Preparing Activity: NAVFAC Replacing without change
UFGS-13401 (August 2004)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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04/06

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USACE / NAVFAC / AFCEC / NASA **UFGS-43 21 29 (April 2006)**

Preparing Activity: NAVFAC **Replacing without change UFGS-13401 (August 2004)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023

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SECTION 43 21 29

FLOW MEASURING EQUIPMENT [POTABLE WATER] [SEWAGE TREATMENT PLANT]
04/06

****

NOTE: This guide specification covers the requirements for flow measuring equipment for use in potable water or sewage treatment plant.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

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

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

****

****

NOTE: Special consideration not included in this guide must be given to sewage with high salt water concentration or carrying industrial wastes containing components detrimental to materials used in typical treatment plant and biodegrading micro-organisms.

****

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 Reference Identifier (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 will automatically be 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 SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME PTC 19.5	(2004; R 2013) Flow Measurement

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case
AWWA C704	(2019) Propeller-Type Meters for Waterworks Applications

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2019) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-24441	(2009; Rev D; Notice 1 2021) Paint, Epoxy-Polyamide, General Specification for

1.2 SYSTEM REQUIREMENTS

The flow measuring equipment shall be the [variable head meter type for closed channel] [variable head meter type for open channel] [variable area meter type] [propeller meter type] [electromagnetic meter type] [volumetric meter for [open] [closed] channel] [ultrasonic meter type]. The design shall permit ease of installation and shall not have any features hazardous to personnel or detrimental to the equipment. Provision shall be made to align and adequately lubricate moving parts.

Interior parts shall be easily accessible for adjustment, repair, and replacement.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G". Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Flow measuring equipment components

Read-out device

SD-06 Test Reports

Flow measuring equipment calibration

Open channel test

Dimensional inspection report

Closed channel test

SD-08 Manufacturer's Instructions

Flow measuring equipment components

Submit manufacturer's written recommendation for installation and handling.

1.4 QUALITY ASSURANCE

1.4.1 Requirements

Perform calibration and submit test report for flume in variable head meter for open channel. Submit dimensional inspection report and flow versus differential head curve for variable head meters for closed channel; accuracy shall be plus or minus 1.0 percent over a 10 to 1 flow range. Submit as required in paragraph entitled "Field Tests and Inspections."

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

****

NOTE: Choose the paragraphs which follow based on type of meter needed for the system selected in the paragraph entitled "System Requirements."

****

Unless otherwise specified, all materials and equipment shall be standard commercial products in regular production by the manufacturer and suitable for the required service.

2.1.1 Variable Head Meter for Closed Channel

****

NOTE: Delete this paragraph and the subparagraphs which follow when variable head meter for closed channel is not required.

****

Shall include [an orifice plate] [a flow nozzle] [a Venturi tube] as differential head producer, a diaphragm meter as differential measurement, and [an indicator] [and an integrator] as read-out device[s]. [Remote transmission also shall be included.] Meter shall be provided for [potable water] [plant water] [water for chlorination] [air for aeration] [recirculated plant effluent] [plant effluent] [plant influent] [bypass line] [primary sludge] [return sludge] [sludge to waste] [digested sludge] flow where indicated.

2.1.1.1 [Orifice Plate

****

NOTE: Select this paragraph entitled "Orifice Plate," or the paragraphs below entitled "Flow

Nozzle," "Venturi Tube," or "Modified Venturi."
****

Shall be of the differential producing type with circular hole, and designed for insertion in a [_____] mm inch pipe where indicated. The orifice plate shall measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. Provide the orifice plate with a flange union to hold the plate perpendicular to the axis of the pipe. The flange shall have a pressure rating of 862 kPa 125 psi and shall have threaded ends. The orifice plate shall be of stainless steel and shall be furnished with a tab designating line size, orifice size, and flow direction. The orifice plate shall be in accordance with recommendations of the ASME PTC 19.5, except as modified herein. The pressure taps shall be of the [flange] [one diameter upstream and one-half diameter downstream] [corner] type and sized in accordance with recommendations of the ASME PTC 19.5.

]2.1.1.2 [Flow Nozzle

Shall be of the differential producing type having a modified Venturi flow nozzle contour, and designed for at least 90 percent head recovery for insertion in [_____] mm inch pipe where indicated. The nozzle shall measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The flow nozzle shall have 862 kPa 125 psi flanged ends conforming to ASME B16.1. Construct the nozzle of cast iron conforming to ASTM A126, Grade B. The throat liner shall be of bronze conforming to ASTM B61. The length of the throat liner shall be equal to 75 percent of the throat diameter. The inlet pressure tap shall be one diameter upstream and the outer pressure tap shall be [one-half diameter downstream] [the throat type]. [The taps for use with sewer and sludge must have built-in capabilities for manual rodding of the holes.]

]2.1.1.3 [Venturi Tube

Shall be of the differential producing type, and designed for [potable water] [sewage] [sludge] service with at least 90 percent head recovery [in accordance with recommendations of the ASME PTC 19.5] for use in a [_____] mm inch pipe where indicated. The Venturi shall measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The Venturi shall have 862 kPa 125 psi flanged ends conforming to ASME B16.1. The laying length shall be approximately that indicated. Construct the body of cast iron conforming to ASTM A126, Grade B. The throat section and vent bushing shall be bronze conforming to ASTM B61. [For sludge service, equip the tube with manual vent cleaners requiring not more than 1.57 rad 90 degrees rotation for full operation.] [For sludge service, provide a water purge system and two matched assemblies of piping, valves, rotometers, and fittings. The purge system shall operate on a clean water supply of 0.000063 cubic meter per second one gpm at a regulated pressure of 69 kPag 10 psiggreater than line pressure. The Venturi interior waterways shall be finished with an anti-stick coating.]

]2.1.1.4 [Modified Venturi

Shall be of the differential producing type, and designed for [potable water] [sewage] [sludge] service with at least a 90 percent head recovery for use in a [_____] mm inch pipe where indicated. The Venturi shall measure the flow of [_____] to [_____] [cubic meter per second] [gpm]. The laying length shall be approximately that indicated. The modified Venturi shall be of the insert type constructed of fiberglass reinforced polyester. The holding flange shall be carbon steel, bronze, or

fiberglass reinforced plastic with integral pressure taps for mounting between 862 kPa 125 psi ASME B16.1 flanges.

]2.1.1.5 Diaphragm Meter

Shall have a range of [_____] to [_____] [cubic meter per second] [gpm], and a minimum differential of not less than 25 mm one inch. The maximum differential shall be equal to the range squared but shall not exceed 2500 mm 100 inches of water column. It shall have stainless steel bellows with built-in overrange protection to prohibit deformation of the bellows. Contain the bellows in a forged brass or cadmium-plated forged carbon steel housing to withstand a working pressure of at least 3.45 MPa 500 psi. Transmit the output motion of the bellows to the local read-out device. There shall be zero adjustment in the diaphragm meter. Accuracy shall be plus or minus 0.5 percent of full scale over a 3 to 1 flow range.

2.1.2 [Variable Head Meter for Open Channel

****
NOTE: Delete these paragraphs when variable head meter for open channel is not required.
****

Shall include [a weir] [a flume] as head producer, a stilling well with float and cable as head measurement, and [an indicator] [a recorder] [and an integrator] as read-out device(s). [Remote transmission also shall be included.] Provide meter for [potable water] [plant influent] [bypass line] [plant effluent recirculation] [return sludge] [plant effluent] flow where indicated.

]2.1.2.1 [Weir

****
NOTE: Select this paragraph entitled "Weir," or the paragraphs below entitled "Parshall Flume," or "Flume."
****

Shall be of the [rectangular] [1.05 rad] [60 degree] [triangular (V-notch)] [1.57 rad] [90 degree] [triangular (V-notch)] [Cipolletti] type as indicated. The weir shall measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The upstream face of the weir plate shall be flat and smooth. Any bolts or rivets used to fasten the plate shall be countersunk flush with the plate. Bolt holes shall include provision for adjustment of height and level. The edges of the weir plate exposed to flow shall not exceed 3 mm 1/8 inch in thickness; where thicker plates must be used, the edge shall be beveled 0.78 rad 45 degrees or more to the required 3 mm 1/8 inch. Make the weir plate of stainless steel or fiberglass reinforced polyester laminate containing at least 30 percent fiberglass by weight.

]2.1.2.2 [Parshall Flume

Shall be of the Parshall type, and shall measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The flume shall have a converging upstream section, a throat, and a diverging downstream section. The complete unit shall have vertical walls. Stilling wells and throat floor shall be inclined downward. Construct the flume of polyester resin reinforced with not less than 30 percent fiberglass by weight and provided

with locking devices for engagement with the grout around the liner. Reinforcing ribs shall be an integral part of the flume while removable bracing shall be provided to ensure proper maintenance of liner dimensions during shipment and installation.

]2.1.2.3 [Flume

Shall be of the characterized type, and shall measure the flow of [_____] to [_____] [cubic meter per second] [mgd]. The flume shall have a cast iron measuring section having a circular inlet and a characterized outlet. The inlet line size shall be [_____] mm inches. The inlet shall be ASME B16.1, 862 kPa 125 psi, flanged. The flume shall have a flat invert free from pockets and obstructions. [Equip the flume with a manual vent cleaner and sediment trap.]

]2.1.2.4 Float and Cable

Shall have a range of [_____] to [_____] [cubic meter per second] [mgd] with a head measurement of [_____] mm inches. Measure the crest level in a stilling well as indicated. The measuring system shall include a float, cable, drum, transfer gear assembly, and cam mechanism to provide uniformly graduated units of flow. The float shall be of polyester, stainless steel, or copper, and of a weight and shape that conform to the application requirements. The cable shall be plastic-coated multi-strand stainless steel, stainless steel beads, or multi-strand monel. Groove the drum to prevent overlapping of the cable. Provide the float and cable with stops to prevent overranging and to provide a zero adjustment. All materials of construction shall be corrosion-resistant. Provide protection tubes for the cables. Accuracy shall be plus or minus 2 percent of the actual rate over a 5 to 1 range.

2.1.3 Variable Area Meter for [Open] [Closed] Channel

****
NOTE: Delete this paragraph when a variable area meter for an open or closed channel is not required.
****

Provide a variable area meter as indicated. Make the variable area meter of a tapered tube with a float that will indicate a flow range of [_____] to [_____] [cubic meter per second] [gpm]. The tube shall be glass with flow units etched on it and shall be placed vertically for reading. It shall consist of fiberglass, stainless steel, or aluminum with stainless steel fitted ends and fluorinated hydrocarbon rubber or chloroprene 0-rings. The float shall be stainless steel and easily read. The metering tube shall be easily removed for range change or cleaning without tools or removing the meter from the line. Provide a needle valve for adjusting flow where indicated. Accuracy shall be plus or minus 5 percent over a 3 to 1 range.

2.1.4 Propeller Meter

****
NOTE: Delete this paragraph when a propeller meter is not required.
****

Provide a propeller meter where indicated. The meter shall measure the velocity and convert it to flow units. The meter shall have a range of

[_____] to [_____] [cubic meter per second] [gpm] for use in a [_____] mm inch pipe. Materials shall conform to the applicable requirements of AWWA C704. [The propeller meter shall be of the saddle type for a working pressure of 862 kPa 125 psi and be supplied with a steel welding saddle and separate straightening vanes.] [The propeller meter shall be of the tube type for a working pressure of 862 kPa 125 psi and be furnished complete with a tube, built-in straightening vanes, and 862 kPa 125 psi ASME B16.1 flanged ends, or threaded connections, as appropriate for the pipe.] Provide the meter head with a conical shaped three-blade propeller mounted transversely in the line. The meter shall be completely sealed from water pressure and able to withstand thrust on the front of the propeller. Accuracy shall be plus or minus 2 percent of actual rate over a 10 to 1 range.

2.1.5 Electromagnetic Meter

****
NOTE: Delete this paragraph when an electromagnetic meter is not required.
****

****
NOTE: For plant influent service, allow the optional use of chloroprene-lined stainless steel or steel, polyurethane-lined stainless steel or steel, or fiberglass tubes. For primary sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, vitreous enamel-lined stainless steel or steel, glass-lined stainless steel or steel, or tetrafluoroethylene-lined aluminum tubes. For recirculated plant effluent, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For return sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For sludge to waste service, allow the optional use of tetrafluoroethylene-lined stainless steel, vitreous enamel-lined stainless steel or steel, or glass-lined stainless steel or steel tubes. For digested sludge service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes. For plant effluent service, allow the optional use of tetrafluoroethylene-lined stainless steel or steel, chloroprene-lined stainless steel or steel, or fiberglass tubes.
****

****
NOTE: Delete the bracketed sentence beginning "Provide a transformer..." when power supply is 120 volts.
****

****
NOTE: Delete requirements for cleaning except when

meter is for any sludge service.
****

Provide a magnetic flow meter where indicated. The magnetic flow meter shall measure the flow of [_____] to [_____] [cubic meter per second] [mgd] and be suitable for a [_____] mm inch pipe. The magnetic flow meter system shall include a flow tube, local read-out receiver, [remote transmission,] and interconnecting cable where indicated. The flow meter shall be a [tetrafluoroethylene-lined stainless steel or steel] [chloroprene-lined stainless steel or steel] [polyurethane-lined stainless steel or steel] [vitreous enamel-lined stainless steel or steel] [glass-lined stainless steel or steel] [tetrafluoroethylene-lined aluminum] [fiberglass] tube with the necessary cores and coils to provide a magnetic field without any interference and with [1034 kPa] [150 psi] [modified ASME B16.1 carbon steel flanges] [Dresser type coupling] [Victaulic type couplings] [integral fiberglass flanges]. Electrodes shall be of stainless steel. The tube shall operate from [120] [240] volts, [_____] hertz, single-phase ac power. A weatherproof housing shall cover the magnets, coils, and connections. [Provide a transformer within the transmitter housing to provide 120 volts power to the receiver.] [Provide a system for cleaning the electrodes or tube automatically without taking the tube out of service. Automatic mechanical cleaning of electrodes or tube will not be acceptable.] The metering tube shall have an approximate laying length as indicated. Provide all necessary cable between the transmitter and receiver. Accuracy shall be plus or minus one percent over a 10 to 1 range. The receiver shall convert the ac voltage signal generated in the flow tube to a uniform flow signal. There shall be an adjustment for zero and span.

2.1.6 Volumetric Meter

****
NOTE: Delete this paragraph when a volumetric meter is not required
****

Provide a volumetric meter where indicated. The meter shall conform to AWWA C700. The meter shall be of the rotating-disc type for use in a [_____] mm inch pipe and shall be of the frostproof type, if applicable.

2.1.7 Ultrasonic Meter

****
NOTE: Delete this paragraph when an ultrasonic meter is not required.
****

Provide an ultrasonic meter where indicated. The meter shall have a velocity range of 0 to 1.52 meters per second through 0 to 6.10 meter per second 0 to 5 feet per second through 0 to 20 feet per second for use with a [_____] mm inch pipe. The flow meter shall consist of [separate transmitting and receiving transducers clamped to the outside of the pipe to measure the liquid flow without, in anyway, intruding into or altering the pipe.] [the primary element employing a single pair of electro-acoustic transducers mounted diagonally in a flow tube, and in direct contact with the liquid flow to be measured] [a single transducer with twin crystals encapsulated in an epoxy housing mounted on the outside of the pipe. The transmitting crystal shall emit a continuous ultrasonic pulse or frequency into the liquid stream to be reflected back to the

receiving crystal. It shall measure the difference in frequencies which is proportional to the liquid flow.] The transmitter shall contain all necessary circuitry enclosed in NEMA 4 [indoor] [outdoor] housing suitable for [wall] [panel] mounting and connected to the transducers by [_____] m feet of cable. It shall produce an accurate 4 to 20 mA dc signal linear with flow rate. It shall provide linearity of plus of minus 0.5 percent and repeatability of 0.1 percent under simulated flow. Long term drift of the pulse rate output shall be less than 0.1 percent. It shall operate with 115 or 230 volt plus or minus 10 percent, 50 or 60 Hz electrical power. The unit shall function over an ambient temperature range of [_____] degrees C F to [_____] degrees C F indoor or [_____] degrees C F to [_____] C F outdoor. The flow rate indicator shall be integrally mounted in the transmitter housing. Graduate 150 mm 6 inch scale length in [meter per second] [cubic meter per second] [fps] [gpm].

2.2 READ-OUT DEVICE

****
NOTE: Retain appropriate paragraphs and delete others.
****

Provide the meter with the following read-out device which shall read from [_____] to [_____] [cubic meter per second] [gpm].

2.2.1 [Local Read-Out

****
NOTE: Choose this paragraph entitled "Local Read-Out," or the paragraph below entitled "Local Read-Out and Remote Transmission," including its subparagraphs "Indicator," "Recorder," and "Integrator."
****

Provide [an indicator] [a recorder] [and an integrator] for local read-out of flow. The scale graduation shall be [uniform] [square root]. The read-out shall be visible through a shatterproof clear window. The read-out mechanism shall not be affected by the intended end use environment. The unit shall be non-corrosive and weatherproof or provided with a separate weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

]2.2.2 [Local Read-Out and Remote Transmission

Provide [an indicating transmitter] [a recording transmitter] [and an integrator] for local read-out and transmission of flow data to remote read-out. The scale graduation shall be [uniform] [square root]. The read-out shall be visible through a shatterproof clear window. The read-out and transmission mechanism shall not be affected by the intended end use of environment. The transmission shall be impulse duration type or milliampere dc analog signal type to the remote read-out. Actuate all transmission by the output motion or the ac voltage signal of the meter. Power required [shall come from the meter] [shall be [_____] volts, [_____] hertz, ac]. When impulse duration type transmission is used, the system shall have a 15 second maximum cycle actuating a cam-operated contact. The contact shall be of the totally-enclosed type. The unit shall be non-corrosive and weatherproof or provided with a separate

weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

2.2.2.1 Indicator

Shall be a minimum of 150 mm 6 inches long.

2.2.2.2 Recorder

Shall be a minimum of 250 mm 10 inches in diameter and shall rotate once [daily] [weekly] [monthly]. The chart drive shall be driven by a synchronous motor from [_____] volts, [_____] hertz, ac.

2.2.2.3 Integrator

Shall read the total flow in the units specified using only a whole power of 10 multiplier.

]2.2.3 Remote Read-Out

Provide [an indicator] [a recorder] [and an integrator] for remote read-out of flow. The scale graduation shall be [uniform] [square root]. The read-out shall accept the signal output and be of the same range and flow units as the local read-out and remote transmission device. The signal shall actuate an electro-mechanical receiver in which the input duplicates the output of the remote transmission device. Ac or dc power supply shall be provided, if required. The read-out shall be visible through a shatterproof clear window. The read-out shall not be affected by the intended end use environment. The unit shall be weatherproof or provided with a separate weatherproof housing with a sealed door for access to the mechanism, and designed to prevent the accumulation of moisture or fog inside the case. Provide a suitable mounting.

2.2.3.1 Remote Read-Out Indicator

Shall be a minimum of 150 mm 6 inches long.

2.2.3.2 Remote Read-Out Recorder

Shall be a minimum of 250 mm 10 inches in diameter and shall rotate once [daily] [weekly] [monthly]. The chart drive shall be driven by a synchronous motor from [_____] volts, [_____] hertz, ac.

2.2.3.3 Remote Integrator

Shall read the total flow in the units specified using only a whole power of 10 multiplier.

2.3 ELECTRICAL REQUIREMENTS

****

NOTE: Delete paragraph except when electromagnetic meter, electric drive chart for recorders, or remote read-out is required.

****

****

NOTE: Delete requirements for signal circuit when

remote read-out is not required.
****

Unless indicated or specified otherwise, the electrical components of the meters, such as chart drives and electrical disconnecting (isolating) means, are included under this section. [Provide wiring for signal circuit as specified by the equipment manufacturer.] The interconnecting conduit and wire (except when otherwise specified herein, or when included in factory-assembled equipment) and the electrical connection of the meters to the electrical power circuit are specified in Division 16.

2.4 SPARE PARTS

****
NOTE: Delete the bracketed sentence when recorder is not required.
****

Provide all standard recommended spare parts as specified in the manufacturer's instruction manuals for each component in the system. [Furnish one year's supply of charts and ink for each recording device.]

PART 3 EXECUTION

3.1 MATERIALS PROTECTION

The entire tube, except the throat section of the [flow nozzle] [Venturi] [characterized flume], shall receive a series of coats of paint conforming to MIL-DTL-24441. Apply the paint in the following order: one coat of Formula 150, one coat of Formula 151, one coat of Formula 156, and one coat of Formula 152. The final total dry-film thickness shall be not less than 0.25 mm 10 mils. Furnish all other items in accordance with the manufacturer's standard practice suitable for end use environment.

3.2 INSTALLATION

Furnish the services of an engineer representative of the manufacturer of the flow measuring equipment for checking the installation, making the necessary adjustments and calibrations, placing the equipment in operation, and performing the acceptance tests. The representative also shall be available for not less than 2 days to instruct operating personnel in the use, operation, and maintenance of the equipment during the initial operating period. Install all flow measuring equipment in accordance with the recommendations of the manufacturer. Install variable head meter[s] for closed channel[s] in accordance with the ASME PTC 19.5. Install weir[s] with the top exactly level at the elevation indicated.

3.3 FIELD TESTS AND INSPECTIONS

Test and calibrate in place the flow measuring equipment to demonstrate that it meets the accuracy requirements for the full range of flows specified herein. Provide all labor, equipment, and incidentals required for the tests, including electric power and water required for tests. The Contracting Officer will witness all field tests and conduct all field inspections. The Contractor shall give the Contracting Officer ample notice of the dates and times scheduled for tests. Rectify any deficiencies found and retest work affected by such deficiencies at the Contractor's expense. Record data from each field test shall be recorded and documented in a formal field test report.

-- End of Section --