SECTION 74

GENERAL REQUIREMENTS FOR HULL AND MACHINERY PIPING SYSTEMS

ITEM		PAGE
74.1	REFERENCES	1
74.2	INTRODUCTION	1
74.3	GENERAL	2
74.4	SYSTEM DESIGN	3
74.5	INSTALLATION	5
74.6	MATERIALS	10
74.7	RESTRICTIONS	11
74.8	CORROSION PRECAUTIONS	13
74.8.1	USE OF PROPER MATERIALS	13
74.8.2	PROPER ISOLATION OF DISSIMILAR METALS	13
74.8.3	MINIMIZING FLOW TURBULENCE	13
74.8.4	PROPER DESIGN AND INSTALLATION OF THROTTLING DEVICES	14
74.9	VALVES, FITTINGS AND INSTRUMENT PIPING	14
74.10	TAKEDOWN JOINTS	17
74.11	CLEANING AND FLUSHING	18
74.12	SPARE PARTS AND INSTRUCTION MANUALS	20
74.13	TESTS, TRIALS AND INSPECTIONS	20
74.14	PHASE II TECHNICAL PROPOSAL REQUIREMENTS	21
74.15	PHASE III DETAIL DESIGN AND CONSTRUCTION REQUIREMENTS	21

74.1 REFERENCES

(74A) Code of Federal Regulations - 46 CFR Sub-chapter F

(74B) Code of Federal Regulations - 46 CFR Sub-chapter H

74.2 INTRODUCTION

This Section contains the Contractor Design and Provide general requirements for the design, fabrication, arrangement, installation, and cleaning of shipboard piping systems and piping

components. Requirements peculiar or supplemental to a specific system are covered by the Section of the Technical Specification governing that system. Where supplemental or differing requirements are in the Section governing the system, that Section of the Technical Specification requirements takes precedence. All piping system design, material selection, installation procedures, and testing shall conform to the requirements of the Authoritative Agencies.

For WSF Fleet-wide Standardization purposes, End No. 1 of the Vessel shall always be considered the bow, and this designation shall delineate port and starboard, fore and aft wherever they are addressed in the Technical Specification.

74.3 GENERAL

The respective piping systems installed on the Vessel shall be designed and provided with the necessary pumps, piping, valves, regulation valves, safety valves, relief valves, flanges, fittings, pressure gages, liquid level indicators, thermometers, etc., for safe and efficient operation of the Vessel under all conditions of service. System design, material selection, installation, and testing for piping systems installed on the Vessel shall meet Authoritative Agency, this Section, and the Technical Specification requirements. Materials for pipes, valves and fittings shall conform to **TABLE 74-4** at the end of this Section of the Technical Specification. System design, routing and size selection shall be determined by the Contractor's design to suit particular requirements, such as allowable pressure drop, length of pipe run, pump characteristics and to avoid cavitation, erosion, water hammer and noise. Except where specifically noted in the Technical Specification, the selection of pipe sizes shall be the responsibility of the Contractor considering particular system and service requirements in accordance with **TABLE 74-3** in the *CLEANING AND FLUSHING* Subsection in this Section of the Technical Specification.

Piping and piping components shall operate under the following conditions:

A. ***External climatic***: Where installed in exposed locations under the climatic conditions given in Section 12 of the Technical Specification.

B. ***Vessel's motion***: Where the Vessel's extremes of trim and list, and pitching and rolling motions are as given in Section 1 of the Technical Specification.

C. ***Ambient pressure***: Over a range of ambient pressure variations from 28 inches Hg to 32 inches Hg absolute.

D. ***Ambient temperature***: Under the extremes of ambient temperature associated with the installed location.

The general welding requirements of Sections 1, 1A, and 2 of the Technical Specification apply.

The requirements of this Section also apply to Section 11 of the Technical Specification, *Hull Piping*.

See Section 24 of the Technical Specification for piping and valve labeling requirements.

74.4 SYSTEM DESIGN

Piping shall be led as directly as practicable with a minimum number of bends and fittings and with sufficient joints to provide for removal, inspection, servicing and replacement of equipment. Bends or long radius elbows shall be used in place of short radius elbows wherever possible. Run piping to avoid cutting of the Vessel's structure where possible. Structural penetrations shall be reinforced where required in accordance with Section 2 of the Technical Specification. Piping systems shall be designed and installed for easy access to valves and components for both operation and maintenance. See Sections 1B and 2 of the Technical Specification for specific access and clearance requirements.

Care shall be exercised to ensure that piping system design and installations permit:

1. Free passage along walkways and ladderways.
2. Free access to perform operational and routine maintenance.
3. Free access to all doors, hatches and openings.
4. As much as is practicable, be free of interference to the ready removal of the Vessel's equipment and system components.

System piping and associated components shall be designed and installed to provide adequate flow to all equipment served under all normal operating conditions. The use of automatic regulators or restrictive devices, such as orifices, in lines servicing auxiliary components, such as heat exchangers, are permissible for obtaining and maintaining operational conditions, provided they do not impose undue restrictions, such as large pressure drops (necessitating an increase in pumping power) or destructive erosion conditions.

Orifices, where installed, shall be incorporated at flanged joints. The design and installation of orifice plates shall be such that a portion of each ("pan handle") extends visibly beyond the incorporating flanged joint and insulation if applicable. Orifice size shall be clearly stamped on the "pan handle".

All sanitary and other drain lines shall be designed and installed to provide a sufficient number of clean-out plugs/fittings to ensure clear access to each run of pipe from at least one end. Clean-out plugs/fittings shall be installed with the flow of the system media. Drains shall be located for easy accessibility and thorough draining of the system. Engine Room pump drains shall be routed to the bilge pockets.

To facilitate flow, **all** drain piping shall utilize sweep tees, and "Y" and lateral type fittings rather than standard tees.

Unavoidable high-points in closed piping systems shall be provided with vent fittings for air or gas removal. These high-point vents shall be provided with a ½ inch globe valve reduced to ¼ inch and provided with ¼ inch stainless steel tubing "gooseneck" to facilitate controlled venting into a cup or bottle.

Piping systems that rely on gravity for their motive force shall be sloped no less than ¼ inch per foot in longitudinal runs and ½ inch per foot on all transverse runs to ensure effective flow when combined with operational system static head.

Slope the piping in each system to drain naturally to the low end.

In order to prevent damage to piping and joints at bulkheads and decks, provide expansion bends sufficient to accommodate piping movement due to working of the Vessel's structure. To accommodate thermal growth, hot water heating supply and return piping shall be provided with at least one (1) expansion bend in each compartment that it passes through. Expansion joints **shall not** be used in lieu of expansion bends.

For WSF Fleet-wide Standardization purposes, flexible connections shall be provided between piping assemblies and resiliently mounted equipment as set forth below. Piping connected to reciprocating machinery shall have flexible connections, located as close to the machines as is practicable.

1. Flexible connections shall be fabricated using AEROQUIP FC-234 or AEROQUIP 2651 hose where applicable, except high pressure hydraulic steering hoses which shall be AEROQUIP FC-1508 (or current WSF approved equivalent), with AEROQUIP reusable fittings. Fire sleeves in accordance with 46 CFR shall be provided where required. Hoses shall be rated for 1½ times the working pressure of the system and be suitable for temperature ranges of system operation. All hose assemblies and installations shall meet 46 CFR §56. See engine GARLOCK EZ-Flo 206 requirements in the *INSTALLATION* Subsection in this Section of the Technical Specification.
2. Air system compressor outlet flexible connections shall be approved Teflon hose, AEROQUIP FC-186 (or current WSF approved equivalent), with stainless steel single wire braid. Hoses shall be sized to 1½ times the working pressure of the system and be suitable for temperature ranges of system operation. Hose connections may be IPS, threaded or flanged as appropriate using AEROQUIP Super Gem fittings.
3. Flexible connections shall not be used to compensate for misaligned piping or to carry the weight of the attached piping.

4. Flexible connections or takedown joints of rubber or neoprene hose with hose clamps ("PEDROS") are not permitted unless specifically approved in writing, on a case-by-case basis, by the WSF Representative.
5. Provide spare flexible connection assemblies in accordance with **TABLE 74-1** in the *INSTALLATION* Subsection in this Section of the Technical Specification.

"Y" type strainers shall be incorporated upstream of each automatic control valve. Strainers, except those for fuel and lubricating oil services, shall have accessible valved blow-off lines to the bilge or suitable "blow-down" containment when not installed in an area accessible to the bilge.

The use of mitered joints or mitered fittings **will not** be permitted unless specifically approved, in writing, by the WSF Representative.

The use of VICTAULIC type grooved piping method, or bolted pipe jointing clamp piping systems, as set forth in ASTM F1476, **will not** be permitted.

Pipe welding, brazing shall comply with 46 CFR §56.70. Joint design shall comply with 46 CFR §56.30 except as limited by the Technical Specification. ASTM F722 may be used as a guide.

Unless specifically approved otherwise by the WSF Representative, all backing rings used for pipe welding shall be of the consumable insert type.

In order to meet operational requirements and to facilitate on board and depot maintenance, isolation valves shall be designed and installed for individual and sectional systems, to include all branch lines, mains and equipment. Isolation capability (valve) is required so that individual components may be secured while the Vessel is in service without the disruption of similar items.

Piping systems shall be sized in accordance with fluid velocity criteria given below in **TABLE 74-3** in the *CLEANING AND FLUSHING* Subsection in this Section of the Technical Specification. Flow turbulence shall be minimized by: restricting the velocities to within the specified limits; elimination of abrupt changes of pipe diameters in piping runs and connections; incorporation of gradual transitions in diametrical changes; and the use of long-radius bends and fittings where feasible, swept tees and "Y"s, and lateral type fittings.

Diesel lube oil and hydraulic oil fill stations shall use KAM-LOK, or equal, fittings.

74.5 INSTALLATION

All piping in accommodation spaces shall be concealed behind ceiling panels and sheathing, except where exposed for purposes of connecting piping to fixtures. In order to maintain maximum headroom, all piping shall be kept behind framing and as close as practical to deck beams, bulkheads, and the underside of decks. Piping may penetrate girders, provided

approved compensation is made at the penetration (see the requirements of Section 2 of the Technical Specification)

All piping subject to mechanical injury shall be adequately protected. All guards shall be bolted in place, using stainless steel fasteners, so that they may be removed for repairs to piping.

During the fabrication, installation and testing of all piping systems, openings shall be kept tightly sealed to ensure foreign matter and moisture exclusion. This includes components such as valves, pumps, coolers, heaters and instruments. Tape alone, or the use of wood blanks **will not** be an acceptable means of foreign matter and moisture exclusion. Use metal or plastic caps, plugs and blanks, or metal plugs and gags as appropriate to limit system and component contamination.

Unless otherwise specified in the Technical Specification, piping penetrating decks or bulkheads shall be provided with tight fitting, extra heavy collars or sleeve fittings (similar to a coupling fitting as set forth in ASTM F682, Type II), at all locations. All such sleeves or collars shall be fabricated with a vent hole, which shall be closed after all welding, brazing, and/or soldering is complete. Collars or sleeves shall be continuously welded to both sides of the structure. Pipes shall be continuously seal welded, brazed, or soldered, as appropriate, to both ends of the sleeve. ***To meet WSF Fleet-wide Standard practices, the welding of a steel pipe passing through an "A" Class deck or bulkhead, directly to that deck or bulkhead (even though acceptable in NVIC 9-97, Figure 3.5(a)) <u>will</u> <u>not</u> be acceptable***.

Hot water supply, heating, waste heat; and refrigeration piping/tubing penetrating decks and/or bulkheads shall be thermally isolated from steel plating by the use of a ROMAC Style 702, or equal, compression type coupling, as a penetration sleeve, to prevent thermal loss from the system, as approved by the Authoritative Agencies.

All piping penetrations through "B" Class and "C" Class accommodation space bulkheads, as defined in USCG NVIC 9-97, shall be closed with tight fitting stainless steel face plates. Hangers shall be welded to basic structure such as beams, frames, stiffeners, flat bar or angle run between stiffeners, or plate that is opposite support structure. Hangers for nonferrous pipe or tube and for hydraulic systems shall be synthetic rubber lined. All piping passing through fire boundaries requiring Structural Fire Protection Insulation shall be insulated for twelve (12) inches (300 mm return) on the insulation side of the boundary to meet the requirements of USCG NVIC 9-97, and Section 75 of the Technical Specification.

Pipe bends shall conform to the ASME Power Piping Code in addition to applicable Authoritative Agency requirements, with due regard being given to erosion, head losses, bent pipe wall thickness, and other salient characteristics of the installed system.

Hydraulic piping shall utilize long radius bends of five (5) pipe diameters minimum (instead of elbows) except where the arrangement will not allow.

Pipe bends shall be to a minimum radius of five (5) times the nominal pipe carbon steel and 90-10 copper-nickel (Cu-Ni) piping up to four (4) inch IPS and 300 psi system design pressure and copper tubing may be bent to a radius of three (3) times the nominal tube diameter.

NOTE: To account for thinning of the bent wall at the outer radius, the ASME Power Piping Code requires increased nominal pipe wall thickness in many cases where pipe is bent to a radius of less than six (6) pipe diameters.

Piping shall be supported by hangers suitable for the material and service in accordance with ASTM F708, supplemented by the Manufacturer's Standardization Society (MSS) Standard Practice SP-69. ASTM F708, **Figure 1** ~ *Split Cap Hangers*, and **Figure 2** ~ *Strap Hangers* are preferred. The hangers shall be suitable for carrying the weight of the pipe and its contents including dynamic loading imposed by the operating conditions of Section 1 of the Technical Specification, and to prevent damage from vibration and thermal expansion. Utilize ASTM F708, Table 2, for maximum distance between pipe hangers. ASTM F708, **Figure 3** ~ *Welded Hangers*, **Figure 5** ~ *Welded Hangers*, and **Figure 6** ~ *J-Band Type Hangers*, are permitted only with specific written approval by the WSF Representative on a case-by-case basis. ASTM F708, **Figure 7 ~ *Nelson Hangers*** and **Figure 10 ~ *Crimp-on Weld Stud Hangers* will not be permitted**. "Piggybacking" of pipe hangers, unless specifically approved otherwise in writing by the WSF Representative, **will not** be acceptable.

Hangers and sway braces shall be attached to the basic structure of the Vessel and shall not be welded to any pipe. Attachments to structural plate shall only be opposite framing attachments. Hangers shall not be attached to shell or deck plating. Care shall be taken to ensure that piping and hangers are of compatible material. Where dissimilar materials occur, hangers shall be lined with a USCG approved isolation material which conforms with ASTM F708, **Table 1** ~ *Pipe Hanger Liner Materials*, except that sheet lead **shall not** be used.

Hangers for engine exhaust piping shall be lined, or, in some other appropriate manner, be thermally isolated from structure. The amount of piping exposed to weather shall be minimized. Piping hangers exposed to weather shall be configured, with 100-percent (100%) weld-out to minimize maintenance due to "running rust," including the use of corrosion resistant material where practical.

In addition to the weight effects of piping components, consideration shall be given in the selection of pipe hangers to other load effects such as those introduced by maximum operating pressure, thermal expansion, shock, vibration and motion of the Vessel as applicable. Hangers shall be chosen to permit the movement of piping caused by external forces and/or by thermal strain. Anchors and/or guides shall be provided, as required, to restrain, direct or absorb piping movements accounting for the dynamic effects of Vessel motion, internal pressure and expansion and contraction of the pipe under a full range of operating conditions.

Piping to resiliently mounted equipment shall be supported by means of resiliently mounted pipe hangers. There shall be at least two (2) resilient mounts in a "V" configuration with suspension such that each mount will be loaded along its axis and will provide total pipe support.

If spring type hangers are needed in conjunction with the resilient mounting of piping or to accommodate thermal or mechanical strains, they shall be suitable for the maximum loads imposed.

Flexible connections shall not be used to compensate for misaligned piping or to carry the weight of the attached piping.

For WSF Fleet-wide Standardization purposes, all flexible connections (expansion joints) shall be GARLOCK EZ-Flo 206 in engine installations for oil and hot fresh water lines. All expansion joint lengths shall be of a standard size for equal diameter pipe and targeted for use so that any joint of the same pipe diameter can be exchanged with any other joint on the Vessel.

As a minimum, except for GARLOCK EZ-Flo 206 applications, all hose ***free length*** shall be no less than eight (8) times the outside diameter of the hose.

All gasket material shall be ***certified asbestos and PCB free***.

All mechanical expansion joints and flexible connections shall remain unpainted.

Provide spare flexible connection assemblies in accordance with **TABLE 74-1**.

TABLE 74-1

Spare Flexible Connection Assemblies

Quantity of Standard Length of Flexible Connection	Quantity of Spares
1-3	1
4-6	2
7-10	3
11 and more	4

Notes:

1. Identify all flexible connections with metal tags that identify Manufacturer, Size, Model, Date of Manufacture, and Material.

2. Identify the application of each spare flexible connection with an attached tag.

Connections to pumps, tanks, etc., above 1½ inch nominal diameter shall be flanged. Connections of 1½ inch nominal diameter and below may be threaded with sufficient unions to permit removal of equipment. Where 150 pound steel flanges make up to valves or equipment with flat face flanges, the steel flanges shall be flat faced.

Piping in way of pumps shall be provided with suitable takedown fittings to allow easy removal of the pump for servicing.

All piping systems shall be fitted with low-point drains. Exterior piping shall be fitted with shut-off valves and drains for freeze protection.

All valves shall be located so as to be accessible for ease of operation and repair. Manually operated valves shall generally be installed with the stems vertical.

Where piping is below floor plates, the hand wheels shall be close to, but below the floor plates, with floor plate access provided over the hand wheels. Where unavoidable, solid reach rods shall be provided and securely attached to valves that would otherwise be difficult to reach. Reach rods shall be fitted with intermediate supports.

There shall be no unions installed in piping systems behind linings, or in inaccessible locations.

When reducers are required at pump inlets, provide eccentric type reducers in a horizontal plane with the straight side on top to prevent air-binding of the pump.

Discharge piping connected to self-priming and fire extinguishing pumps shall rise vertically not less than 30 degrees from the horizontal plane to permit self venting of air and/or gas.

Connections shall be provided for thermometers (with dry wells) and pressure gages as required to check proper operation of systems and/or equipment.

To facilitate inspection and maintenance of equipment (including tube or tube bundle withdrawal on components having removable heads), the piping connection thereto shall be designed and installed to permit access without breaking more than the connecting flanges.

Where systems have unavoidable low-points and/or pockets that may be affected by freezing temperatures or where trapped water may be detrimental to the operation of the system and/or system component, these systems shall be designed and installed with either flanged or bossed drainage fittings. Drainage points requiring drainage during start-up and those requiring relatively frequent manual drainage in service shall be provided with valved drains. Other points requiring infrequent drainage (in conjunction with maintenance, dry-docking and periodic inspection), may be provided with screwed plugs or caps. All low-points or pockets in the Firemain system shall be serviced by valved, capped, drains with remote operators as necessary. All low-points or pockets subject to weather in the Upper and Lower Vehicle Deck Sprinkler systems, shall be provided with a ⅜ inch diameter drain hole drilled in the bottom of the tubing or pipe.

Tubing systems shall be designed and installed utilizing the PARKER Multi-Clamp Tube Clamping System, or equal, throughout the Vessel. To conserve space stacking will be permitted; however, each tube in a stacked system shall be clearly and permanently identified at suitable intervals (not to exceed ten (10) feet), to aid in tracing systems for repair and/or maintenance. See Section 24 of the Technical Specification for additional marking requirements.

Pipe and/or tubing are not permitted in or on electrical cableway hangers, nor may they share deck and/or bulkhead penetrations.

All piping shall be fit without springing or forcing into place, and flange faces shall be parallel (plus $^{1}/_{32}$ inch, minus 0) before bolting.

Pressure control stations (reducing or regulating), unless specifically approved otherwise, shall consist of the following in order: isolation ball valve, "Y" strainer with valved blow-off (except in oil service piping), automatic control valve, isolation ball valve, pressure gage, and relief valve (where necessary). Pressure gages shall be provided with root valves as a means of isolation and a gage valve if the gage is not installed at the station. A single globe valved bypass line shall be incorporated, connecting upstream of the upstream isolation ball valve and downstream of the downstream isolation ball valve.

Keep sounding tubes, air escapes, valve operating rods, etc., behind the face of stiffeners and frames where practicable.

Each bilge branch connection shall have a suction bellmouth or pipe reducer with the inlet diameter not less than 1½ times the pipe diameter. The bottom of the inlet shall be ½ the pipe diameter from the bottom of the sump, but not over 1½ inches.

All piping systems shall be inspected by the Contractor in accordance with requirements of the Authoritative Agencies. If radiography is required, a weld joint identification plan shall be provided by the Contractor for each applicable piping system.

74.6 MATERIALS

Materials for the various piping systems shall be in accordance with **TABLE 74-4** included in this Section of the Technical Specification. The rules of the American Bureau of Shipping and the United States Coast Guard, in conjunction with ASTM F1155, shall be used in selecting materials. Should there be conflict between the requirements of ASTM F1155 and the Technical Specification, the latter shall prevail.

Where piping penetrates a watertight bulkhead, a deck or a tank top, provide an approved penetration fitting to insure the water tightness of the structure. In no case shall the plating form part of a joint or piping.

Where stainless steel bolting is used, the threads of all bolts shall be coated with MolyKote, or equal, anti-seize compound, prior to assembly. Any excess compound shall be cleaned up (removed) prior to application of coating systems.

Valves 2½ inches and above shall be supported from the Vessel's structure. Hangers shall be placed so as to avoid strain, where piping is connected to machinery. All non-ferrous piping which passes through a fire boundary shall be supported so that in the event of solder or brazing material melting, the piping system cannot sag and/or shift and thereby open a joint which would allow passage of smoke and/or flame.

Control air, gauge, and impulse tubing shall be minimum ¼ inch O.D. stainless steel tubing. Copper tubing may be used for copper and copper-nickel piping systems. The tubing may be hand bent or machine bent to a radius of three (3) times the nominal diameter. Hand bending without the use of an appropriately sized tubing bender shall not be acceptable.

1. Installations for the Sewage Tank level air bubbler gauges air shall use ⅜ inch OD stainless steel tubing installed with compression type fittings. The routing of tank level gauge air shall be free of low-points and installed with a minimum number of fittings and joints. See Section 71 of the Technical Specification for a description of the Sewage Tanks level indication systems.

Unless otherwise specified, ferrous pipe with welded fittings required to be galvanized shall be galvanized generally by the "hot dip" process; however ASTM A123/A123 and/or ASTM A153/A153M apply, as appropriate (see Section 100 of the Technical Specification for additional requirements). Where galvanizing is damaged during installation, GALVICON, or equal, brush-on galvanizing coating shall be applied on the damaged areas after appropriate surface preparation.

Where galvanized screwed fittings are required, both galvanized piping and fittings shall be used.

Where screwed plugs or caps are incorporated, they shall be bronze for either ferrous or non-ferrous materials except that plugs exposed to seawater shall be Monel.

Except where otherwise required, the designation of valve trim includes stem, disc (or gate), nut, seat, back seating bushing and guides.

74.7 RESTRICTIONS

Keep fuel and lubricating oil piping away from engine exhaust pipes and the oil-fired hot water heater uptake. Avoid routing pipes near electrical equipment as much as possible, and in no case locate flanges or joints over electrical equipment. In particular, do not run piping over the switchboards, motor control centers, distribution panels, etc.

Piping systems containing combustible or flammable liquids under pressure shall be designed and installed so that flanged connections and valves are located remotely from exposed surfaces having a temperature in excess of 450F degrees. Protective spray shields selected in accordance with ASTM F1138 shall be provided around flanged connections and valves where necessary to prevent the possibility of spray onto exposed hot surfaces.

Lubricating oil systems shall be located at least eighteen (18) inches away from surfaces which have temperatures under the insulation or lagging in excess of 650F degrees. All other systems containing combustible and/or flammable liquid shall be located at least eighteen (18) inches away from surfaces which have temperatures under the insulation or lagging in excess of 450F degrees.

Piping penetrating watertight or oil-tight decks and/or bulkheads shall be designed and installed with a tight fitting, extra heavy collar or sleeve fitting similar to ASTM F682 at all locations. The collars or sleeves shall be continuously welded on both sides of the plating. Pipes that pass through the collar/sleeve shall be continuously welded, brazed or soldered, as appropriate, to the sleeve. Piping that is open ended to a compartment as well as propulsion system and vital system piping shall not penetrate main sub-division bulkheads within one-fifth ($^1/_5$) of the beam from the side of the Vessel. Where possible, propulsion and vital system piping shall not be routed within one-fifth ($^1/_5$) the beam from the side of the Vessel. For this purpose, "propulsion and vital system piping" shall be considered necessary to maintain full propulsion and control capability of the Vessel. Firemain piping that is arranged such that damage from one (1) side of the Vessel would not disable the system, may penetrate outside the one-fifth ($^1/_5$) beam if necessary.

Piping penetrations through non-tight structure shall be reinforced where necessary in accordance with Section 2 of the Technical Specification.

Precautions shall be taken to preclude personnel hazard from the bulkhead or deck penetrated by hot water piping (both heating water and domestic hot water) if surface temperature of the bulkhead or deck exceeds 125F degrees. Heated piping systems and piping exposed to freezing shall be insulated in accordance with Section 75 of the Technical Specification.

Swing check valves shall be installed in a fore/aft orientation where possible.

Unless directly associated with equipment installed in those spaces, piping shall not pass through the Small Galley or Cafeteria areas, or through spaces predominantly equipped with electrical equipment or components. When it is necessary to pass through or enter such spaces, piping shall be of ***one length throughout*** unless it can be demonstrated that such installation is impractical. Joints, when permitted, shall be either welded, soldered, or brazed sleeved joints.

Drains from piping and equipment shall not be less than ½ inch IPS.

Silver-base filler metals used in the brazing of nonferrous to nonferrous base metals shall conform to "SILVALOY 15," or equal. The brazing temperature should not exceed the

annealing temperature of the base pipe material, but in no case shall the brazing temperature range exceed 1,300F through 1,500F degrees for 90-10 copper-nickel pipe and tube.

Brazing of ferrous to non-ferrous base metals shall be accomplished using "SILVALOY A45," or equal.

Teflon tape **shall not** be used for sealing threaded joints.

74.8 CORROSION PRECAUTIONS

Piping conveying corrosive media shall be designed and installed so as to be protected from the effects of corrosion and/or corrosion erosion by:

74.8.1 Use of Proper Materials

Valves and fittings (except resilient-seated butterfly valves and other approved lined or liner type valves and fittings) in nonferrous piping runs shall either be bronze or of a material comparable to the applicable piping material.

74.8.2 Proper Isolation of Dissimilar Metals

Avoid unnecessary joints of ferrous and nonferrous materials. Where such joints cannot be avoided, a flanged "waster piece," fourteen (14) inches long, of extra-heavy black iron pipe and black iron fittings shall be provided. In piping 1½ inches and below, dielectric unions may be substituted for the flanged waster piece between the dissimilar metal lines. However, no waster piece or dielectric union is required where a nonferrous line connects to a ferrous line having a diameter two (2) or more times larger. Waster pieces shall be designed for easy replacement and incorporated in readily accessible locations. ***Waster pieces shall not be galvanized nor painted***. Wherever any waster spool is installed, an identical waster spool shall be provided as an emergency replacement. Spare waster spools shall be attached to structure as near as practicable to the installed spool piece with ASTM F708, **Figure 1** ~ *Split Cap Hangers.*

All waster pieces shall be clearly located and indicated on piping arrangements and FINAL AS-BUILT drawings.

74.8.3 Minimizing Flow Turbulence

Observe the maximum allowed velocities of **TABLE 74-3** in the *CLEANING AND FLUSHING* Subsection in this Section of the Technical Specification. Avoid abrupt changes in direction of flow. Provide gradual transitions in changes of piping runs and connections by using long-radius bends and/or fittings, sweep tees, and "Y" and lateral type fittings. Ensure flanges are properly aligned and pipes are finished flush with the flange face. Ensure pipe internals are free of protruding jointing material, weld bead, or braze bead.

74.8.4 Proper Design and Installation of Throttling Devices

Body passages in throttling devices shall be designed to provide gradual changes in flow direction. In addition, the downstream cavity shall be as large as practicable to permit dissipation of the issuing jet before making wall contact. At points where direct impingement at close range does occur and cannot be avoided, section thickness shall be increased to provide adequate material to withstand the additional erosive effect. Piping downstream of throttling devices shall have a straight run at least ten (10) times the inside pipe diameter where practical.

74.9 VALVES, FITTINGS AND INSTRUMENT PIPING

Except where indicated differently in specific Sections of the Technical Specification, for pipe sizes two (2) inches and below, full-port ball valves shall be used.

WSF Fleet-wide Standardization purposes specify a specific type and manufacturer for certain valves onboard the Vessel. Those standardized valves are listed in **TABLE 74-2**.

TABLE 74-2

WSF Fleet-wide Standardized Valves

Service	Type	Manufacturer	Model
All through-hull discharge connections	elastomer-lined insert check valve	CENTER LINE, MARK CONTROLS CORP.	Series 800, Buna-N liner, 316 Stainless steel plates, 316 Stainless steel springs
Sewage overboard discharge valves at Vehicle Deck stations	ball valve	MILWAUKEE VALVE CO.	6" F91SS150R-02-H-AD, uni-body, Fire-Safe, flanged end

Instrumentation piping system components and materials shall be designed and installed in accordance with Authoritative Agency requirements, ASTM F721, and this Section and Section 85 of the Technical Specification.

Except where indicated differently in this Section and other Sections of the Technical Specification, where shut-off or throttling is required, full-port ball valves shall be used for pipe sizes two (2) inches and below; gate valves shall be used where shut-off only is required for pipe sizes above two (2) inches; globe or angle valves shall be used where throttling is required above two (2) inches.

Butterfly valves may be used in water service pipe sizes above two (2) inches, provided the seat material suits the system's maximum operating temperature. Butterfly valves **shall not** be used on Sea Chests and overboard shell connections.

Spindles, seats, and disks of valves shall be of corrosion-resisting materials except as may be specifically noted in the Technical Specification or **TABLE 74-4,** Material Schedule.

Stop, throttling, and check valves shall have renewable disks, gates and balls, and re-grindable seats.

To the greatest extent possible, valves shall be right-hand closing and shall be rising stem with hand wheel. Otherwise an indicator shall be provided to show whether the valve is open or closed in accordance with 46 CFR §56.20-9 (a).

Valves 2½ inches and over, except for butterfly valves, fire station hose valves, and ball valves, shall be commercially (ANSI) flanged with bolted bonnets and stuffing boxes. Unless otherwise specified, valves two (2) inches and under shall have flanged or union ends (or the equivalent) and bonnets as outlined in **TABLE 74-4**.

Butterfly valve body and disk materials shall be as noted in the Material Schedule, **TABLE 74-4**. Valve stems shall be ANSI 316 stainless steel. Valve seats shall be Buna N in water service, Viton in diesel oil and lubricating service, or as required to suit the service intended. Fit butterfly valves between weld-neck flanges wherever possible.

Except where otherwise specified, ball valves shall be WORCESTER CONTROLS Maxi-Miser, Series 59, full-port, with bolted body construction, or PITTSBURGH BRASS MANUFACTURING CO. two-way SP-Series, Special Port-Extra Large, or equal. Seats and seals shall be TFE or Buna N in water service; Viton in diesel oil and lubricating oil; and reinforced TFE in compressed air.

Application of resiliently seated valves shall be subject to limitations of 46 CFR §56.

Hand wheels for valves located below the deck plates and/or gratings, except as noted in this Technical Specification, shall not extend through the deck plate or grating so as to present a tripping hazard. Hand wheels for sea valves shall be designed and installed above the deck plates and/or grating levels. These hand wheels shall be easily accessible and identifiable, and not be located in walkways nor present a tripping hazard.

Manually operated valves shall be readily operable by one person directly or through mechanical advantage type remote valve operators or **substantial**, permanently fixed, reach rods. Portable, "pickle-fork" type reach rods are **not** acceptable. The valve control operator handles or hand wheels shall be easily accessible to operating personnel without the need for lifting floor plates and/or gratings, climbing over or through machinery and/or piping, and reaching higher than 6 foot - 6 inches (6½) feet above deck plate/grating levels. Hinged access doors through floor plates and/or gratings will be allowed to reach hand wheels no more than six (6) inches below the above mentioned plates and/or gratings. Rigid rod type

remote valve operators manufactured by B.W. ELLIOTT MANUFACTURING Co. Inc., or equal, shall be designed and installed as necessary to avoid such lifting and/or reaching. Where rigid rod type operators used in conjunction with universal joints up to a maximum of 30 degree offset and gearboxes beyond 30 degree offset cannot be installed, remote valve operators of the gear box type (90 degree or swivel gear), or flexible type, manufactured by B.W. ELLIOTT MANUFACTURING Co. Inc., or equal, shall be designed and installed. All valves 2½ inches and over shall be labeled or stamped on the valve control handle or hand wheel to clearly show the direction of movement required to open and to close.

Valve locking devices shall be in accordance with ASTM F993, Type II. Locking devices for ball valves shall be a WSF Representative approved derivative of the Type II locking device.

Valves and remote valve operators shall be fitted with nameplates in accordance with Section 24 of the Technical Specification, and shall be accessible under any service condition.

Valves shall be right-hand closing and shall have either a **rising stem, or an indicator** to show whether the valve is open or closed in accordance with 46 CFR §56.20-9 (a).

Firemain system hose valves shall be USCG approved bronze, 1½ inch, screwed valves with nine (9) threads per inch (TPI) hose connection, and bronze “cap-and-chain”.

Unless it can be demonstrated to be impractical by reason of access or interference, manually operated valve stems shall be installed with the valve stem on or above the horizontal plane. Ball and butterfly valves shall be installed in such a manner that the valve opens and the handle points with the media flow under normal conditions of operation.

Provide relief valves in accordance with 46 CFR §54 of sufficient capacity to relieve maximum pump flow on the discharge side of all positive displacement pumps that do not have built-in relief valves, and as necessary to protect piping and equipment from possible over pressure.

Provide check valves or approved backflow preventers wherever flow reversals would be detrimental to operational requirements or required by rule, regulation, or law whether local, State or Federal.

Where pressure reducing valves are installed, except in tank level air systems, provide a bypass with a globe valve around the reducing valve, a pressure gage, and relief valve on the low pressure side.

Automatic control valves shall be designed and installed to meet full operational requirements and permit field adjustments, inspection and maintenance without removal from the line. They shall also be designed to assume a fail-safe position that will satisfy the requirements of system safety while affording continued operation.

System balancing valves shall be provided with a position indicator that will clearly indicate valve position. These indicators shall be permanently marked after system balancing is complete to allow for resetting any valve inadvertently readjusted to it's original "balanced system" position.

Stop check valves shall be incorporated where required by regulation, or where both stop and check features are necessary.

Motor operated valves shall be suitable for remote and local operation and shall be provided with local indicator and remote position indicator lights.

Gate or butterfly valves shall not be used in throttling service.

Ball valves shall be used to the maximum extent in potable water, flushing and compressed air systems.

All globe valves shall be incorporated with the system's pressure under the disc. Sea valves shall be installed with sea pressure under the disc.

Except where otherwise specified, the designation of valve trim includes the following: stem, disc (or gate or ball), nut, seat, back seating bushing and guides.

Unless specifically approved by the WSF Representative, manifolds shall be fabricated from assembled valves and fittings in lieu of integral castings.

The use of Association of American Railroad (AAR) fittings in lieu of Extra Heavy 300 pound malleable iron fittings is prohibited.

The use of cocks in place of valves is prohibited.

Where sil-braze fittings are specified in accordance with MIL-F-1183, Type A shall be provided.

74.10 TAKEDOWN JOINTS

Unless specifically specified otherwise, necessary takedown joints in stainless steel tubing for low pressure air, and water tubing shall be PARKER "Triple-Lok", or equal. Necessary takedown joints in stainless steel tubing for diesel oil, lubrication oil, and hydraulic systems shall be SWAGELOK, or equal, and shall incorporate the SWAGELOK Gap Inspection Gage for installation pull-up in all cases. The Gap Inspection Gage shall be turned over to the WSF Representative at delivery for each Vessel.

Flanged takedown joints and unions in piping systems shall be in accordance with **TABLE 74-4 -** Material Schedule. Flanges in piping shall conform to ANSI Standards for the appropriate service.

Where a steel flange is used with a cast iron or bronze flange, the steel flange shall have a flat face and a full face gasket shall be used. For WSF Fleet-wide Standardization purposes, flange gaskets shall be GARLOCK Blue-Gard 3300 in water service, and they shall be GARLOCK Blue-Gard 3000 in fuel, lubricating, and hydraulic oil service. All gasket material shall be certifiable asbestos free. Certifications shall be provided prior to shipboard installation.

Takedown joints in soft copper tubing shall be PARKER "Intru-Lok", or equal. Standard, flared, flareless and compression type joints may be used in tubing joint under two (2) inches, subject to the limitations of 46 CFR §56.

Suitable takedown joints shall be provided in piping to allow access to and/or removal of piping system components such as pumps, pressure regulators, valves and strainers (and their baskets), and to remove **unavoidable** piping interferences to the ready removal of the Vessel's equipment and/or system components. Unions will not be permitted in piping in inaccessible locations.

74.11 CLEANING AND FLUSHING

All piping, piping appurtenances, and associated equipment shall be thoroughly cleaned after fabrication. After installation and ***prior*** to pressure testing, each system shall be thoroughly cleaned of **ALL** foreign material utilizing the system's normal medium or an approved substitute. Prior to final assembly, internal surfaces of newly fabricated fuel oil, lube oil, and hydraulic fluid piping shall be cleaned by acid pickling (or by other WSF approved means to remove scale and contaminants), oiled to prevent corrosion, and preserved. All pickled and oiled piping shall have their ends sealed after cleaning until installation to preserve the interior pipe surfaces.

Prior to flushing of all silver-brazed or soldered piping, piping appurtenances, and associated equipment, these systems shall be thoroughly cleaned after installation in the Vessel of all flux deposits. Flux deposit removal shall be accomplished by a twelve (12) hour soak with ambient fresh water followed by either a four (4) hour flush with ambient fresh water, or a one (1) hour flush with 100F degree (plus 30F degrees, minus 0F degrees) fresh water.

Prior to any flushing activities, such units as auxiliaries, heat exchangers and control valves having in-line mechanisms capable of trapping, or being affected by the carry-over of foreign matter, shall either be removed or blanked-off and bypassed.

Unless otherwise specified, system cleaning shall be accomplished using independent (not WSF shipboard) flushing machines using system fluids or other WSF approved medium at normal pressures, and at a velocity greater than the normal operating system fluid velocity (see **TABLE 74-3** for *Fluid Design Velocities*), except that fuel oil, when used as a flushing medium, **shall not** be heated.

Except on copper-nickel or copper pipe, during flushing activities the complete piping system (along its full length) shall be **continuously** vibrated by using pneumatic or electric motor driven line vibrators (of the temporary in-line type) firmly affixed to the piping throughout the cleaning cycle, and/or portable hand types.

Temporary jumpers shall be installed so that all portions of the system are flushed. Fit temporary strainers in systems where required while systems are being flushed. Temporary strainers shall be lined with ten (10) micron filter bags, (five (5) micron for fuel and hydraulic systems), and shall be inspected every two (2) hours during flushing activities. Clean temporary strainers periodically while changing filter bags, and continue flushing until it is demonstrated to the satisfaction of the WSF Representative that two (2) consecutive bags show no signs of dirt, scale and/or foreign material. **Cleanliness for hydraulic systems shall be National Aerospace Standard (NAS) 1638, Class 8 or better**. Sumps, tanks and equipment which cannot be adequately flushed, shall be hand cleaned and inspected prior to service.

Specific cleaning and flushing requirements for each piping system are described in its particular Section of the Technical Specification.

After system flushing, drain all fuel, lube, and hydraulic oil used for flushing. Open and manually clean affected sumps and tanks with lint-free rags or other suitable wiping material to remove all traces of residual contamination and oil. Final inspection of oil sumps and closure of accesses is to be witnessed by the WSF Representative. Close the sumps and tanks utilizing new gaskets and fill with new, clean oil.

Piping systems or affected sections shall be re-flushed after any modifications.

TABLE 74-3
Fluid Design Velocities

Type of Service	Nominal Pipe Diameter (in)	Maximum Velocity (FPS)
Fuel Oil Suction	2 × SQRT(D)	7
Fuel Oil Discharge	5 × SQRT(D)	12
Lubricating Oil Suction	1 × SQRT(D)	4
Lubricating Oil Discharge	2 × SQRT(D)	6
Sea Water Suction	3 × SQRT(D)	**
Sea Water Discharge	5 × SQRT(D)	**
Freshwater Suction	3 × SQRT(D)	15
Freshwater Discharge	5 × SQRT(D)	20

Where: (D) = pipe internal diameter in inches

** = 9 FPS for galvanized steel and 12 fps for Cu-Ni pipe except for occasional use service systems

After successful cleaning and flushing, and pressure testing of all POTW piping systems, disinfecting of the entire system shall be accomplished as set forth in the *Cleaning and Disinfecting* Subsection in Section 59 of the Technical Specification.

74.12 SPARE PARTS AND INSTRUCTION MANUALS

Provide a list of recommended spare parts and special tools for those items which are Contractor furnished, together with parts lists and instruction manuals necessary to maintain and service provided equipment and accessories in accordance with the requirements of Sections 86 and 100 of the Technical Specification.

74.13 TESTS, TRIALS AND INSPECTIONS

Tests and/or trials shall be provided in accordance with this Section and Section 101 of the Technical Specification.

Inspections shall be performed as defined in this Section and in Sections 1, 2 and 14 of the Technical Specification.

74.14 PHASE II TECHNICAL PROPOSAL REQUIREMENTS

See Section 100 of the Technical Specification for requirements regarding technical documentation.

74.15 PHASE III DETAIL DESIGN AND CONSTRUCTION REQUIREMENTS

The following deliverables, in addition to other deliverables required by Section 100 of the Technical Specification and the Authoritative Agencies, shall be provided during the Phase III Detail Design stage of Work in accordance with the requirements of Section 100 of the Technical Specification:

A. List of Flexible Hoses

B. Piping Hanger Calculations

C. List of Waster Pieces

The ***List of Flexible Hoses*** shall identify locations, sizes, system fluids, assembly dates, hose and fitting type, manufacturer, design pressure and material.

Piping Hanger Calculations shall be made for each system and may be included with each system's calculations or prepared separately. However, load calculations for variable and constant support type spring hangers shall be provided separately.

See Section 100 of the Technical Specification for additional requirements regarding technical documentation.

(END OF SECTION)