

Preparing Activity: AFCEA

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UML dated October 2009

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UNIFIED FACILITIES GUIDE SPECIFICATIONS

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SECTION 33 12 33.00 30

WATER METERS 08/08

NOTE: This specification covers the requirements for installation of water meters (5/8-inch x 3/4-inch, 1-inch, 1-1/2-inch, and 2-inch Displacement Meters; 2-inch, 3-inch, 4-inch, and 6-inch Compound Meters; 2-inch Turbine Meters; 2-inch, 3-inch, 4-inch, and 6-inch Strainers) suitable for billing, allocation of costs, and recording of data for water management and control applications, and provides guidance for the facility energy manager or design engineer after determining what data will be gathered and what analysis procedures will be used.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer. Since metering for water management and costs allocation varies widely, it is expected that the designer will make significant adjustments and additions to this guide specification.

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.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 DEFINITIONS

Unless otherwise specified or indicated, water terms used in this specification and on the drawings shall be as defined in AWWA C700.

1.2 REFERENCES

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. The latest version is required when applied to this specification.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

- AWWA C700 (2002; Errata 2008) Standard for Cold Water Meters - Displacement Type, Bronze Main Case
- AWWA C701 (2007) Standard for Cold-Water Meters - Turbine Type for Customer Service
- AWWA C702 (2001) Cold-Water Meters - Compound Type
- AWWA C707 (2005) Encoder-Type Remote-Registration Systems for Cold-Water Meters

ASME INTERNATIONAL (ASME)

- ASME B1.20.1 (1983; R 2006) Pipe Threads, General Purpose (Inch)
- ASME B16.1 (2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

- IEEE C2 (2007; Errata 2006; Errata 2007; INT 44-56 2007; INT 47, 49, 50, 52-56 2008; INT 57, 58, 51, 48 2009) National Electrical Safety Code
- IEEE C37.90.1 (2002; Errata 2003; Errata 2004) Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

- IEC 61000-4-5 (2005) Electromagnetic Compatibility (EMC) - Part 4-5: Testing and Measurement Techniques; Surge Immunity Test

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

- ISO 9001 (2008; CORR 2009) Quality Management Systems- Requirements

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

- NEMA C12.18 (2006) Protocol Specification for ANSI Type 2 Optical Port
- NEMA C62.61 (1993) Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- NFPA 70 (2008; AMD 1 2008) National Electrical Code - 2008 Edition

1.3 SUBMITTALS

NOTE: The submittal description (SD) numbers and names, assigned by the SPECSINTACT Configuration, Control and Coordinating Board, relate to the terminology of the technical sections and should not be changed.

Review SD definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 Air Force projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Recommended codes for Air Force projects are "RE" for Resident Engineer approval, "ED" for Engineering approval, and "AE" for Architect-Engineer approval. Submittal items not designated with a "G" are considered as being for information only for Air Force projects.

a. Maintenance manual shall provide:

- (1) Condensed description of how the equipment operates.
- (2) Block diagram indicating major assemblies.
- (3) Troubleshooting information.
- (4) Preventive maintenance.
- (5) Spare parts information.

b. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data."

SD-02 Shop Drawings

SD-03 Product Data

Protocol modules[; G][; G, [_____]]

Data recorder[; G][; G, [____]]
Modems[; G][; G, [____]]

Submittals shall include manufacturer's information for each component, device, and accessory provided with the meters, **protocol modules** or communications modules.

SD-06 Test Reports

Acceptance checks and tests[; G][; G, [____]]

SD-10 Operation and Maintenance Data

Water meters[; G][; G, [____]]
Communications modules[; G][; G, [____]]
Protocol modules[; G][; G, [____]]
Data recorder[; G][; G, [____]]
Modems[; G][; G, [____]]

1.4 QUALITY ASSURANCE

1.4.1 Installation Drawings

Drawings shall indicate, but not be limited to, the following:

- a. Elementary diagrams and wiring diagrams with terminals identified of[**protocol modules**,][**communications modules**,][Ethernet connections,][telephone lines]. [For each meter installation, provide a diagram identified by the building number.]
- b. One-line diagram, including meters,[**protocol modules**,][**communications modules**,][Ethernet connections,][telephone outlets,][and fuses]. [For each meter installation, provide a diagram identified by the building number.]

1.4.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for five years prior to bid opening. The five-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the five-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section. All meters provided shall be manufactured by a registered **ISO 9001** quality standard facility. All specifications shall meet or exceed the latest revision of **AWWA C702**.

1.4.3 Alternative Qualifications

Products having less than a five-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 10,000 hours, exclusive of the manufacturer's factory or laboratory tests, is provided.

1.4.4 Material and Equipment Manufacturing Data

Products manufactured more than two years prior to date of delivery to the site shall not be used, unless specified otherwise.

1.5 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract. All meters shall carry the following published warranties:

- a. Meters shall be guaranteed to be free from defective materials and workmanship and meet AWWA New Meter Accuracy Standards for a period of five years from the date of installation. At the expiration of this period, meters shall be guaranteed to meet AWWA Repaired Meter Accuracy Standards for the following time periods:

(1) 5/8 inch to 1 inch: 5 to 15 years from the date of shipment.

(2) 1-1/2 inch and larger: 5 to 10 years from the date of shipment.

- b. All registers are guaranteed for a ten-year period from the date of purchase. Any defective register will be replaced at no cost to the Government.
- c. All brass maincases are guaranteed for life by the manufacturer. Any defective maincase will be replaced at no cost to the Government.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

The metering and reading system, consisting of commercial, off-the-shelf meters, protocol modules and communications modules, and communication channels, will be used to record the water consumption and other values as described in the sections that follow and as shown on the drawings.

1.6.2 Selection Criteria

Metering components are part of a system that includes the physical meter, data recorder function, and communications method. Every building site identified shall include sufficient metering components to measure the water parameters identified and to store and communicate the values as required in the following sections. The Contractor shall verify that the metering system installed on any building site is compatible with the facility-wide communication and meter-reading protocol system.

PART 2 PRODUCTS

2.1 WATER METERS

NOTE: This specification is designed for projects where multiple metering systems will be installed on the same project. It is expected that different buildings may have different metering systems depending on the metering system that can be

installed economically for any specific building and that meets the needs of the facility analysis and billing system.

Metering features that are unique to a building should be listed in a schedule either in this specification or on accompanying drawings.

2.1.1 Physical and Common Requirements

- a. Metering system components shall be installed according to the Metering System Schedule shown[in this specification][on the drawings].
- b. Meter shall be rated for use at temperatures from -40 [_____] degrees Centigrade to +70 [_____] degrees Centigrade.
- c. Surge withstand shall conform to **IEEE C37.90.1**.

2.1.1.1 Cold-Water Meters - Displacement Type 5/8-inch x 3/4-inch, 1-inch, 1-1/2-inch, 2-inch Size

Small meters shall be as follows or shall be approved equivalents: Positive displacement meters provided hereunder shall be full-size nutating-disc, magnetic drive, sealed register, cold water meters and shall fully comply with the requirements of **AWWA C700** unless otherwise specified hereunder. **No oscillating-piston style meters will be accepted.**

a. Materials

- (1) Cases **5/8-Inch x 3/4-Inch, 1-Inch, 1-1/2-Inch**: The main case of the meter shall be cast all-bronze, bottom caps shall be cast all-bronze, excepting register boxes and register box lids which shall be bronze or an approved plastic material as specified in **AWWA C700**. Meter cases constructed of plastic will not be accepted.
- (2) Cases **2-Inch**: The main case of the meter shall be cast all-bronze, including bottom caps, excepting register boxes and register box lids which shall be bronze or an approved plastic material. Meter cases constructed of plastic will not be accepted.
- (3) Register Box Rings and Lids: Register box rings and lids shall be made of a copper alloy containing not less than 57 percent copper, or all bronze, or an approved suitable synthetic polymer.
- (4) Measuring Chambers: Measuring chambers shall be made of a copper alloy containing not less than 85 percent copper and suitable amounts of tin, lead, and zinc or of a suitable synthetic polymer.
- (5) Discs: Discs shall be made of vulcanized hard rubber or a suitable synthetic polymer with specific gravity approximately equal to that of water. They shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to +27 degrees Centigrade and not warp or deform when exposed to operating temperatures of +37 degrees Centigrade.
- (6) Measuring Chamber Diaphragms: Measuring chamber diaphragms shall be made of phosphor bronze, stainless steel, hard rubber, or a suitable synthetic polymer.

- (7) Spindles, Thrust Rollers, and Thrust-Roller Bearing Plates: Spindles, thrust rollers and thrust-roller bearing plates shall be made of phosphor bronze, stainless steel, hard rubber, or a suitable synthetic polymer.
- (8) Intermediate Gear Trains: Frames, gears, and pinions shall be made of a suitable copper alloy, other suitable non-corrosive metals, or other suitable materials.
- (9) External Fasteners (Casing Bolts, Studs, Nuts, Screws, and Washers): External fasteners shall be made of a copper alloy containing not less than 57 percent copper, stainless steel, or steel treated to resist corrosion by a process approved by the Government. Fasteners for no-pressure assemblies may be made of a suitable synthetic polymer. All external case closures, such as rings, clamps, screws, bolts, cap bolts, nuts and washers, shall be designed for easy removal following lengthy service.
- (10) Water Meter Coupling - 5/8-Inch x 3/4-Inch: A water coupling shall be composed of one meter coupling nut, one meter coupling tail piece (straight), and one rubber-type washer for meter coupling. The meter coupling tailpiece and nut shall be a copper alloy containing not less than 57 percent copper. The coupling nut shall have internal straight pipe threads conforming to ASME B1.20.1. Pitch diameter shall be that shown on AWWA C700. The coupling tailpiece shall have external taper pipe threads conforming to ASME B1.20.1 and an internal diameter approximately equal to the nominal thread size of the tailpiece. Lengths and thread sizes shall be those listed in AWWA C700. One water meter coupling and one additional rubber-type washer for meter coupling (total of two rubber-type washers) shall be provided with each meter.
- (11) Companion Flanges - 1-1/2-Inch and 2-Inch: Companion flanges shall be made of cast iron.

b. General Design

- (1) Pressure Requirements: Meters supplied under this specification shall operate without leakage or damage to any part at a working pressure of 150 psi.
- (2) Accessibility: All 1-1/2-inch and 2-inch meters shall be designed for easy removal of all interior parts without disturbing the connections to the pipeline.

c. Detail Design

- (1) Cases: All meters shall have an outer case with separate, removable measuring chambers. Cases shall not be repaired in any manner. The inlet and outlet shall have a common axis. A meter case shall include the top case and bottom case, or main case and bottom plate, whichever is applicable. Connection flanges shall be parallel.
- (2) Connections: Meter case connections for 5/8-inch x 3/4-inch and 1-inch meters shall be meter casing spuds on both ends. Spuds shall have external straight threads conforming to ASME B1.20.1 as

far as the specifications apply. Pitch diameters shall be those shown in [AWWA C700](#). Main case connections for 1-1/2-inch and 2-inch meters shall be oval-flanged on both ends. Flanges shall be faced and drilled and shall be the oval type. The drilling shall be on a horizontal axis; the number of bolt holes and the diameters of the bolt holes and bolt circle shall be as listed in [AWWA C700](#). Two oval companion flanges, gaskets, bolts and nuts shall be provided with each meter. Companion flanges shall be faced, drilled, and tapped in conformance with [ASME B1.20.1](#). Dimensions shall be those listed in [AWWA C700](#). Companion flanges shall be cast iron.

- (3) Registers: Registers shall be straight-reading and shall read in 1000-gallon increments. The register shall be equipped with a center-sweep test hand with the test circle located on the periphery of the register and graduated in 100 equal parts, with each tenth graduation being numbered. Register construction shall conform to all applicable requirements of [AWWA C700](#).
- (4) Register Boxes: The lid shall be recessed and shall overlap the register box in order to protect the lens. The lens shall be held securely in place.
- (5) Intermediate Gear Trains: Intermediate gear trains may be mounted on the measuring chamber, in the upper main casing, or when not exposed to water, combined with or adjacent to the register gearing.
 - (a) Oil-enclosed type - Gear trains exposed to water shall be of the oil-enclosed type, shall have a separate housing or form housing with the main casing or measuring chamber, and shall operate in a suitable lubricant.
 - (b) Magnetic coupled drives - When intermediate gear trains are located in the water compartment of the meter, the revolutions of the train output spindles shall be transmitted to the registers by means of magnetic couplings through the meter cases. When the intermediate gear trains are located in the register compartments, the disc nutations shall be transmitted by magnetic couplings.
- (6) Measuring Chambers: The measuring chambers shall be self-contained units, smoothly finished, firmly seated, and easily removed from the main cases, and shall not be cast as part of the main cases. The measuring chambers shall be so secured in the main cases that the accuracy of the meter will not be affected by any distortion of the cases that might occur when operating with a pressure less than 150 psi.
- (7) Discs: Discs shall be smoothly finished, disc plated, whether flat or conical, shall be either reinforced or equipped with thrust rollers. Discs may be one piece or composed of a plate with two half balls. The disc spindles shall be fastened securely. The disc nutations shall not exceed the quantities listed in [AWWA C700](#).
- (8) Strainers: All meters shall be provided with strainer screens installed in the meter. Strainer screens shall be rigid, fit snugly, be easy to remove, and have an effective straining area at least double that of the main case inlet.

- (9) Seal Wire Holes: Register box screws and inlet and outlet coupling nuts, if provided, shall be drilled for seal wires. Seal wire holes shall not be less than 3/32 inch in diameter.
- (10) Registration Accuracy: Meters shall meet the following requirements for accuracy with water of a temperature of less than +27 degrees Centigrade.
 - (a) Normal Flow Limits - At any rate of flow within the normal test flow limits specified on AWWA C700, the meter shall not register less than 98.5 percent and not more than 101.5 percent of the water that actually passes through it.
 - (b) Minimum Test Flow - At the minimum test flow rate specified in AWWA C700, the meter shall not register less than 95 percent and not more than 101 percent of the water that actually passes through it.
- (11) Markings: The size, model, and direction of flow through the meter shall be marked permanently on the outer case of all meters. All meters shall have the manufacturer's serial numbers stamped on the meter main case and top of the reading lid.
- (12) Register Boxes: The name of the manufacturer shall be marked permanently on the lid of the register box. The serial number of the meter shall be imprinted on the lid and the main case.

2.1.1.2 Cold-Water Meters - Compound Type 2-Inch, 3-Inch, 4-Inch, and 6-Inch Size

Compound meters shall consist of a combination of a main-line meter of the turbine type for measuring high rates of flow and a meter of appropriate size for measuring low rates of flow. The compound meter shall have an automatic valve mechanism for diverting low rates of flow through the bypass meter. **Both metering devices with registers shall be contained in the same case.** The operating and physical characteristics shall conform to those specified within AWWA C702.

a. Materials

- (1) Cases: The main case of the meter shall be made of a copper alloy containing not less than 75 percent copper.
- (2) Register Box Rings and Lids: Register box rings and lids shall be made of a cast copper alloy containing not less than 75 percent copper, forged or die-cast copper alloy containing not less than 57 percent copper or a suitable synthetic polymer.
- (3) Measuring Cages or Chambers: Measuring cages or chambers shall be made of a copper alloy containing not less than 84 percent copper and suitable amounts of tin, lead, and zinc or of a suitable synthetic polymer.
- (4) Measuring Turbines, Pistons and Discs: Turbines, pistons and discs shall be made of vulcanized hard rubber or a suitable synthetic polymer with specific gravity approximately equal to that of water. They shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to +27 degrees Centigrade and not warp or deform when exposed to operating

temperatures of +37 degrees Centigrade.

- (5) Disc and Turbine Spindles: Measuring chamber spindles shall be made of phosphor bronze, stainless steel, ceramic, or suitable synthetic polymer.
- (6) Intermediate Gear Trains: Frames, gears and pinions of intermediate gear trains exposed to water shall be made of copper alloy containing not less than 85 percent copper and suitable amounts of tin, lead, and zinc, or suitable synthetic polymer. When not exposed to water, intermediate gear trains may be made of a suitable synthetic polymer.
- (7) External Fasteners (Casing Bolts, Studs, Nuts, Screws, and Washers): External fasteners shall be made of a copper alloy containing not less than 57 percent copper, stainless steel, or steel treated to resist corrosion by a process approved by the Government. Fasteners for no-pressure assemblies may be made of a suitable synthetic polymer. All external case closures, such as rings, clamps, screws, bolts, cap bolts, nuts and washers, shall be designed for easy removal following lengthy service.
- (8) Companion Flanges: Companion flanges shall be made of cast iron.
- (9) Automatic Valves: The valve weights shall be lead, or a copper alloy containing not less than 75 percent copper, or a copper alloy shell loaded with lead. The valve and supplemental hinge pins or spindles shall be a copper alloy containing not less than 75 percent copper, or stainless steel, and all valve and supplemental weight hinge bearings shall be bushed with hard rubber or bronze or other suitable bushing material. If the valve contains a clapper, it shall be faced with a removable semi-hard seat. Valve seats shall be made of a copper alloy containing not less than 75 percent copper and suitable amounts of tin, lead, and zinc.

b. General Design

- (1) Pressure Requirements: Meters supplied under this specification shall operate without leakage or damage to any part at a working pressure of 150 psi.
- (2) Accessibility: All compound meters shall be designed for easy removal of all interior parts without disturbing the connections to the pipeline.
- (3) Registration Accuracy: Meters shall meet the following requirements for accuracy with water of a temperature of less than +27 degrees Centigrade.
 - (a) Normal Flow Limits - The meter shall not register less than 97 percent and not more than 103 percent of the water actually passed through it at any rate of flow within the normal test flow limits specified in [AWWA C702](#), except in the registration of flows within the changeover from bypass meter to main meter.
 - (b) Changeover Flow - The beginning of the changeover is when the accuracy of registration falls below 97 percent due to the operation of the automatic valve mechanism, and the end of

changeover is when accuracy of registration again reaches 97 percent. The registration of these changeover rates of flow shall not be less than 90 percent and not more than 103 percent. The difference in the rate of flow at the beginning and at the end of the changeover shall not exceed the figures listed in [AWWA C702](#).

(c) Minimum Test Flow - There shall not be less than 95 percent of actual flow recorded when a test is made at the minimum test flow shown in [AWWA C702](#).

- (4) Markings: The size, model, and direction of flow through the meter shall be cast or stamped in the outer case of all meters.

(a) Register Boxes - The name of the manufacturer shall be permanently impressed on the lid of the register box. The serial number of the meter shall be imprinted on the lid.

c. Detail Design

- (1) Main Case: All meters shall have an outer case with separate, removable measuring chambers. Cases shall not be repaired in any manner. The inlet and outlet shall have a common axis. Connection flanges shall be parallel.

- (2) External Case Screw, Bolts, Nuts and Washers: All external screws, bolts, cap bolts, nuts and washers shall be designed for easy removal after lengthy service.

- (3) Main Case Connections: All main case connections shall be flanged. The bolt holes shall comply with [AWWA C702](#).

(a) 2-Inch Meters - The flanges for 2-inch meters shall be oval. The drilling of oval flanges shall be on the horizontal axis.

(b) Meters Larger than 2-Inch - The flanges for 3-inch, 4-inch, and 6-inch meters shall be the round type, faced and drilled, and shall conform to [ASME B16.1](#) for bronze pipe flange, Class 125.

- (4) Companion Flanges: Companion flanges of the same size and type as the meter flanges shall be provided, and gaskets, nuts, and bolts shall be provided. Round companion flanges shall be faced, drilled, and tapped in accordance with [ASME B1.20.1](#) and shall conform to [ASME B16.1](#) for cast-iron pipe flange, Class 125. All companion flanges shall comply with [AWWA C702](#) for drilling, diameter, and thickness specifications.

- (5) Tapped Bosses: All meters shall be provided with tapped bosses in the top of the case near the outlet for field testing purposes.

- (6) Registers: Registers shall be straight reading and shall read in cubic feet (cu.ft.). Except for those instances when test conditions require the use of a different register, the register provided with the meter shall be the same register that was on the meter when it was tested for accuracy. The register lock and side gears shall be fastened securely to the number wheel discs and hubs. The tumbler pins shall mesh accurately at the turnover points with the lock and side gears of the adjacent number wheels. Both main and pinion shafts shall be so secured in the register frame and/or register plates that they cannot get out of position.

The pinion shaft shall be so designed that there is no possibility of its bending and allowing the pinion to skip the turnover point. The numerals on the number wheels shall not be less than $\frac{3}{16}$ inch in height and should be readable at a 45-degree angle from vertical. Registers that are hermetically sealed shall have gears and pinion which shall run free on fixed shafts or be fixed on shafts that run free in the register frame and/or register plates and shall be constructed so that they cannot be unmeshed. The registers shall have a center-sweep test hand with a test circle located on the periphery of the register and graduated in 100 equal parts, each tenth graduation numbered. The maximum quantity indicated by a single revolution of the test hand and the minimum capacity of the register shall be as listed in AWWA C702. The maximum indication on the test circle and the minimum register capacity of the bypass unit shall be in accordance with the approved AWWA Standard for the type of meter used as the bypass unit.

(a) Coordinator Registers - The meter may be equipped with a coordinator so that the readings of both sections can record on a single register. The register construction shall conform to previously mentioned requirements, and the maximum quantity indicated by a single revolution of the test hand and the minimum capacity of the register shall conform to AWWA C702.

- (7) Register Boxes: The lid shall be recessed and shall overlap the register box to protect the lens.
- (8) Intermediate Gear Trains: Intermediate gear trains may be mounted on the measuring chamber or cage or in the main casings. When not exposed to water, they may also be combined with or adjacent to the register gearing. Gear trains exposed to water shall be the oil-enclosed type, shall have separate housings or shall form housings with the main casings or measuring chambers, and shall operate in a suitable lubricant. Gear trains made of non-corrosive metals or synthetic polymers may be exposed to water.
- (9) Measuring Chambers or Cages: The main-line section chambers or cages shall be self-contained units firmly seated and easily detached and removed from the main case. Chambers or cages with turbines that have revolving spindles shall have removable bearings for such spindles. Chambers or cages with stationary spindles on which the turbines revolve shall provide rigid, centrally located fastenings for the spindles. The spindles shall be removable. The main-line section chambers or cages shall be interchangeable in all meters of the same size, make, and model.
 - (a) Bypass Chamber - The bypass chamber shall be a type covered by an approved AWWA Standard. The chamber shall be a self-contained unit, firmly seated and easily removed from the case, and shall not be cast as part of the outer case. The chamber shall be secured in position in the outer case so that any slight distortion of the case which might occur under 150 psi pressure will not affect the accuracy of the meter.
- (10) Measuring Turbines and Discs: Measuring turbines that have revolving spindles shall rotate on spindles supported by bushings or replaceable bearings. Turbines that rotate on stationary spindles shall also have bushings or replaceable bearings. The

plates of disc pistons, whether flat or conical, shall have metal reinforcements or shall be equipped with thrust rollers.

- (11) Magnetic Coupled Drives: When intermediate gear trains are located in the water compartment of the main or bypass section of the meter, the revolutions of the train output spindles shall be transmitted to the registers by means of magnetic couplings through the meter case. When intermediate gear trains are located in the register compartments, the revolutions shall be transmitted by magnetic coupling.
- (12) Automatic Valves: The automatic valve shall be of a type suitable for such purpose. It shall close by force. The weight of the valve and any supplemental force imposed on it shall offer sufficient resistance to the incoming water to divert all small rates of flow through the bypass meter until such time as the rate of flow through the meter is great enough to ensure efficient operation of the main measuring section. Valve hinge pins or spindles shall be bushed. Valve sets shall be bronze or other corrosion-resistant material, shall have a satisfactory width of face, and shall be held firmly in place. A clapper or swing-type valve shall be provided with a removable semi-hard seat.
- (13) Bypass Meter: The physical and operating characteristics and dimensions of the bypass meter shall be in accordance with the approved AWWA Standard for the type of meter used as the bypass.
- (14) Strainers: Strainers, if provided, shall be rigid, shall be easily removed and shall have an effective straining area at least double that of the water main-case inlet.
- (15) Seal Wire Holes: Register box screws shall be drilled for seal wires. Seal wire holes shall be not less than 3/32 inch in diameter.

2.1.1.3 Cold-Water Meter - Turbine Type 2-Inch Size

Turbine meters provided hereunder shall be Class II, in-line, horizontal-axis, high-velocity type and shall fully conform to the requirements of AWWA C701, except as otherwise specified herein. The 2-inch turbine meter shall have oval flanged ends and shall be supplied with one companion flange, gaskets, and with bolts and nuts as specified herein.

a. Materials

- (1) Cases: All turbine main cases shall be bronze. No exceptions will be allowed.
- (2) Register Box Rings and Lids: Register box rings and lids shall be made of a cast copper alloy containing not less than 75 percent copper, forged or die-cast copper alloy containing not less than 57 percent copper or a suitable synthetic polymer.
- (3) Measuring Cages or Chambers: Measuring cages or chambers shall be made of a copper alloy containing not less than 84 percent copper and suitable amounts of tin, lead, and zinc or of a suitable synthetic polymer.
- (4) Measuring Turbines, Pistons and Discs: Turbines, pistons and discs

shall be made of vulcanized hard rubber or a suitable synthetic polymer with specific gravity approximately equal to that of water. They shall have sufficient dimensional stability to retain operating clearances at working temperatures of up to +27 degrees Centigrade and not warp or deform when exposed to operating temperatures of +37 degrees Centigrade.

- (5) Disc and Turbine Spindles: Measuring chamber spindles shall be made of phosphor bronze, stainless steel, ceramic, or suitable synthetic polymer.
- (6) Intermediate Gear Trains: Frames, gears and pinions of intermediate gear trains exposed to water shall be made of copper alloy containing not less than 85 percent copper and suitable amounts of tin, lead, and zinc, or suitable synthetic polymer. When not exposed to water, intermediate gear trains may be made of a suitable synthetic polymer.
- (7) External Fasteners: (casing bolts, studs, nuts, screws, and washers). External fasteners shall be made of a copper alloy containing not less than 57 percent copper, stainless steel, or steel treated to resist corrosion by a process to be approved by the Government. Fasteners for no-pressure assemblies may be made of a suitable synthetic polymer. All external case closures, such as rings, clamps, screws, bolts, cap bolts, nuts and washers, shall be designed for easy removal following lengthy service.
- (8) Companion Flanges: Companion flanges shall be made of cast iron.

b. General Design

- (1) Pressure Requirements: Meters supplied under this specification shall operate without leakage or damage to any part at a working pressure of 150 psi. Pressure drop through turbine meters and strainers, when operated within specified normal flow limits, shall not exceed the characteristics outlined in [AWWA C701](#).
- (2) Accessibility: All turbine meters shall be designed for easy removal of all interior parts without disturbing the connections to the pipeline. Turbine meters shall have readily accessible change gears, adjustable vanes or other approved means to adjust meter registration. Such adjustment feature shall be an integral part of the removable rotor/register assembly and not of the main or bottom case of the meter.
- (3) Registration Accuracy: Meters shall meet the following requirements for accuracy with water of a temperature of less than +27 degrees Centigrade.
 - (a) Normal Flow Limits - The meter shall not register less than 97 percent and not more than 103 percent of the water actually passed through it at any rate of flow within the normal test flow limits specified in [AWWA C702](#), except in the registration of flows within the changeover from bypass meter to main meter. Turbine meters shall be designed to allow prolonged operation at or near the upper limit of the specified normal flow range without premature degradation of registration accuracy or other evidence of undue wear. Meters shall also be capable of accepting sudden increases in flow at high rates of flow without decoupling the register.

2.1.1.4 Cold-Water Meter Strainers 2-Inch, 3-Inch, 4-Inch and 6-Inch Size

General: All strainers provided shall have top access. Cases for 2-inch, 3-inch, 4-inch and 6-inch strainers shall be bronze. Strainer plates for all sizes shall be 18-8 stainless steel or bronze. All strainers shall conform to AWWA C702.

NOTE: SeBiLOY is an acceptable substitute for bronze.

**NOTE: If programming capability is not required,
omit the following section.**

2.1.2 Meter Programming

- a. Meter shall be programmable by software supplied by the meter manufacturer.
- b. Software shall have a user-friendly, Windows-compatible interface.
- c. Software shall operate on [Windows, [____]] operating systems.
- d. Software shall allow the user to configure the meter, troubleshoot the meter, query and display meter parameters and configuration data and stored values.
- e. Meter firmware shall be upgradeable through one of the communications ports without removing the unit from service.

**NOTE: The following optional features will usually
be deleted. These features could be used for
connection to an Energy Management and Control
System (EMCS).**

- f. [Meter shall include output options for analog milliamp signals.]
- g. [Meter shall have two channels of analog output, 0-1mA or 4-20mA, for positive [and negative] watt/hour readings.]
- h. [Meter shall have two form C, dry contact relay outputs for alarm or control.]

2.1.3 [Register Requirements for Remote Registration

- a. Meters must have encoder-type remote-registration conforming to the latest version of AWWA C707. Registers using generator pulses or low voltage conversions are not permitted. Power requirement for data transmission must be supplied by an interrogation device. Registers must be compatible with various brands of interrogation equipment. The register must provide at least six-digit visual registration at the meter. The units, the month and year of manufacture, and other identification information must clearly be printed on the face of the register. The register must also have a full test sweep hand or dial. The register must, in a digital format, simultaneously encode at least six significant digits of the meter reading for transmission through

the remotely located receptacle. A meter identification number must also be provided with each reading.

- b. All registers shall be easily upgraded to Automatic Meter Reading (AMR), which includes telephone, radio, cable, Energy Management and Control System (EMCS), Direct Digital Control (DDC), and Supervisory, Control and Data Acquisition (SCADA), with the substitution of the remote receptacle with a Meter Interface Unit (MIU). Data transmission shall be instantaneous and supplied in ASCII format without conversion or modification. The register must operate reliably down to at least 3.0 volts. Color-coded wire terminals (red, green and black) shall be provided; however, only the red and black terminals will be utilized for a two-wire connection to the interface ScanPad. The green terminal shall only be utilized to convert to AMR via the use of a MIU. A suitable wire terminal cover shall be provided and be factory potted when ordered for underground pit installations.
- c. All registers must be removable without disassembly of the meter or depressurizing the service line. The register must be free of openings to protect the internal electronics of the register. Lens covers shall be made of polycarbonate or other suitable engineering polymer for indoor installations and mineral glass for underground pit installations. All other register assembly and material requirements stated herein shall also apply.]

2.2 COMMUNICATIONS

NOTE: Communications features may not be needed.
Data logging of one month of data may be recorded
inside the meter. Recorded data may be read simply
by a handheld instrument if read daily or monthly.

2.2.1 Communications Methods

a. Optical Port

The optical port shall communicate with a hand-held reading device according to the following requirements.

- (1) Communications standards
 - (a) NEMA C12.18
 - (b) MV90 protocol
- (2) Read operations
 - (a) Current values
 - (b) Values since last reset
 - (c) Last reset value
 - (d) Meter status
 - (e) [Load profile]

(3) Write operations

(a) Meter setup

b. Serial Port

Provide a serial port for connection to the modem module where required in this specification.

(1) [On-board serial port types]

(a) [RS232]

(b) [RS485]

c. Ethernet

For those meters using the Ethernet, logged information shall be sent using open standard Internet protocols.

(1) On-board Ethernet port support

(a) HTTP

(b) SMTP

(c) Modbus

(2) Distribute stored data by:

(a) FTP

(b) [E-mail]

(3) [On-board web server]

2.2.2 Communications Protocols and Methods

Communications protocols and methods shall be native to the meter. Provide [communications modules](#) as required to accomplish the following.

- a. Meter shall include an IR port ("IR" in Metering Systems Schedule) (for communication to external devices such as handheld readers) that supports a minimum speed of 9600 baud.
- b. [Meter shall include [one] [RS-232 ("RS232" in Metering Systems Schedule)] or [one][RS-485 ("RS485" in Metering Systems Schedule)] digital communication port. Each port shall be user-configurable with regard to speed, protocol, address, and other communications parameters. Ports shall support a minimum communication speed of 9600 baud for the RS232 port.]
- c. [Meter shall have a port that can be configured as a [10/100 Base-T Ethernet port ("BaseT" in Metering Systems Schedule)].]
 - (1) [A communication module that converts serial RS232 or RS485 to Ethernet will be acceptable.]
- d. [Auto Answer minimum 1200 baud internal modem ("A56K" in Metering

Systems Schedule). Internal modems shall include automatic data buffering to provide faster, more reliable communications and the ability to automatically answer on a connected line.]

- e. [Meter shall be equipped with one pulse output channel ("Pulse" in Metering Systems Schedule) that can be configured for operation as KYZ pulse output.]

2.2.3 Communications Channels Surge Protection

Communications equipment shall be protected against surges induced on its communications channels. Communication interfaces to all field equipment shall be protected to meet the requirements of IEEE C37.90.1 or the requirements of IEC 61000-4-5, test level 4, while the equipment is operating. Fuses shall not be used for surge protection. Metallic cables and conductors which serve as communications channels between buildings shall have surge protection installed at equipment rated for the application installed at each end, within three feet of the building cable entrance. Surge protectors shall meet the requirements of the applicable extension of ANSI C62 (for example, NEMA C62.61).

NOTE: Communication methods, modules and software can be used for Automatic Meter Reading (AMR). AMR may not be needed. If AMR is to be implemented, considerable coordination of the communications sending, receiving and protocols will be required.

2.3 METER DATA PROTOCOL

Power meters shall have communicating data protocols native or provided in supplemental modules to communicate with the communications methods that follow.

2.3.1 Open Protocol

NOTE: This section should be modified to be facility-specific.

The Contractor shall verify that the meter native protocol is consistent with the facility data recording and communication and data storage system. The Contractor shall provide additional converters and modules as required for a complete measurement, recording, communicating and data storage system.

- a. [Meter shall be fully supported by MV-90 software system] or existing AMR software that is MV-90 compatible.
- b. For systems that use proprietary software, an alternative, competitive software system must be available.

Systems capable of using more than one brand of commercially available meters are expected. In addition, if proprietary meter reading software is used, meters are to be capable of being read by more than one manufacturer's software.

2.4 SPARE PARTS

2.4.1 Parts List

Provide spare parts as follows:

- a. **Water meters** - one for every 20 installed.
- b. **Communications modules** - one for every 20 used.
- c. **Protocol modules** - one for every 20 used.
- d. Other electronic and power components - one for each type used.

2.5 METERING SYSTEM SCHEDULE

NOTE: Each building should be listed on a separate row. Identify the characteristics for the specific meter and communications method for each building. The following completed data is an example only. Delete existing values.

METERING SYSTEM SCHEDULE				
<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
<u>Bldg #</u>	<u>Type of Meter</u>	<u>Communication</u>	<u>Meter Location</u>	<u>Remarks</u>
101	1" displacement	IR RS232	Bldg	Small building. Consumption reimbursable billing only.
102	2" turbine	BaseT, 56K	Bldg	Interval recording
103	3/4" displacement	Local	Bldg	

Metering System Schedule Notes by column position:

NOTE: Provide a drawing to show locations and details for mounting and routing conduit and wires.

PART 3 EXECUTION

3.1 INSTALLATION

Water meter installations shall conform to **AWWA C700**, **AWWA C701** and **AWWA C702**. Electrical installations shall conform to **IEEE C2**, **NFPA 70** (National Electrical Code), and to the requirements specified herein. Provide new equipment and materials unless otherwise indicated or specified.

**NOTE: Remove the following section if existing
condition surveys are not required.**

3.1.1 [Existing Condition Survey]

The Contractor shall perform a field survey, including inspection of all existing equipment, resulting clearances, and new equipment locations intended to be incorporated into the system, and provide an existing conditions report to the Government. The report shall identify those items that are non-workable as defined in the contract documents. The Contractor shall be held responsible for repairs or modifications necessary to make the system perform as required.]

**NOTE: Installation of water meters will require
that water service be disconnected from the
building. Provide coordination steps for the work
and require the Contractor to perform the work after
normal hours if disconnected service will impact
mission requirements for that facility.**

3.1.2 Scheduling of Work and Outages

The Contract clauses shall govern regarding permission for water/power outages, scheduling of work, coordination with Government personnel, and special working conditions.

3.2 [FIELD-APPLIED PAINTING]

Where field painting of enclosures is required to correct damage to the manufacturer's factory-applied coatings, provide the manufacturer's recommended coatings and apply in accordance with the manufacturer's instructions.]

3.3 FIELD QUALITY CONTROL

3.3.1 Performance of [Acceptance Checks and Tests](#)

a. Meter Assembly

(1) Visual and mechanical inspection

- (a) Compare equipment nameplate data with specification and approved shop drawings.
- (b) Inspect physical and mechanical condition.
- (c) Verify grounding of metering enclosure, if required.
- (d) Verify the presence of surge arresters.

(2) Electrical tests

- (a) Verify that correct multiplier has been placed on face or meter, where applicable.

(b) Prior to system acceptance, the Contractor will demonstrate and confirm the meter is properly wired and is displaying correct and accurate water information.

3.3.2 Follow-up Verification

Upon completion of [acceptance checks and tests](#), the Contractor shall show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the Contract, the Contracting Officer shall be given five working days' advance notice of the dates and times of checking and testing.

3.3.3 Training

The Contractor shall conduct a training course for meter configuration, operation, and maintenance of the system as specified. The training shall be oriented for all components and systems installed under this Contract. Training manuals shall be delivered for [_____] trainees with two additional copies delivered for archiving at the project site. The Contractor shall provide all audiovisual equipment and all other training materials and supplies. A training day is defined as eight hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility. For guidance in planning the required instruction, the Contractor shall assume that attendees have a high school education or equivalent, and are familiar with utility systems. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

a. Training

The course shall be taught at the project site within 30 days after completion of the installation for a period of one [_____] day(s). A maximum of [6] [_____] personnel will attend the course. The training shall include:

- (1) Physical layout of each piece of hardware.
- (2) Meter configuration, troubleshooting and diagnostics procedures.
- (3) Repair instructions.
- (4) Preventive maintenance procedures and schedules.
- (5) Testing and calibration procedures.

-- End of Section --