwise obscure and clutter the schematic section. Notes shall be under the categories of system characteristics, system requirements, and other categories, if required.

- 5.2.1 **SYSTEM CHARACTERISTICS**—The following system design characteristics shall be provided under this category:
- Fluids:** The type of fluid to be installed shall be identified. If different fluids are to be used for testing or cleaning, it is recommended that they be identified or the applicable test and flushing procedure referenced.
 - Pressures:** The following hydraulic system pressures shall be identified:
 - System design pressures
 - Hydrostatic Test:** Where multiple levels of hydrostatic test pressure apply and are not easily described in a note, the component and line tables shall identify hydrostatic test pressures.