
NATIONAL AERONAUTICS NASA/KSC-21 30 00.00 98 (October 2007)
AND SPACE ADMINISTRATION -----
Preparing Activity: KSC Superseding
NASA/KSC-21 30 00.00 98 (February 2007)

NASA/KSC GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2009

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DIVISION 21 - FIRE SUPPRESSION

SECTION 21 30 00.00 98

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10/07

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SECTION 21 30 00.00 98

FIRE PUMPS
10/07

NOTE: This specification covers the requirements for internal combustion engine and electric motor driven fire pumps and associated equipment. Combustion engine drive must be provided, unless electric power is provided from two separate sources or the KSC AHJ deems the power source to be reliable. Dual drive pumps are not permitted. System requirements must conform to KSC-STD-F-0004 (latest revision), "Standard for Fire Protection Design" and NFPA 20, "Installation of Centrifugal Fire Pumps."

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

NOTE: The following information must be shown on the project drawings:

1. Configuration, and minimum sizes for each piping system (see Table 2-20 in NFPA 20);
2. Location and type of each pump, controller, test header including associated equipment housekeeping pads and appurtenances;
3. Capacity of each item of equipment, including showing the size of all floor drains and their

locations. Ensure the minimum size floor drain is 6 inches 152 millimeter. Show the pitch of the floor also.

4. Locations and details for special supports for piping; and

5. For pipe larger than 12 inches 300 millimeter, details of anchoring piping including pipe clamps and tie rods.

6. Provide redundant pumping for all installations.

7. This specification is intended for use as part of a performance based criteria, with the detailed engineering calculations and design to be provided by the Contractor. The preparer must evaluate the existing water supply and estimated system requirements to provide an approximation of the actual pump capacity and pressure needed.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text are automatically deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 317 (1992; Reprint 1999) ASD Manual of Steel Construction, Vol II: Connections

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4 (2003) Cement-Mortar Lining for

	Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	(2008) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2000) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/A21.51	(2002; Errata 2002) Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C500	(2002; R 2003) Metal-Seated Gate Valves for Water Supply Service

ASME INTERNATIONAL (ASME)

ASME B16.11	(2005) Forged Fittings, Socket-Welding and Threaded
ASME B16.21	(2005) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.26	(2006) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2006) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(2004) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1998; R 2006) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2007; Addenda 2008) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 135/A 135M	(2006) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A 193/A 193M	(2008b) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(2008b) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

Welded and Seamless

- ASTM B 135 (2008a) Standard Specification for Seamless Brass Tube
- ASTM B 42 (2002e1) Standard Specification for Seamless Copper Pipe, Standard Sizes
- ASTM B 88 (2003) Standard Specification for Seamless Copper Water Tube
- ASTM B 88M (2005) Standard Specification for Seamless Copper Water Tube (Metric)
- ASTM C 533 (2007) Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation

FM GLOBAL (FM)

- FM P7825 (2005) Approval Guide

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

- MSS SP-58 (2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
- MSS SP-69 (2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
- MSS SP-80 (2008) Bronze Gate, Globe, Angle and Check Valves

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 13 (2006; Errata 2007; Amendment 1 2008) Installation of Sprinkler Systems
- NFPA 20 (2006) Installation of Stationary Pumps for Fire Protection
- NFPA 24 (2006) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
- NFPA 37 (2006) Installation and Use of Stationary Combustion Engines and Gas Turbines
- NFPA 70 (2007; AMD 1 2008) National Electrical Code - 2008 Edition
- NFPA 72 (2006) National Fire Alarm Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

- NICET 1014-7 (2003) Program Detail Manual for Certification in the Field of Fire

Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-101 (Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595 (Rev B; Am 1) Colors Used in Government Procurement

FS A-A-1922 (Rev A) Shield, Expansion (Caulking Anchors, Single Lead)

FS A-A-1923 (Rev A; Notice 1) Shield, Expansion (Lag, Machine and Externally threaded Wedge Bolt Anchors)

FS A-A-1924 (1995, R 2001-Rev A) Standard for Shield, Expansion; (Self Drilling Tubular Expansion Shell Bolt Anchors)

FS A-A-1925 (Rev A; Notice 1) Shield, Expansion (Nail Anchors)

FS A-A-55614 (1995) Shield, Expansion (Non-Drilling Expansion Anchors)

FS A-A-55615 (1995) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors)

UNDERWRITERS LABORATORIES (UL)

UL 1247 (200; Rev thru Sep 2008) Diesel Engines for Driving Centrifugal Fire Pumps

UL 142 (2006; Rev thru Dec 2007) Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 262 (2004) Standard for Gate Valves for Fire-Protection Service

UL 789 (2004; Rev thru Aug 2008) Indicator Posts for Fire-Protection Service

UL 80 (2007; Rev thru Jan 2008) Steel Tanks for Oil-Burner Fuel

UL Fire Prot Dir (2008) Fire Protection Equipment Directory

1.2 FIRE PUMP SYSTEM

Provide fire pumps and associated equipment complete and ready for operation. Equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in

accordance with NFPA 20, NFPA 70, and NFPA 72, except as modified herein. Devices and equipment for fire protection service must be UL Fire Prot Dir listed or FM P7825 approved. In the NFPA standards referenced herein, consider the advisory provisions to be mandatory, as though the word "must" had been substituted for "should" wherever it appears; interpret reference to the "Authority Having Jurisdiction" to mean the [Kennedy Space Center] [Cape Canaveral Air Force Station], Fire Protection Engineer, and whose opinion is final.

1.2.1 Pump Room

Show detail plan view of the pump room including elevations and sections showing the fire pumps, associated equipment, and piping. Show piping schematic of pumps, devices, valves, pipe, and fittings. [Provide an isometric drawing of the fire pump and all associated piping]. Show point to point electrical wiring diagrams. Show piping layout and sensing piping arrangement. Show engine fuel and cooling system. Include:

- a. Pumps, drivers, and controllers
- b. Hose valve manifold test header
- c. Circuit diagrams for pumps
- d. Wiring diagrams of each controller

1.2.2 Design

This is a performance based specification with the Contractor responsible for providing engineering design, installation and testing associated with the work to be performed. Design work must be performed by a "delegated engineer" as defined under Florida Statutes, Chapter 471, who must be a Professional Engineer, licensed to practice in Florida.

1.3 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Keep submittals to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, use a code of up to three characters within the submittal tags following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office

(Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that reviews the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Piping layout and sensing piping arrangement

Pump room

Prepare working drawings on sheets not smaller than 610 x 914 millimeter 24 by 36 inches drawings must be signed and sealed by a registered engineer, licensed to practice in Florida. In addition to hard copies, provide an electronic .DWG, .DXF or DGN computer format on a CD ROM.

SD-03 Product Data

Fire pumps

Jockey Pump

Driver including [electric motor] and [diesel engine]

Fire Pump Controller, including [electric motor] and [diesel engine]

Jockey Pump Controller

Pipe

Fittings

Valves, including gate, check, globe, and relief

Hose valve manifold test header

Pipe hangers and supports

[Flow meter]

Submit manufacturer's certified test characteristic curves for each pump, including pump discharge curves and horsepower curves.

SD-07 Certificates

Qualifications of welders

Qualifications of installer

Preliminary test certificate

Final test certificate

Contractor's State Certification

SD-10 Operation and Maintenance Data

Fire pumps

Driver
Fire Pump Controller
[Flow meter]
Valves
Operation and Maintenance Manuals

Include manufacturers catalog data, installation instructions, maintenance manuals, wiring diagrams, and test results. Organize data in a three ring loose-leaf notebook binder, into sections with identifying tabbed dividers, a table of contents and identifying front and spline covers.

SD-11 Closeout Submittals

Posted operating instructions for fire pump components

1.4 QUALITY ASSURANCE

1.4.1 Qualifications of Welders

Submit certificates of each welder's qualifications prior to site welding; certifications must not be more than one year old.

1.4.2 Qualifications of Installer

Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings must be prepared, by or under the supervision of, an individual who is experienced with the types of work specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies (NICET 1014-7) as an engineering technician with minimum Level-III certification in Automatic Sprinkler System layout program. Submit data for approval showing the name and certification of all involved individuals with such qualifications prior to submittal of drawings. The installing fire pump contractor must provide Contractor's State Certification as a Class I, per Florida Statutes for Fire Pump Installation Services.

1.4.3 Preliminary Test Certificate

When preliminary tests have been completed and corrections made, submit a signed and dated certificate with a request for a formal inspection and tests.

1.4.4 Components

Components installed under this contract must not be more than one (1) year older than date of installation.

1.5 ELECTRICAL MOTORS, CONTROLLERS, CONTACTORS, AND DISCONNECTS

Furnish motors, controllers, contactors, and disconnects with their respective pieces of equipment. Motors, controllers, contactors, and disconnects must be provided as specified herein and must have electrical connections provided under Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Controllers and contactors must have a maximum of 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of providing additional electrical service and related work under this section.

1.6 ELECTRICAL WORK

NOTE: Include Section 28 31 00.01 98 FIRE DETECTION AND ALARM (PROPRIETARY) when a fire alarm panel or transmitter is required to transmit pump supervisory signals to a constantly attended location as required by NFPA 20. Provide four (4) signals for each pump, pump controller in manual/off mode, pump running, loss of AC power, phase reversal.

Provide electrical power work associated with this section under Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL except for control and fire alarm wiring. Provide fire alarm system under Section 28 31 00.01 98 FIRE DETECTION AND ALARM (PROPRIETARY). Provide control wiring under this section in accordance with NFPA 20 and NFPA 70. Provide wiring in metal conduit of a type as specified in Division 16.

1.7 POSTED OPERATING INSTRUCTIONS

Provide for pumps, drivers, controllers, and flow meters.

PART 2 PRODUCTS

2.1 SYSTEM COMPONENTS

2.1.1 Fire Pumps

NOTE: In selecting rated head pressures of fire pumps, consider the fact that horizontal split case fire pumps and vertical turbine fire pumps develop 140 percent of rated head pressure when operating under shutoff or "churn" conditions. Maximum desired fire pump rated head pressure is 125 psig 862 kPa (gage).

Provide [[_____] electric motor driven] [and] [[_____] diesel engine driven] [horizontal split-case] [vertical turbine] [vertical in-line] [end suction] [factory skid mounted] fire pump(s). Fire pump(s) must be [automatic start and manual stop] [manual pushbutton start and stop] [and] [_____] pump[s] must be [automatic start and automatic stop]. Each pump capacity at rated head must be [not less than that indicated] [_____] liter per minute (L/m) gpm at a discharge pressure of [_____] [kPa (gage) psig]. Each pump must furnish not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Pumps must be of the centrifugal [horizontal split case with automatic air release] [water lubricated, vertical turbine type]. [Maximum pump, motor, and engine speed must be 188 rad/sec 1800 rpm.]

NOTE: Use the following requirements for horizontal split case pumps.

[The impeller must be double suction type, made of cast bronze, balanced

hydraulically and dynamically, keyed to the shaft and securely retained in an axial position by positive mechanical means.]

Suction and discharge connections must be located on opposite sides of the lower half casing, allowing removal of the rotating element without disturbing the system piping connections.

Fire pump discharge flange must be rated for 79.4 kilograms 175 pounds.

Fire pump casting must be smooth, free of scale, lumps, cracks, sand holes, and defects of any nature, which make the casting unfit for it's intended use.

The bolting of pressure-holding castings must be such that the maximum stress on any bolt must not exceed 1/4 the elastic limit of the material as computed by using the stress area and on the basis of the water pressure equivalent to the shut-off pressure effective over the area out of the centerline of the bolts.

The fire pump bearings must have an L-10 rating of not less than 5,000 hours, based on load ratings and fatigue life.

The shaft must be sealed with a stuffing box and packing with external water-seal piping. The stuffing box glands must exert uniform pressure on the packing.

Replaceable shaft sleeves must be furnished and are to be of a corrosion-resistant material.

Provide the following accessories:

Suction eccentric reducer, with the flat side on top, at the pump inlet; reducer must be cast iron or wrought steel with flanged connections.

Automatic air release valve with threaded inlet and discharge connections, to vent air from the pump casing.

Casing relief valve, non-adjustable bronze-type, set above the design pressure anticipated but below the combined suction pressure and shut-off head pressure, to discharge water from the system to avoid pump overheating, conforming to NFPA 20.

[Main relief valve and open waste cone discharge where required by NFPA 20.]

2.1.2 Fire Pump Alarms

NOTE: Power for alarms must be from a source other than the engine starting batteries and must not exceed 125 volts. Power must not be supplied from the same circuit supplying power to the fire pump controllers or from an emergency circuit. The preferred method of remote pump supervision is via the KSC/CCAFS supervised alarm system reporting to CFMS, not via a remote pump trouble panel. Use a remote pump panel only as a last resort, and only if the wiring between the pump and the panel is

supervised in accordance with NFPA 72.

Provide audible and visual alarms as required by NFPA 20 on the controller. Provide remote supervision as required by NFPA 20, in accordance with NFPA 72 under [Section 28 31 00.01 98 FIRE DETECTION AND ALARM (PROPRIETARY)] [____]. [Provide remote pump trouble panel located [at [____]] [where shown].] Alarm signal must be activated upon the following conditions: [electric motor controller has operated into a pump running condition, pump controller has been turned to manual or to off position, loss of electrical power to electric motor starter, and phase reversal on line side of motor starter] [engine drive controller has operated into an engine running condition, engine drive controller main switch has been turned to OFF or to MANUAL position, trouble on engine driven controller or engine]. Exterior alarm devices must be weatherproof type. Provide alarm silencing switch and red signal lamp, with signal lamp arranged to come on when switch is placed in OFF position.

2.1.3 Pressure Maintenance (Jockey) Pump

NOTE: Include this item to prevent fire pumps from cycling due to system pressure drops. Capacity of pump must be less than the flow from a sprinkler head.

Provide jockey pump with U.L. listed full voltage combination motor controller to maintain a pressure of [____] kPa (gage) psig on the system. Pump must be [horizontal shaft] [or] [in-line vertical shaft] centrifugal type with rated discharge pressure of [____] L/m gpm at [____] kPa (gage) psig. Pump shutoff pressure must not exceed [the design working pressure of the system] [____] kPa (gage) [____] psig. Pump must start when the pressure drops to [____] kPa (gage) [____] psig and to stop when the pressure reaches [____] kPa (gage) [____] psig.

The jockey pump must be rated to 2068 kilopascal 300 psi CWP, having drain and gauge tappings. Pump impeller must be hydraulically balanced, non-vapor-binding type, mechanically keyed to the shaft. Pump must have replaceable bronze impeller (casing) wear rings, threaded connections, mechanical seal, non-regreasable cast iron cartridge roller ball bearings, close-coupled too an open-drip proof motor.

Pump must be arranged to draw water [from the suction supply side of the gate valve of the fire pump(s)] [as indicated] and must discharge into the system on the downstream side of the pump discharge gate valve. Provide an approved indicating gate valve of the outside stem and yoke (O.S.&Y.) type in the jockey pump discharge and suction piping. Provide an approved [oil-filled with a pulsation snubber] [glycerin filled] pressure gauge and approved check valve in the jockey pump discharge piping. Check valve must be a swing type with removable inspection plate.

2.1.3.1 Jockey Pump Controller

Jockey pump controller must be UL listed, completely assembled, wired, and tested at the factory. Provide a lockable disconnect switch adjacent to, or as an integral part of the jockey pump controller. The unit must be complete with across-the-line magnetic starter equipped with overload protection, 3-pole fusible disconnect switch, H-O-A selector switch, 2068

kilopascal 300 psi bourdon tube type pressure regulator, with independent high and low setpoints, [solid-state pressure switch with independent high and low adjustment for automatic starting and stopping] pump running light, and NEMA 2 [NEMA 4] [NEMA 12] enclosure with lockable handle, automatic stop function, minimum run time timer, and contacts for remote start. Provide and connect a sensing line to the pressure maintenance pump discharge piping between the control valve and the check valve. The sensing line must conform to the paragraph "Pressure and Sensing Line". The jockey pump sensing line must be completely separate from the fire pump sensing line(s). Provide an adjustable relay (0-60 minute) with a Form "C" NO/NC alarm contact such that if the jockey pump cycles off and then is restarted before the expiration of the relay timer, the alarm contact must be energized and send an excessive cycling alarm to the FEMS and KCCS. Start/stop pressure settings must exceed those of the main fire pump(s). Also include a run timer to ensure the jockey pump runs for the minimum time, as recommended by the manufacturer of the jockey pump motor.

2.1.3.2 Pressure Sensing Line

Provide a completely separate pressure sensing line for each fire pump and for the jockey pump. The sensing line must be arranged in accordance with Figure A-7-5.2.1 of NFPA 20. The sensing line must be 12.7 millimeter 1/2 inch H58 brass tubing complying with ASTM B 135. The sensing line must be equipped with two (2) restrictive orifice unions each. Restricted orifice unions must be ground-face unions with brass restricted diaphragms drilled for a 2.4 millimeter 3/32 inch. Restricted orifice unions must be mounted in the horizontal position, not less than 1.5 m 5 feet apart on the sensing line. Two (2) test connections must consist of two (2) brass 12.7 millimeter 1/2 inch globe valves and 6.3 millimeter 1/4 inch gauge connection tee arranged per NFPA 20. One of the test connections must be equipped with a 0 to 2068 kPa 0 to 300 psi water oil-filled gauge. Sensing line must be connected to the pump discharge piping between the discharge piping control valve and the check valve.

2.1.4 Electric Motor Driver

Provide electric motor drive by the fire pump manufacturer, of the electrical characteristics indicated. Motor must be open drip-proof (ODP), 1.15 service factor. The electric motor must have an energy efficiency of 93 [_____] percent or greater.

Provide fire pump and jockey pump electrical motors, controllers, contactors, and disconnects as specified herein. Power supply to each motor and controller must be as indicated.

2.1.4.1 Motors

Motor power must be not less than pump power requirements at all points on the pump operating curve.

2.1.4.2 Fire Pump Controller [Electric Driven]

NOTE: Do not specify automatic shutdown for pumps which provide the sole source of water supply to a sprinkler system or standpipe. Verify whether the AHJ requires a second source of power or deems the existing power source reliable as defined in NFPA 20.

The fire pump controller must meet NFPA 20 requirements for fire pump service.

[Controllers must be approved for electric motor driven fire pump service and arranged for manual pushbutton [and automatic] starting and manual pushbutton shutdown [and automatic shutdown following expiration of a minimum running period of 10 minutes, the timing of which must begin after all starting causes have returned to normal.] [Controller must be completely terminally wired, ready for field connections, and mounted in a moisture resistant [NEMA 2] [NEMA 3] [NEMA 4] [_____] enclosure arranged so that controller current carrying parts must not be less than 300 millimeter 12 inches above the floor. [Provide controllers with [_____] and]] sequential starting timers as required by NFPA 20.] [Provide controller with [digital pressure readout which displays water system pressure] [, and] [paperless recorder which records water pressure, time, and date for at least the previous 7 days into a non-volatile memory] [, and] [low voltage monitor which alarms when the starting and running voltage drops below the level required by NFPA 20] [, and] [motor overload monitor which alarms when the motor exceeds 125 percent of the full load motor current] [, and] [low pump room temperature monitor which alarms when the pump room temperature drops below 40 degrees F] [4.4 degrees C] [, and] [low reservoir monitor which alarms when the suction supply water reservoir level drops below 85 percent of capacity].] Provide a NEMA rated starting contactor sized for the motor load. Controls to be furnished must include a built-in 2068 kilopascal 0 to 300 psi bourdon tube type pressure switch with independent high and low setpoints, automatic and manual start and manual stop pushbuttons, an adjustable minimum run timer, power available light, and power monitoring sensing all phases for loss of any phase, under voltage or phase reversal. Provide controller with Form "C" dry contacts for remote monitoring of each condition required to be monitored by NFPA 20 and by this specification. [Provide controller enclosures with legs that are a minimum of [304] [_____] millimeter [12] [_____] inches long.] Controller must be of the [solid-state reduced voltage] [across the line] [part winding] [primary resistor], [primary reactor], [autotransformer] [wye delta] [open or closed transition] starting type with a fault current interrupting capacity of [_____] amperes RMS. Controller must be designed for [_____] kilowatt (kW) horsepower (HP) at [_____] volts and must be service entrance labeled. [Provide an approved power transfer switch to transfer emergency power to the fire pump; the transfer switch must transfer power from [an emergency generator].]

2.1.1.5 Diesel Engine Driver

NOTE: Select bracketed choice of method of specifying power requirements. Special caution must be exercised in using the second expression because once a proper pump is selected only that diesel engine driver in the UL Fire Protection Equipment Directory corresponding to pump requirements is acceptable. Selection of a specific power can then further limit the suppliers of the equipment. Where diesel-engine-driven pumps are provided because reliable electrical power is not available to the pump, design the pump room so that electrical power is not required for supply ventilation required for engine operation or engine cooling, or provide two totally independent sources of ventilation.

UL 1247 and must be listed or approved for fire pump service and must be [of the make and kW hp rating recommended by the pump manufacturer for the pump being provided. Engine power must be adequate to drive the pump at all conditions of speed and load over the full range of the pump performance curve] [of [_____] kW hp rating]. Diesel engine must be of the compression ignition type with electric starting device taking current from two battery units mounted not less than 304 millimeter 12 inches above the floor. Provide lead-acid or lead-calcium type batteries.

2.1.5.1 Fire Pump Controller (Diesel Engine)

Controllers must be approved for diesel-engine-driven fire pump service and arranged for manual pushbutton [and automatic] starting and manual pushbutton shutdown [and automatic shutdown following expiration of a minimum running period of 30 minutes, the timing of which must begin after all starting causes have returned to normal.] Provide a weekly program timer to automatically start and run the engine for a test period of at least 30 minutes once per week. [If during this test period the engine develops critically low lubricating oil pressure or high engine jacket coolant temperature, the controller must initiate a "trouble on engine or controller" alarm as required by NFPA 20 and stop the engine. While in this stopped condition, if any other starting input is received by the controller, the controller must restart and run the engine as required by NFPA 20.] [Provide controller with [digital pressure readout which displays water system pressure] [, and] [paperless recorder which records water pressure, time, and date for at least the previous 7 days into a non-volatile memory] [, and] [low voltage monitor which alarms when the starting and running voltage drops below the level required by NFPA 20] [, and] [motor overload monitor which alarms when the motor exceeds 125 percent of the full load motor current] [, and] [low pump room temperature monitor which alarms when the pump room temperature drops below 40 degrees F] [4.4 degrees C] [, and] [low reservoir monitor which alarms when the suction supply water reservoir level drops below 85 percent of capacity].] Provide controller with Form "C" dry contacts for remote monitoring of each condition required to be monitored by NFPA 20 and by this specification.

2.1.5.2 Battery Charger

Charger must be an integral part of the controller or a separate wall-mounted unit. For each battery unit, provide voltmeter to indicate the state of the battery charge and provide ammeter to indicate rate of charge.

2.1.5.3 Fuel System External to Engine

Provide in accordance with NFPA 20 and NFPA 37. Provide vent piping with weatherproof vent cap. Provide flexible bronze or stainless steel piping connectors with single braid at each piping connection to diesel engine. Supply, return, vent, and fill piping must be steel piping, except supply and return piping is allowed to be copper tubing.

- a. Steel Pipe: ASTM A 53/A 53M, Weight Class XS (Extra Strong), black steel, threaded end connections. Provide ASME B16.3 threaded fittings and ASME B16.39 threaded unions.
- b. Copper Tubing: ASTM B 88 ASTM B 88, Type K, soft annealed, with ASME B16.26 flared fittings or compression type fittings.

- c. Tanks: **UL 80** or **UL 142** for aboveground steel tanks.
- d. Valves: Provide valves suitable for fuel oil service. Valves must have union end connections or threaded end connections.
 - (1) Gate, Globe, and Angle Valves: **MSS SP-80**, Class 125.
 - (2) Check Valves: **MSS SP-80**, Class 125, swing check.
 - (3) Ball Valves: Full port design, copper alloy body, two-position lever handles.

Extend vents to the outside. Each tank must be equipped with a fuel level gauge. Fuel lines must be protected against mechanical damage. Fill line must be equipped with 16 mesh removable wire screen. Extend fill lines to the exterior. Mount a weatherproof tank gauge on the exterior wall near each fill line for each tank. The fill cap must be able to be locked by padlock. The engine supply (suction) connection must be located on the side of the fuel tank so that 5 percent of the tank volume provides a sump volume not useable by the engine. The elevation of the fuel tank must be such that the inlet of the fuel supply line is located so that its opening is no lower than the level of the engine fuel transfer pump. The bottom of the tank must be pitched **21 millimeter per meter 1/4 inch per foot** to the side opposite the suction inlet connection, and to an accessible **25.4 millimeter 1 inch** plugged globe drain valve.

Provide an indicating and lockable ball valve in the supply line adjacent to the tank suction inlet connection. Provide a check valve must be provided in fuel return line.

2.1.5.4 Exhaust System External to Engine

Provide in accordance with **NFPA 20** and **NFPA 37**. Provide exhaust mufflers to reduce noise levels less than 85 [] dBA.

- a. Steel Pipe: **ASTM A 53/A 53M**, Weight Class XS (Extra Strong), black steel, welding end connections. Provide **ASME B16.9** or **ASME B16.11** welding fittings of the same material and weight as the piping.
- b. Flanges: **ASME B16.5**, Class 150. Provide flanges at connections to diesel engines, exhaust mufflers, and flexible connections. Gaskets must be **ASME B16.21**, composition ring, **1.60 millimeter 0.0625 inch** thick. Provide **ASTM A 193/A 193M**, Grade B7 bolts and **ASTM A 194/A 194M**, Grade 7 nuts.
- c. Piping Insulation: Products containing asbestos are not permitted. Provide exhaust piping system inside the building with **ASTM C 533** calcium silicate insulation minimum of **76 millimeter 3 inches** thick; secure with not less than **9.65 millimeter 0.38 inch** width fibrous glass reinforced waterproof tape or stainless steel bands spaced not more than **203 millimeter 8 inches** on centers. Provide one layer of asphalt-saturated felt over the insulation prior to installing aluminum jacket. Provide insulation with aluminum jacket, minimum thickness of **0.40 millimeter 0.016 inch**, with factory-applied polyethylene and kraft paper moisture barrier on inside surface. Secure jacket with stainless steel bands spaced not more than **203 millimeter 8 inches** on centers.

2.1.6 Flow Meter

NOTE: Where a flow meter is desired, show a straight line run of pipe without valves or fittings equal to at least 10 times the pipe diameter on the intake side and at least 5 times the pipe diameter on the discharge side of the flow meter. Where possible, arrange the piping so that the metered flow can be discharged through the pump test header and/or back into the pump suction supply by the proper configuration of valves. Only use flow meters where testing can not be performed on an open stream and with the concurrence of the NASA AHJ.

Provide UL listed or FM approved flow meter for fire pump installation with direct flow readout device. The flow meter must have a flow range between [_____] gpm and [_____] gpm. The suction piping must be galvanized. [Meter must be of the [venturi] [annular probe] [orifice plate] [_____] type.]

2.1.7 Pressure Gauges

Pressure gauges must be minimum 89 millimeter 3.5 inch in diameter, brass case with chrome finish, glass or polycarbonate window, brass dial with white background, black markings, dual units (English and metric), phosphor bronze bourdon tube, brass precision geared movement, plus or minus 3 percent accuracy, 2068 kilopascal 300 psi working pressure, and three-way globe style gauge isolation valve with a plugged end. Provide liquid filled gauges or pulsation dampers for gauges located at pumps.

NOTE: Carefully coordinate piping requirements including supports and valves in related fire protection system specifications, to avoid conflicting requirements.

2.2 ABOVEGROUND WATER PIPING SYSTEMS

The following requirements apply to miscellaneous fire pump trim piping located in the fire pump room, except where other related specification sections have more stringent requirements, the more stringent requirements prevail.

2.2.1 Sizes 63.5 Millimeter 2.5 Inches and Larger

2.2.1.1 Steel Pipe

ASTM A 53/A 53M, or ASTM A 135/A 135M Weight Class Schedule 40; black steel pipe with buttwelding end connections.

2.2.1.2 Buttwelding Fittings

ASME B16.9. Provide the same material and weight as the piping in which fittings are installed. Elbows must be of the long radius type, reducing bushings must not be used.

2.2.1.3 Steel Pipe Flanges

Provide ASME B16.5, Class 150 flanges at valves, connections to equipment, and where indicated. Extend bolts no less than two full threads beyond the nut with the bolts tightened to the required torque.

- a. Gaskets: AWWA C111/A21.11, provide one piece factory cut cloth inserted red rubber gaskets.
- b. Bolts: Provide ASTM A 193/A 193M, Grade B7 bolts.
- c. Nuts: ASTM A 194/A 194M, Grade 7.
- d. Washers: Provide steel flat circular washers under bolt heads and nuts.

2.2.2 Piping Sizes 50 Millimeter 2 Inches and Smaller

2.2.2.1 Steel Pipe

ASTM A 53/A 53M, Weight Class Schedule 80; zinc-coated steel pipe with threaded end connections.

- a. Threaded Fittings: ASME B16.3, Class 300, zinc-coated.
- b. Unions: ASME B16.39, Class 300, zinc-coated.
- c. Copper Tubing: ASTM B 88M ASTM B 88, Type L, soft annealed.
- d. Fittings: ASME B16.26 flared joint fittings.
- e. Pipe Nipples: ASTM B 42 copper pipe with threaded end connections.

2.2.3 Valves

Provide valves of types listed or approved for fire protection service with flanged grooved or threaded end connections.

2.2.3.1 Gate Valves

Provide outside screw and yoke type which open by counterclockwise rotation.

Butterfly type control valves are not permitted and must not be used.

2.2.3.2 Check Valves

Check valve must be UL listed or FM approved standard swing check type with elastomer disc seat. Check valve must have a ductile iron body with flanged or grooved ends and be of the clear opening type with flanged inspection and access coverplate for sizes 152 millimeter 6 inches DN 150 or larger. Check valve must be able to be installed vertically or horizontally, and be rated for 2068 kilopascals 300 psi working pressure. Clapper must be type 304 stainless steel or bronze, with field replaceable EDPM or Nitrite seal with nickel or bronze seat. Spring, hinge shaft and retaining ring must be stainless steel, the valve body must be painted with a corrosion resistant non-lead coating.

2.2.3.3 Relief Valve

Provide each [engine driven] pump with an approved [pilot operated] [or] [spring operated] circulation relief valve conforming to NFPA 20. Provide a discharge relief valve where the combination of the static pressure and pump churn pressure produce pressures downstream of the pump that exceeds the rating of the components.

2.2.3.4 Circulating Relief Valve

An adjustable circulating relief valve must be provided for each fire pump in accordance with NFPA 20.

2.2.4 Hose Valve Manifold Test Header

NOTE: A detail of the hose valve manifold test header must be indicated on the contract drawings showing supply arrangement, size of header supply piping, number of hose valves, valve arrangement, and test header location. Provide a "straight line manifold" test header which allows the pump to be tested without the use of fire hoses the "rosebud" test header are not permitted. Where the straight line manifold test header is not a stock item and must be shop fabricated provide a fabrication detail on the contract drawings. In lieu of the hose valve manifold test header, this paragraph can be changed to specify an inline water metering device in accordance with NFPA 20, subject to the approval of the NASA AHJ.

Construct manifold test header of steel pipe as specified in paragraph entitled "Aboveground Water Piping Systems." Provide ASME B16.5, Class 150 flanged inlet connection to hose valve manifold assembly. Provide approved bronze hose gate valve with 63.5 millimeter 2.5 inch National Standard male hose threads with cap and chain; locate 914 millimeter 3 feet above grade in the horizontal position for each test header outlet. Welding must be metallic arc process in accordance with ASME B31.1. Base the number of DN 65 2.5 inch valves upon the capacity of the fire pump with not less than one (1) valve for every 946 liters per minute 250 gallons per minute of pump capacity.

2.2.5 Pipe Sleeves

Provide where piping passes entirely through walls, ceilings, roofs, and floors. Secure sleeves in position and location during construction. Provide sleeves of sufficient length to pass through entire thickness of walls, ceilings, and floors. Provide 25 millimeter one inch minimum clearance between exterior of piping or pipe insulation, and interior of sleeve or core-drilled hole. Firmly pack space with mineral wool insulation. Seal space at both ends of the sleeve or core-drilled hole with plastic waterproof cement which dries to a firm but pliable mass, or provide a mechanically adjustable segmented elastomeric seal. In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled hole with UL listed fill, void, or cavity material.

- a. Sleeves in Masonry and Concrete Walls, Ceilings, Roofs, and

Floors: Provide hot-dip galvanized steel, ductile-iron, or cast-iron pipe sleeves. Core drilling of masonry and concrete is allowed in lieu of pipe sleeves provided that cavities in the core-drilled hole be completely grouted smooth.

- b. Sleeves in Other Than Masonry and Concrete Walls, Ceilings, Roofs, and Floors: Provide 26 gage galvanized steel sheet.

2.2.6 Escutcheon Plates

Provide split-hinge metal plates for piping entering floors, walls, and ceilings in exposed areas. Provide polished stainless steel or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on plates in unfinished spaces.

2.3 BURIED WATER PIPING SYSTEMS

2.3.1 Pipe and Fittings

NOTE: In last sentence, use first phrase in brackets for connection to existing water distribution system where no other Civil work is being performed; delete first phrase in brackets only for connection to new water distribution system where underground piping materials are specified in Division 2, Section 33 11 00 WATER DISTRIBUTION. For pipe larger than 300 millimeter 12 inches, detail methods for anchoring piping including pipe clamps and tie rods. Consult NFPA 24 for required depth of coverage of buried fire mains.

Provide outside-coated, cement mortar-lined, ductile-iron pipe and fittings conforming to NFPA 24 for piping under the building and less than 1.50 meters 5 feet outside of the building walls. Anchor the joints in accordance with NFPA 24; provide concrete thrust block at the elbow where the pipe turns up toward the floor, and restrain the pipe riser with steel rods from the elbow to the flange above the floor. Minimum pipe size must be 152 millimeter 6 inches. Minimum depth of cover must be as required by NFPA 24, but no less than 914 millimeter 3 feet. Piping more than 1.50 meters 5 feet outside of the building walls must be [outside coated, AWWA C104/A21.4 cement mortar-lined, AWWA C151/A21.51 ductile-iron pipe, and AWWA C110/A21.10 fittings conforming to NFPA 24] [provided under [Section 33 11 00 WATER DISTRIBUTION.]].

2.3.2 Valves

Provide as required by NFPA 24. Gate valves must conform to AWWA C500 or UL 262 with cast-iron body and bronze trim and must open by counterclockwise rotation.

2.3.3 Post Indicator Valves

Provide UL 262 gate valve and UL 789 indicator post with operating nut located 914 millimeter 3 feet above grade. Provide post indicator valves with one coat of primer and two coats of red enamel paint.

2.3.4 Valve Boxes

Except where indicator posts are provided, provide each gate valve in buried piping with an adjustable cast-iron or ductile-iron valve box of a size suitable for the valve on which the box is to be used. Provide cast-iron or ductile-iron cover for the box with the word "WATER" cast on the cover. Boxes outside of paved areas are allowed to be constructed of ABS plastic or inorganic fiber reinforced black polyolefin plastic. The least diameter of the shaft of the box must be 133 millimeter 5.25 inches. Coat cast-iron and ductile-iron boxes with bituminous paint.

2.3.5 Buried Utility Warning and Identification Tape

Provide detectable aluminum foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape must be detectable by an electronic detection instrument. Provide tape in rolls, 76.2 millimeter 3 inches minimum width, color coded for the utility involved, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification must be CAUTION BURIED WATER PIPING BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 304 millimeter 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

2.4 PAINTING

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Furnish other mechanical equipment with a shop-applied prime paint.

Paint piping in accordance with paragraph entitled, "Painting", in Part 3 of this specification section.

2.5 SUPPORTING ELEMENTS

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; standpipe equipment and fire hose cabinet stations; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Supporting elements must be suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces. Include an additional 113 kilogram 250 pound load at each anchor per NFPA 13.

NOTE: Refer to Section 23 05 48.00 40 VIBRATION AND
SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT if
design requires vibration isolation.

Supporting elements must be FM approved or UL listed and must conform to ASME B31.1, MSS SP-69, and ASME B16.34.

2.5.1 Building-Structure Attachments

2.5.1.1 Anchor Devices, Concrete and Masonry

Anchor devices must conform to [FS A-A-1922](#), [FS A-A-1923](#), [FS A-A-1924](#), [FS A-A-1925](#), [FS A-A-55614](#) and [FS A-A-55615](#):

Group I: Shield, expansion (lead, bolt, and stud anchors)

Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

Group III: Shield, expansion (self-drilling tubular expansion shell bolt anchors)

Cast-in floor mounted equipment anchor devices must provide adjustable positions.

Powder-actuated anchoring devices must not be used to support mechanical systems components.

2.5.1.2 Beam Clamps

Beam clamps must be center-loading types 21, 28, 29, and 30, UL listed catalogued, and load-rated commercially manufactured products.

Type 20 beam clamps are allowed for pipe [DN 50 2 inches](#) and under.

Where Type 25 beam clamps are used, use two (2) per point of pipe support.

2.5.1.3 C-Clamps

NOTE: Avoid C-clamps, as a means of attaching hangers to structural steel. For metal building system roofs, Z-purlin beam clamps can be used if approved by the Contracting Officer and KSC AHJ. Where used, consider vibration forces and single or accumulated load and resultant moment on structural steel.

C-clamps must not be used.

2.5.1.4 Inserts, Concrete

Concrete inserts must be constructed in accordance with the requirements of [MSS SP-58](#) for Type 18 or 19, and [ASME B16.34](#). When applied to piping in sizes [DN 50 2 inch](#) iron pipe sizes (ips) and larger, and where otherwise required by imposed loads, insert a [300 millimeter length of 15 millimeter 1 foot length of 1/2 inch](#) reinforcing rod and wire through wing slots.

2.5.2 Horizontal-Pipe Attachments

2.5.2.1 Single Pipes

Support piping in sizes up to and including [DN 50 2 inch](#) ips by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

Support piping in sizes DN 65 2-1/2 inches and larger by Type 1, 2, 3, or 4 attachments or with Type 41 or Type 49 pipe rolls.

2.5.2.2 Parallel Fire Protection Pipes

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, when so specified. Structural steel shapes must conform to supplementary steel requirements or the support must be of commercially available, approved proprietary design rolled steel.

2.5.3 Vertical Pipe Attachments

Single vertical pipe attachments must be Type 8.

2.5.4 Hanger Rods and Fixtures

Use only circular solid cross-section rod hangers to connect building structure attachments to pipe support devices. Use pipe, straps, or bars of equivalent strength for hangers.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members, or where structural members are used in lieu of commercially rated supports, such supplementary steel must be designed and fabricated in accordance with AISC 317.

Supplementary steel must be hot dipped galvanized or otherwise protected from corrosion, as acceptable to the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment, materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing must be in accordance with NFPA 20, except as modified herein. Provide all materials required for a completely functional and operational system. Install piping straight and true to bear evenly on supports.

Install pumps with recommended clearances provided for service and maintenance. Complete servicing of the pump must be possible without breaking piping or motor connections.

Unless otherwise indicated, pump assemblies must include suction and discharge isolation valves with tamper switches and discharge check valve. Suction and discharge piping must be rigidly connected. Provide strain relief coupling where pump and suction piping are installed on separate foundations.

Pressure gauges must be provided with gauge valves and must be equipped with a pulsation snubber or be glycerin filled. The gauges must be located as close to the pump impeller as possible on each suction and discharge. The suction side gauge must be of the compound type.

Align the pump and motor with a dial indicator to within 0.05 millimeter misalignment tolerance.

The pump and motor combination must be factory-tested prior to shipment. The suction and discharge flanges must be covered with wood or metal blanks, the pump must be thoroughly cleaned and painted with one coat of machinery enamel, and the entire pump unit must be assembled and sealed in plastic for shipment.

Prior to fire pump testing, verify proper rotation and check for excessive noise or vibration. [Install vibration isolation for the fire and jockey pump according to the manufacturers recommendations.]

Install fire, jockey pumps and controllers on minimum 152.4 millimeter 6 inch concrete housekeeping pads. Anchor pumps to the housekeeping pads using leveling bolts and grouted with non-shrink grout. Anchor controllers to the pad, jockey pump controller are allowed to be of the wall mount type.

Extend all drain and outlets from relief valves, drip rims, and similar items full size to discharge directly above floor drains. Drain piping must be Type "L" copper with soldered joints or galvanized Schedule 80 steel with threaded or welded joints.

[Provide conduit, wiring, relays, contacts, and related devices for control signals between the fire pump controller, jockey pump controller and the remote alarm panel. Test each alarm point and control point.]

3.1.1 Cleaning of Piping

Keep the interior and ends of new piping and existing piping affected by the Contractor's operations thoroughly cleaned of water and foreign matter. Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping and fittings so that water and foreign matter does not enter the pipes or fittings. Inspect piping before placing into position.

[3.1.2 Demolition]

[Carefully remove materials so as not to damage material which is to remain. Replace existing work damaged by the Contractor's operations with new work of the same construction.]

3.2 PIPE AND FITTINGS

Test, inspect, and approve piping before burying, covering, or concealing. Provide fittings for changes in direction of piping and for all connections. Make changes in piping sizes through tapered reducing pipe fittings; do not use bushings. Perform welding in the shop, field welding is not permitted. [Photograph all piping prior to burying, covering, or concealing.]

3.2.1 Threaded Connections

Jointing compound for pipe threads must be Teflon pipe thread paste; apply only on male threads. Provide exposed ferrous pipe threads with one coat of zinc molybdate primer applied to a minimum dry film thickness of 0.025 millimeter one mil.

3.2.2 Pipe Hangers and Supports

Provide additional hangers and supports for concentrated loads in piping between hangers and supports, such as for valves.

3.2.2.1 Vertical Piping

Support metal piping at each floor, but at not more than 3 meters 10 feet intervals.

3.2.2.2 Horizontal Piping

NOTE: Add to table for pipe sizes greater than six inch (DN 150).

Support piping as follows:

MAXIMUM SPACING (METERS)

Nominal Pipe Size (mm)	25 and under	32	40	50	65	80	90	100	125	150
Copper Tube	1.80	2.10	2.40	2.40						
Steel Pipe	2.10	2.40	2.70	3.00	3.40	3.70	4.00	4.30	4.57	4.57

MAXIMUM SPACING (FEET)

Nominal Pipe Size (inches)	One and under	1.25	1.5	2	2.5	3	3.5	4	5	6
Copper Tube	6	7	8	8						
Steel Pipe	7	8	9	10	11	12	13	14	15	15

3.3 NAMEPLATES

Provide laminated plastic nameplates for equipment, gages, thermometers, and valves. Nameplates must be melamine plastic, 3 millimeter 0.125 inch thick, black with white center core. Surface must be a matte finish. Corners must be square. Accurately align lettering and engrave into the white core. Minimum size of nameplates must be 63.5 millimeter one by 2.5 inches. Lettering must be minimum of 6.3 millimeter 0.25 inch high normal block style. Key the nameplates to a chart and schedule for each system. Frame charts and schedules under glass and place where directed near each system. Furnish two copies of each chart and schedule. Each inscription must identify its function. Equipment nameplates must show the following information:

- a. Manufacturer, type, and model number;
- b. Contract number and accepted date;

- c. Capacity or size;
- d. System in which installed; and
- e. System which it controls.

3.4 INSTRUCTING OPERATING PERSONNEL

Upon completion of the work and at a time designated by the Contracting Officer, provide for a period of not less than two separate four hour sessions on two separate days the services of experienced technicians regularly employed by the manufacturer of the pumps and the drivers to instruct Government operating personnel in the proper operation and maintenance of the equipment.

At the option of the Contracting Officer, all training sessions are documented by the Government using audio, visual, or a combination of methods. All training information presented must be contained in the Operations and Maintenance Manuals.

Post operating instructions for all devices to include pumps, drivers, controllers, valves and similar devices. Instructions must include warning statements as to actions that can take the system out of service, or that can cause accidental discharge and/or activation. Include operating instructions in the Operations and Maintenance Manuals.

[Operation and Maintenance Manuals](#), grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed.

3.5 FLUSHING

Flush all new pump suction and discharge piping at 150 percent of rated pump capacity. Where the pump installation involves more than one pump, the flushing volume must be the total quantity of water flowing when all pumps are discharging at 150 percent of their rated capacities. The new pumps can be used to attain the required flushing volume. No underground piping must be flushed by using the fire pumps. Continue flushing operations until water is clear, but for not less than 10 minutes. Submit a signed and dated flushing certificate with a request for field testing.

3.6 FIELD INSPECTIONS AND TESTS

3.6.1 Inspections

Prior to initial operation, inspect equipment and piping systems for compliance with drawings, specifications, and manufacturer's submittals.

3.6.2 Preliminary Tests

Pressure test must be hydrostatic, unless otherwise specified. Use only potable water for testing.

Hydrostatically test each above ground piping system at [_____] 345 kPa (gage) 50 psig above normal system working pressure or 1379 kPa (gage) 200 psig, whichever is greater, for a period of 2 hours in accordance with [NFPA 20](#), without a drop in pressure or observed leakage. Perform tests on pumps, drivers, and equipment, including visual equipment checks to ensure

compliance with approved detail drawings; pump start-run to ensure proper operation and to detect leakage of piping, valves, and fittings; sequence of operation check; verification that required pump accessories have been provided; test of pump alarm devices; and additional inspections and tests necessary to ensure that the entire pump installation is correct, complete, and ready for operation. Upon completion of the preliminary test, submit a preliminary test certificate to the contracting officer.

Hydrostatically test below ground piping at not less than 1379 kilopascal 200 psi pressure for not less than two hours, or at 345 kilopascal 50 psi in excess of the maximum static pressure when the maximum static pressure is in excess of 1034 kilopascal 150 psi. Measure leakage in underground systems by pumping from a calibrated container at the required test pressure. For new piping, leakage must not exceed 1.89 liters two quarts per hour per 100 gaskets or joints irrespective of pipe diameter. This rate can be adjusted upwards where the test section contains metal seated valves or dry barrel hydrants under pressure by the amounts specified in NFPA 24.

3.6.3 Final Formal Inspection and Tests

NOTE: Where specific list of test equipment is warranted by design or site conditions, list equipment such as hoses, play, pipe nozzles, tachometers, and current measuring devices.

The Contracting Officer and NASA AHJ must witness final formal tests and approve all systems before they are accepted. Test must be in accordance with NFPA 20. Submit the request for formal inspection at least [15] [_____] days prior to the date the inspection is to take place. An experienced technician regularly employed by the pump installer must be present during the inspection. Where pumps are engine driven, an experienced technician regularly employed by the engine manufacturer capable of demonstrating that all engine trouble alarms and operating features perform as required must be present. Provide portable radios, hoses, nozzles, calibrated pitot gauges, calibrated pressure gauges, digital tachometer, and volt/ammeter to conduct a complete fire pump acceptance test. Acceptance test must include a full water flow test. Secure all hoses and nozzles during the tests. Conduct water flow testing in a safe manner with no destruction to the existing facility or new construction. Tests must include 100 and 150 percent capacity flows and pressures, and no-flow pressures for compliance with manufacturer's characteristic curves. At this inspection repeat the required tests as directed. Correct defects in the work, and make additional tests to demonstrate that the system complies with the contract requirements. Furnish manufacturer's certified shop test characteristic curves for each pump being tested at the time of the pump acceptance test. Furnish appliances, equipment, [water,] electricity, instruments, connecting devices, and personnel for the tests. [The Government will furnish water for the tests.] Upon completion of the final test, submit a final test certificate to the Contracting Officer.

3.7 OPERATIONAL TESTING

3.7.1 Sequence

Perform system operating tests, valve operating test, fire pump/controller

test, and jockey pump/controller test in accordance with NFPA 20.

The jockey pump pressure switch must be set to energize the jockey pump when the system pressure falls through the pressure deadband, and must open upon re-pressurizing the system to the setpoint pressure. Upon further loss of pressure, the pressure switch for the lead fire pump must close and start the main pump.

The [_____] pump must [be the lead pump which must]start [automatically whenever the pressure in the main system is reduced to [_____] psig] [automatically upon activation of the [_____] sprinkler system,] [and] [or] manually when the starter is operated. [Pump(s) must continue to run until shut down manually.] [Pump(s) must automatically shut down after a running time of [_____] minutes, unless manually shut down.] [If after [_____] seconds, the lead pump can not maintain a pressure of at least [_____] psig on the system, Pump No. 2 must start.] [If after an additional [_____] seconds, Pump No. 1 and Pump No. 2 can not maintain a pressure of at least [_____] psig on the system, then Pump No. 3 must start.] [Failure of the lead pump to start must not prevent subsequent pumps from starting.]

Base final pressure settings upon actual performance during acceptance testing.

3.7.2 Testing

Perform testing of the automatic operation of the jockey and fire pump(s). The inspectors test station must be slowly partially opened until the jockey pump starts. The inspectors test must then be fully closed and the system restored to "normal" status. The inspectors test must then be fully opened, which must first start the jockey pump then the lead fire pump.

3.7.3 Adjusting

Adjust and record the pressure switch setpoints and deadbands upon successful completion of the above test. Deficiencies such as rapid cycling of the jockey pump, activation of both fire pumps (non-sequential starting) and similar anomalies must be corrected for final acceptance. Verify all trouble, supervisory and alarm conditions.

3.8 PAINTING

Manufacturer's standard finish equipment surfaces damaged during construction must be brought to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replaced with new undamaged equipment at no additional cost to the Government.

Thoroughly clean and paint pipe hangers, supports, and other iron work in concealed spaces.

All fire sprinkler system piping, valves, and appurtenances must receive two coats of enamel, color no. 11105 (red) in accordance with MIL-STD-101 and FED-STD-595.

3.9 CLEANING AND ADJUSTING

At the completion of the work, thoroughly clean all parts of the

installation. Equipment, pipes, valves, and fittings must be cleaned of grease, metal cuttings, and sludge that accumulated from the installation and testing of the system. Automatic control devices must be adjusted for proper operation.

-- End of Section --