UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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10/07, CHG 2: 08/18

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SECTION 26 27 13.10 30

ELECTRIC METERS
10/07, CHG 2: 08/18

****
NOTE: This guide specification covers the requirements for the installation of poly-phase electricity meters suitable for billing, allocation of costs, and recording of data for energy management and control applications and is intended to comply with the metering requirements of EPACT05.

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: Since metering for energy management and costs allocation varies widely, it is expected that the designer will make significant adjustments and additions to this guide specification.

NOTE: Use the following related guide specifications for power distribution equipment:

- - Section 26 12 19.10 THREE-PHASE, LIQUID-FILLED PAD-MOUNTED TRANSFORMERS

- - Section 26 11 14.00 10 MAIN ELECTRIC SUPPLY STATION AND SUBSTATION

- - Section 26 22 00.00 10 480-VOLT STATION SERVICE SWITCHBOARD AND TRANSFORMERS

- - Section 26 23 00 SWITCHBOARDS AND SWITCHGEAR

NOTE: This specification provides guidance for the facility energy manager or design engineer after determining what data will be gathered and what analysis procedures will be used.

****

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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE C2	(2017; Errata 1-2 2017; INT 1 2017) National Electrical Safety Code
IEEE C37.90.1	(2013) Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C57.13	(2016) Requirements for Instrument Transformers

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61000-4-5	(2017) Electromagnetic Compatibility (EMC)

	- Part 4-5: Testing and Measurement Techniques - Surge Immunity Test
IEC 62053-22	(2020) Electricity Metering Equipment (A.C.) - Particular Requirements - Part 22: Static Meters for Active Energy (Classes 0,2 S and 0,5 S)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.18	(2006; R 2016) Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.20	(2015; E 2018) Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes
ANSI C62.61	(1993) American National Standard for Gas Tube Surge Arresters on Wire Line Telephone Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification and on the drawings shall be as defined in IEEE 100.

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:

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

Power Meters; G[, [_____]]

Current Transformers; G[, [_____]]

Potential Transformer; G[, [_____]]

Communications Module; G[, [_____]]

Protocol Modules; G[, [_____]]

Data Recorder; G[, [_____]]

Modem; G[, [_____]]

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

SD-06 Test Reports

Acceptance Checks and Tests; G[, [_____]]

SD-10 Operation and Maintenance Data

Power Meters; G[, [_____]]

Communications Module; G[, [_____]]

Protocol Modules; G[, [_____]]

Data Recorder; G[, [_____]]

Modem; G[, [_____]]

SD-11 Closeout Submittals

System Function Verification; 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[kilowatt][advanced] meter,[current transformers,][potential transformers,][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,[switch(es),][current transformers,][potential transformers,][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 2 years prior to bid opening. The 2-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 2-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.

1.4.3 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.4.4 Material and Equipment Manufacturing Data

Products manufactured more than 2 years prior to date of delivery to 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.

1.6 SYSTEM DESCRIPTION

1.6.1 System Requirements

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

1.6.2 Selection Criteria

****

NOTE: Coordinate with the Public Works Department - when an installation-wide energy and utility monitoring system exists, include the last sentence.

****

Metering components are part of a system that includes the physical meter, data recorder function and communications (modem) method. Every building site identified shall include sufficient metering components to measure the electrical parameters identified and to store and communicate the values as required in the following sections. Contractor shall verify that the metering system installed on any building site is compatible with the facility-wide communication and meter-reading protocol system.[Contractor must connect the metering system to the facility-wide energy and utility monitoring and control system.]

PART 2 PRODUCTS

2.1 POWER 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

****

NOTE: Meters will generally be installed outside the building in a readily accessible location. In

that case, use the socket-mount design. In the situations where panel-mounting is required, add the panel-mounting section.
****

a. Metering system components shall be installed according to the Metering System Schedule shown[in this specification][on the drawings].

[b. Power meter shall be socket-mount design.]

[c. Power meter shall be panel-mounted design. Meters shall be semi-flush, back-connected, dustproof, draw-out switchboard type. Cases shall have window removable covers capable of being sealed against tampering. Meters shall be of a type that can be withdrawn through approved sliding contacts from fronts of panels or doors without opening current-transformer secondary circuits, disturbing external circuits, or requiring disconnection of any meter leads. Necessary test devices shall be incorporated within each meter and shall provide means for testing either from an external source of electric power or from associated instrument transformers or bus voltage.]

d. If existing meter base is usable, the meter base determines meter form factor. If a new meter is being installed, use meter and base form factor of 9S.

****
NOTE: If the measured load is less than 220 amps, use Class 200 meters for direct current reading without current transformers.
****

[e. Use Class 200 meters for direct current reading without current transformers.]

f. Meter shall be a Class 20, transformer rated design.

g. Meter shall be rated for use at temperature from -40 [_____] degrees Centigrade to +70 [_____] degrees Centigrade.

h. Meter shall have NEMA 3R enclosure for surface mounting.

****
NOTE: Select if the recorded data will be in a module inside the meter or external in a data logger. The preferred method is to install the recording module inside the meter case. Some retrofit applications may require an external data logger.
****

i. Surge withstand shall conform to IEEE C37.90.1.

j. Meter shall have a standard[4] [_____]-year warranty.

k. Meter shall comply with IEC 62053-22 (Part 21: Static Meter for Active Energy, classes 0.2S and 0.5S), certified by a qualified third party test laboratory.

2.1.2 Voltage Requirements

a. Meter shall be capable of connection to the service voltage phases and magnitude being monitored. If the meter is not rated for the service voltage, provide suitable potential transformers to send an acceptable voltage to the meter.

b. Meter shall be capable of connection to the service voltage indicated in the Metering System Schedule:

c. Meter shall accept independent voltage inputs from each phase. Meter shall be auto-ranging over the full range of input voltages.

d. Voltage input shall be optically isolated to 2500 volts DC from signal and communications outputs. Components shall meet or exceed IEEE C37.90.1 (Surge Withstand Capability).

e. The Contractor shall be responsible for determining the actual voltage ratio of each potential transformer. Transformer shall conform to IEEE C57.13 and the following requirements.

1. Type: Dry type, of two-winding construction.

2. Weather: Outdoor or Indoor rated for the application.

3. Frequency: Nominal 60Hz, 50Hz for those bases that operate on 50Hz.

4. Accuracy: Plus or minus 0.3% at 60Hz or 0.3% for those systems that operate at 50Hz.

2.1.3 Current Requirements

a. Meter shall accept independent current inputs from each phase. Current transformer shall be installed with a full load rating as shown in the schedule.

b. Single ratio current transformer shall have an Accuracy Class of [0.3][0.6] [1.2] with a maximum error of +/- [0.3%][0.6%][1.2%] at 5.0 amps.

c. Current transformer shall have:

1. Insulation Class: All 600 volt and below current transformers shall be rated 10 KV BIL. Current transformers for 2400 and 4160 volt service shall be rated 25 KV BIL.

2. Frequency: Nominal 60Hz, 50Hz for bases that operate on 50Hz.

3. Burden: Burden class shall be selected for the load.

4. Phase Angle Range: 0 to 60 degrees.

d. Meter shall accept current input from standard instrument transformers (5A secondary current transformers.)

e. Current inputs shall have a continuous rating in accordance with IEEE C57.13.

****

NOTE: Since loads in building can vary over time, multi-ratio current transformers allow the flexibility to change the ratio of the current transformer to match the load. The accuracy of current transformer performance decreases when the actual current is in the lower band of its measuring range.

****

f. Multi-ratio current transformer where indicated shall have a top range equal to or greater than the actual load. The Contractor shall be responsible for determining the actual ratio of each transformer. Current transformer shall conform to IEEE C57.13.

2.1.4 Electrical Measurements

Power meter shall measure and report the following quantities:

****

NOTE: Select each of the following measuring capabilities that are required and include the abbreviation in the Metering System Schedule for each building. Since power meters have a service life greater that 10 years, include optional features that are expected to be used and analyzed over the life of the meter.

****

a. Kilowatt-hours ("kWh" in Metering Systems Schedule) of consumption. Cumulative.

b. Kilowatts of demand ("kW" in Metering Systems Schedule). Peak average over a selectable demand interval between 5 and 60 minutes (typically 15 minutes).

c. Reactive power ("kVAR" in Metering Systems Schedule). Measured over the same interval as the peak kW reading.

d. Power factor ("PF" in Metering Systems Schedule). Measured over the same interval as the peak kW reading.

****

NOTE: At locations where time of use (TOU) billing is required by the electric company, this specification provides that all TOD meters cover the same periods as defined in the next section.

****

e. Time of use consumption ("TOU" in Metering Systems Schedule). Kilowatt-hours recorded separately for each period set by programming into the meter. Time periods shall be capable of being changed without removal from service. The meter shall internally record and store Time of Use data.

1. [Four (4)] minimum [_____] TOU Rates (Registers)

2. [Twenty (20)][_____] Year Calendar

3. [Two (2)] minimum [_____] seasons per year

****

NOTE: Interval recording is an important tool for analyzing energy consumption within a building. For billing purposes, real-time reporting is not required. For non EPACT05 meters, the meter can be read nominally once per month with all recorded interval data captured at that time. Where real-time data is needed by an energy management control system (EMCS) or other system, the systems may have their own connection to the meter or its own current and potential transformers.

****

f. Interval recording ("IR" in Metering Systems Schedule). Kilowatt-hours shall be recorded for each[15][_____] minute interval and shall accumulate for[30][_____] days. Memory for recording the interval readings shall be internal to the meter and ANSI C12.19 compliant. Meter shall provide time-stamped readings for every measured parameter.

g. Meter readings shall be true RMS.

2.1.5 Meter Accuracy

****

NOTE: Meters used for billing purposes should generally be held to the same metering accuracies as established standards by utility companies.

****

Power meter shall provide the following accuracies. Accuracies shall be measured as percent of reading at standard meter test points.

a. Power meter shall meet ANSI C12.20 for Class 0.2 and IEC 62053-22 accuracy requirements.

2.1.6 An on the Meter Display, Output and Reading Capabilities

Meter shall include the following output signals.

a. The meter will have a face display plate and shall display every electrical parameter indicated to be recorded. Meters shall not be required to indicate interval data collected in a data logger with a communications output feature. Peak values, instantaneous and cumulative values shall be displayed.

[b. Meter shall include optical output port capable of 9600 bps communication with a hand-held reading device. Optical device shall be compatible with ANSI C12.18]

****

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

****

[c. Meter shall include output options for analog milliamp signals.]

[d. Meter shall have two channels of analog output, 0-1mA or 4-20mA, for positive[and negative] watt/hour readings.]

[e. Meter shall include output option for pulse output. KYZ pulse output related to kWatts/HR.]

[f. Meter shall have two form C, dry contact relay outputs for alarm or control.]

2.1.7 Installation Methods

****
NOTE: Pad-mounted transformers have proven to be very reliable over a long life span. Installing the meters on the outside of the secondary wiring compartment has become somewhat a standard installation for military facilities, resulting in minimal maintenance. However, meters may be installed on the sides of buildings or within buildings.
****

a. Transformer mounted (XFMR)

1. Meter base shall be located outside on the secondary side of the pad-mounted transformer.

****
NOTE: Do not use the stand-mounted method unless the transformer pad is being poured and the instrumentation conduit can be installed before the pour. Provide a drawing to show details for mounting and routing conduit and wires.
****

b. Stand-mounted adjacent to transformer ("STAND" in Metering Systems Schedule)

1. Meter base shall be mounted on a structural steel pole approximately 4 feet from the transformer pad. See detail on the drawings.

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

c. Building mounted ("BLDG" in Metering Systems Schedule)

1. Meter base shall be mounted on the side of the existing building near the service entrance. See detail on the drawings.

d. Panel mounted. ("PNL" in Metering Systems Schedule)

1. Meter shall be mounted where directed. See detail on the drawings.

e. Common features.

1. PTs (if required for proper voltage range) and CTs shall be

physically connected to the service entrance cables inside the service entrance disconnect enclosure.

2.1.8 Disconnecting Switches

****
NOTE: Shorting-type wiring blocks are recommended to allow connections to be corrected and changed without the necessity of disconnecting power to the transformer, resulting in another power outage to the building being served.
****

a. Disconnecting wiring blocks shall be provided between the current transformer and the meter. A shorting mechanism shall be built into the wiring block to allow the current transformer wiring to be changed without removing power to the transformer. The wiring blocks shall be located where they are accessible without the necessity of disconnecting power to the transformer. For multi-ratio current transformers, provide a shorting block from each tap to the common lead.

b. Voltage-monitoring circuits shall be equipped with disconnect switches to isolate the meter base or socket from the voltage source.

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

2.1.9 Meter Programming

a. Power 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 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.

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.
****

2.2.1 Communications Methods

2.2.1.1 Optical Port

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

a. Communications standards

1. ANSI C12.18

2. MV90 protocol

3. ANSI C12.20

b. Read operations

1. Current kWh values

2. Demand (kW) values since last reset

3. Last reset value

4. Meter status

[5. Load profile]

c. Write operations

1. Meter setup

2.2.1.2 Serial Port

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

[a. On-Board serial port types]

[1. RS232]

[2. \[RS485]]

2.2.1.3 Ethernet

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

a. On-board Ethernet port support

1. HTTP

2. SMTP

(a) Modbus

b. Distribute stored data by

1. FTP

[2. E-Mail]

[(a) On-board web server]

2.2.2 Communications Protocols and Methods

Communications protocols and methods shall be native to the meter. Provide communications module(s) 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 support 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 modem 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 3 feet 0.9 meters of the building cable entrance. Surge protectors shall meet the requirements of the applicable extension of ANSI C62 (for example, ANSI C62.61).

****

NOTE: Communication methods, modules and software can be used for automatic meter reading (AMR). AMR may not be needed. If automatic meter reading (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.

****

Power meter shall support the following open protocols. Contractor shall verify that the meter native protocol is consistent with the facility data recording and communication and data storage system. 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. Power meter - two for each type used.

b. Current transformer - three for each type used.

c. Potential transformer - three for each type used.

d. Communications module - one for each type used.

e. Protocol module - one for each type used.

f. 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 is available at

http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/forms-graphic

****

NOTE: Provide a drawing to show locations and details for mounting and routing conduit and wires. Identify CT ratio and multi-tap ratios if known.

****

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

[3.1.1 Existing Condition Survey

****

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

****

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 furnish 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 of modifications necessary to make the system perform as required.

]3.1.2 Scheduling of Work and Outages

****

NOTE: Installation of current transformers and potential transformers will require that power be disconnected from the transformer and/or building. Provide coordination steps for the work and require Contractor to perform the work after normal hours.

****

The Contract Clauses shall govern regarding permission for 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 manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

]3.3 FIELD QUALITY CONTROL

3.3.1 Performance of Acceptance Checks and Tests

3.3.1.1 Meter Assembly

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specification and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

4. Verify grounding of metering enclosure.

5. Verify the presence of surge arresters.

6. Verify that the CT ratio and the PT ratio are properly included in the meter multiplier or the programming of the meter.

b. Electrical tests

[1. Calibrate watthour meters according to manufacturer's published data.]

2. Verify that correct multiplier has been placed on face or meter where applicable.

3. Prior to system acceptance, the Contractor will demonstrate and confirm the meter is properly wired and is displaying correct and accurate electrical information.

3.3.1.2 Current Transformers

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specification and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

5. Verify that required grounding and shorting connections provide good contact.

b. Electrical tests

1. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

2. Perform insulation-resistance test.

3. Perform a polarity test.

4. Perform a ratio-verification test.

3.3.1.3 Potential Transformers

a. Visual and mechanical inspection

1. PT's are rigidly mounted.

2. PT's are correct voltage.

3. Verify that adequate clearances exist between primary and secondary circuit.

b. Electrical tests

1. Perform a ratio-verification test.

3.3.2 Follow-Up System Function 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 5 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 furnish 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 thirty 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 --