

ISO New England Operating Procedure No. 18 Metering and Telemetry Criteria (OP-18)

Effective Date: June 1, 2018

REFERENCES:

ISO New England Inc. Transmission, Markets, and Services Tariff Section I - General Terms and Conditions Section I.3.9 Review of Market Participant's Proposed Plans

ISO New England Market Rules and Procedures

ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Response Resources, Asset Related Demands and Alternative Technology Regulation Resources (OP-14)

ISO New England Operating Procedure No. 17 - Load Power Factor Correction (OP-17)

ISO New England Manual for Market Rule 1 Accounting Manual M-28 (Manual M-28)

ISO New England Manual for Definitions and Abbreviations Manual M-35 (Manual M-35)

ISO New England Manual for Registration and Performance Auditing Manual M-RPA (Manual M-RPA)

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I. PURPOSE

These criteria establish standards for metering (measurement) and telemetry (data transmission) for the purposes of ISO New England (ISO) dispatching, Market Settlement, Transmission Owner (TO) and Market Participant (MP) peak load determination, factors that impact voting shares and load power factor (Ipf) measurement. The power system parameters which each TO and MP are to meter and/or telemeter are identified. Standards are established to verify that the equipment each TO and MP installs will provide an appropriate level of accuracy and/or appropriate recordings for audit purposes. Maintenance procedures and schedules to be followed by each TO and MP are prescribed so that the level of accuracy which is attainable will be realized.

Local state utility control and distribution utilities may have additional requirements.

II. IMPLEMENTATION

Each TO and MP shall have in-service or be progressing towards having in-service all the metering, recording or telemetry equipment necessary to meet the requirements of this OP. The equipment standards for new and replacement installations, and the testing, calibration, and maintenance standards, contained in this OP, are applicable upon adoption of this OP and all revisions.

III. METERING, RECORDING AND TELEMETRY ON INTERCONNECTIONS WITH SYSTEMS OUTSIDE NEW ENGLAND

A. OVERALL REQUIREMENTS

1. The metering, recording and telemetry requirements for each transmission line interconnecting Pool Transmission Facilities (PTF) to systems outside of New England are:
 - Metering and telemetry of instantaneous megawatts (MW) from all terminals of the line
 - Metering and telemetry of instantaneous megavars (MVAR) from all terminals of the line [except for High Voltage Direct Current (HVDC) interconnection]
 - Metering, recording and telemetry of megawatt hours (MWh) per hour (i.e. energy per hour)
2. MW and MWh per hour metering shall be at the same terminal of each interconnection.
3. The location of the metering terminal shall be agreed upon by the TO/MP and the non-TO/MP who own the line.
4. Wherever feasible, both technically and economically, data transmission in the ISO Reliability Coordinator Area/Balancing Authority Area (RCA/BAA) should be via the New England dispatch communications network.

B. INSTANTANEOUS MEGAWATTS AND MEGAVARS

1. This data must be telemetered to both ISO and the control center of the interconnected system.

2. This data may also be required by other dispatch centers within either system and by systems beyond the interconnecting systems.
3. For new interconnections, and any upgrades of existing equipment, state-of-the-art telemetry equipment shall be used and quantities shall be transmitted to each receiver location directly without retransmission (i.e., without an intermediate receiver and transmitter).

C. MEGAWATT-HOURS PER HOUR

1. There shall be a device at each interconnection facility to record the hourly billing watt-hours on site. In all new and upgraded installations, solid-state data recorders shall be installed.
2. The MWh data shall be telemetered hourly to either ISO or the control center of the interconnected system. If it is telemetered to ISO, it shall be telemetered via the applicable TO/MP Local Control Center (LCC) or Supervisory Control And Data Acquisition (SCADA) Control Center (CC), which has responsibility for the particular interconnection line.
3. The watt-hour data shall be compensated for line losses to the ISO RCA/BAA boundary.
4. MWh may be recorded and telemetered as a net or as two quantities, MWh IN and MWh OUT.

IV. METERING AND RECORDING FOR SETTLEMENTS

A. OVERALL REQUIREMENTS

1. MWh per hour (i.e. energy per hour) data is required for each Generator Asset, Tie-Line Asset and Load Asset as these assets are defined in ISO New England Inc. Transmission, Markets, and Services Tariff Section I - General Terms and Conditions (Tariff Section I) There is an option for Generator Assets, Tie-line Assets and Load Assets, subject to appropriate authorization¹, to have metering data submitted at the subhourly 5-minute interval. The 5-minute data reported is calculated by measuring the generation or consumption energy in units of MWh in the 5-minute interval and multiplying that value by 12 (resulting in an average generation or consumption in units of MW during the interval). This 5-minute subhourly data reporting option also applies to all other settlement Watt-hour (Wh) and MWh requirements.
2. In order for an Asset to be eligible to participate in one or more of the Markets, the Asset must have Wh metering as defined in this OP. The exception to this is in the case of intra-MP Tie-Line Assets as defined in section IV.D.3 of this OP.
3. For Demand Response Resources (DRR), MWh per 5-minute interval data is required for each Demand Response Asset (DRA). The 5-minute data reported is calculated by measuring the consumption or generation in the 5-minute interval and multiplying that value by 12 (resulting in an effective hourly consumption or generation). In order for a DRA to be eligible to participate in one or more of the Markets, the DRA must have a Wh metering or recording device as defined in this OP. Where statistical sampling is used, the data submitted will be in the

¹ See ISO New England Manual for Registration and Performance Auditing Manual M-RPA (M-RPA_, Section 1
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same format, but shall be developed in accordance with an ISO approved Measurement and Verification plan pursuant to Manual M-RPA.

B. Wh METERING AND MWh PER HOUR DATA

1. New and upgraded Wh metering installations shall conform to the requirements in Section VII of this OP.
2. The hourly MWh per hour data shall be submitted to ISO in accordance with ISO New England Manual for Market Rule 1 Accounting Manual M-28 (Manual M-28).
3. For Tie-Line Assets: The hourly MWh per hour data may be recorded for a given Asset as two quantities, MWh IN and MWh OUT, but must be submitted to ISO as a net quantity.
4. The MWh per hour data quantities must be automatically recorded at **no** greater than an hourly interval in accordance with Section VII.B.5 of this OP. If the option for submitting 5-minute interval data is used, the quantities must be automatically recorded at **no** greater than the 5-minute interval.
5. Wh meters shall be equipped with kilowatt-hour (kWh) or MWh registers which shall be read a minimum of once a month. The purpose of this register read is to validate hourly data and allow for an adjustment, which corrects the sum of the hourly readings submitted to ISO during the month to the total energy actually metered. (See section IX.D.5 for required energy comparison)
6. The location of applicable Wh metering shall comply with this OP and be reported to ISO by the responsible MP.
7. The hourly MWh per hour data or subhourly data shall be reported to ISO to reflect the Asset at the Interconnection Point. The Interconnection Point is hereafter defined as:
 - i.) the PTF boundary,
 - ii.) the agreed upon point of interconnection between two TOs/MPs or,
 - iii.) the agreed upon point of interconnection between a TO/MP and a non-MP.

Wh meters **not** located at the Interconnection Point shall be compensated for losses to the Interconnection Point as follows:

a) Level I Accuracy

Wh metering which is:

- Physically located at the Interconnection Point, or
- **Not** physically located at the Interconnection Point but continuously compensated within the Wh meter or Wh metering circuit for excitation and load losses to the Interconnection Point.

b) Level II Accuracy

Wh metering that complies with this OP, except that it is **not** physically located at the Interconnection Point, but the recorded meter data is compensated through external calculations for excitation and load losses to the Interconnection Point. The integration interval for the loss compensation calculations shall **not** exceed a one-hour period, Compensation calculations shall be based on both real power (kW) and reactive power (kVAr or kQ) measurements. Voltage may be either measured or assumed constant.

c) Level III Accuracy

Existing Wh metering without reactive recording capability that complies with this OP, and is **not** physically located at the Interconnection Point, may have its MWh recorded meter data compensated through external calculations for excitation and load losses to the Interconnection Point. In such cases, the compensation calculations will be based on real power (kW) measurements, a fixed 95% power factor, and voltage may be either measured or assumed constant. The integration interval for the loss compensation calculations shall **not** exceed a one-hour period.

8. For DRAs, the 5-minute (MWh) data submitted to the ISO in accordance with Manual M-28 shall be either energy billing quality as defined in OP-18, Appendix C - Minimum Accuracy Standards For New And Upgraded Metering, Recording And Telemetry Installations And For Calibration Of Existing Equipment (OP-18 App C) or in the case where metering is installed specifically for the DRA (and will **not** be used for utility billing purposes), a metering system with an overall accuracy as defined in App C may be used. Metering used for utility billing purposes is also known as revenue quality metering.

C. GENERATOR ASSETS

1. Generator Assets directly connected to the 345 kV (or above) PTF system shall be metered at the PTF boundary or compensated to the PTF boundary in accordance with Section IV.B of this OP.
2. Generator Assets directly connected to the PTF system at 230 kV or below where PTF boundary metering is utilized shall be metered at the PTF boundary or compensated to the PTF boundary in accordance with Section IV.B of this OP.
3. Generator Assets directly connected to the PTF system at 230 kV or below where PTF boundary metering is **not** utilized shall be metered at either the generator terminals in accordance with the terms of the Interconnection Agreement of the parties involved, or as moreover recommended at the PTF boundary or compensated to the PTF boundary in accordance with Section IV.B of this OP.
4. Generator Assets **not** connected to the PTF system shall be metered at the Interconnection Point or compensated to the Interconnection Point in accordance with Section IV.B of this OP. The Interconnection Point is determined in accordance with the terms of the Interconnection Agreement of the parties.

D. TIE-LINE ASSETS

1. Tie-Line Assets connect a TO/MP to another TO/MP, a non-MP or the 345 kV (or above) PTF system. Tie-Line Assets are also used to connect different sections of a TO/MP system that is divided by a Load Zone boundary.
2. Tie-Line Assets shall have a Wh meter or in the case of intra-TO/MP tie-lines an instantaneous watt meter to calculate Wh at the Interconnection Point or compensated to the Interconnection Point with the other TO/MP or non-MP unless otherwise agreed to by the parties involved or the PTF boundary as appropriate and in accordance with Section IV.B of this OP.
3. Intra-TO/MP tie-lines are Tie-Line Assets used to connect different sections of a TO/MP system that is divided by a Load Zone boundary. For these Tie-Line

Assets, MWh per hour data derived from integrating instantaneous MW data used for Dispatch purposes (Section V.) is acceptable provided the metering equipment meets the minimum accuracy standards defined in App C.

E. LOAD ASSETS

1. Every Load Asset except DRAs shall have a Wh meter or be determined on an hourly basis as an allocation of Wh meters. The Wh meter must be located either at the Interconnection Point or compensated to the Interconnection Point in accordance with Section IV.B of this OP.
2. The load that is measured by a TO/MP Load Asset metering system may include PTF losses. If the Load Asset metering system includes such PTF losses, these losses, as determined by the ISO State Estimator (SE) in accordance with the procedures embodied in Manual M-28, will be supplied to the TO/MP by ISO, and will be subtracted from the total load as metered, to determine a TO/MP non-PTF demand.

V. INTERNAL NEW ENGLAND METERING AND TELEMETERING FOR DISPATCH, MARKET, AND RELIABILITY PURPOSES

A. GENERATOR ASSET, ALTERNATIVE TECHNOLOGY REGULATION RESOURCES (ATTR) AND LOAD TELEMETERING CRITERIA

Metering, as set forth below, is required for all Generator Assets and Load Assets (excluding DRAs) which are modeled and defined in the ISO Energy Management System (EMS) and are eligible to participate in the hourly markets. The metering must measure the Generator Asset or Load Asset as it is offered or bid in the Market in accordance with OP-14. Additionally any major change to modify an existing facility shall also conform to the procedures set forth below.

The following quantities are to be telemetered:

1. Market Requirements:
 - a) Generator Asset net (Net_1) MW, net (Net_1) MVA_r and Generator Step-Up (GSU) transformer high and low-side breaker status must be telemetered. Refer to OP-18, Appendix D - OP-18 Metering and Telemetering Diagrams (App D) for definition of Net_1 . In a combined cycle configuration modeled as a single Asset in the Markets, the total net output (Net_2) is required.
 - b) Dispatchable Asset Related Demands (DARDs) MW must be telemetered.
 - c) Generator net (Net_3) MW and (Net_3) MVA_r status must be telemetered for Pseudo Combined Cycle Generators. Refer to OP-18, Appendix E - OP-18 Metering and Telemetering for Pseudo Combined Cycle Generator (App E) for definition of Net_3 .
 - d) **No** telemetering is required for Generator Assets receiving "Settlement Only" treatment and generators **not** registered in accordance with OP-14.
 - e) ATTR MWs must be telemetered. MVA_r must be telemetered for non-aggregated ATTRs with a maximum regulation capacity of 20 MW injection/consumption or larger and for aggregated ATTRs with a maximum Regulation capacity of 75 MW injection/consumption or larger.

NOTE

OP-18, Appendix G - Price Responsive Demand RTU Specification (App G), is a Confidential document and distributed in accordance with the ISO New England Information Policy. If document access is required, contact ISO Customer Support as detailed on the ISO external website.

- f) For DRAs, MWh per 5-minute interval must be telemetered and meet the requirements specified in OP-18, App G. The MWh per 5-minute data reported is calculated by measuring the consumption or generation in the 5-minute interval and multiplying that value by 12 (resulting in an effective hourly consumption or generation). For Settlement purposes, revised MWh per 5-minute interval is submitted through the appropriate MUI (Market User Interface) as defined in ISO New England Manual for Definitions and Abbreviations Manual M-35 (Manual M-35). In addition to 5 minute data, any DRA providing TMSR or TMNSR shall supply 1 minute or less MW telemetry at the retail delivery point.
- g) Other data may be required to be telemetered, as determined on a case-by-case basis based on bulk power system (BPS) monitoring and operations requirements and also based on how ISO models the Asset. The determination of the data that must be telemetered will be made jointly by ISO, the LCC/SCADA CC and the MP.

2. Reliability Requirements:

- a) Generator Asset Net MW, and Net MVAR, as measured at the low side of the GSU transformer. Refer to OP-18, App D for definition of Net. Combined cycle plants are required to supply measurements for each unit.
- b) Automatic voltage regulation (AVR) indicator, which indicates whether the unit(s) and/or Flexible Alternating Current Transmission System (FACTS) device(s) is/are in automatic voltage regulating mode and regulating voltage. This includes AVR status for individual generators or synchronous condensers, that are part of a composite Asset, except for wind plants which are described in (i) below.
 - i. For a wind plant, the AVR status indicates the combined status of all the various pieces of equipment that make up the voltage regulation system. That equipment may include Dynamic Volt-Amp Reactive (D-VAR) devices, capacitor banks, master control computers, breakers, Static VAR Compensators (SVCs), FACTS, Special Protection System (SPS) equipment, or any other equipment that contributes to the functioning of the full specified voltage regulation capability. If any of these contributing pieces of equipment are degraded or out of service then the AVR status indicator should indicate OFF
- c) Power system stabilizer status shall be provided if installed.
- d) MW and MVAR station service load values may also be requested.
- e) Generator Asset terminal voltage measurements may also be requested.
- f) Other telemetered data to be determined on a case-by-case basis which are required for ISO BPS monitoring and operation based on how ISO models the

Asset. The determination of the data that must be telemetered will be made jointly by ISO, the LCC/SCADA CC and the MP.

- g) OP-18 Appendix A - ISO New England ICCP CNP Node Requirement (App A) defines the binary representation expected for status data types.

B. TRANSMISSION SYSTEM TELEMETERING CRITERIA

The following quantities are to be telemetered. Any major change to modify an existing facility shall conform to the procedures set forth below.

1. Transmission substation voltage from the following:
 - a) Each generating station 50 MW or larger that connects to the 69 kV and above transmission system.
 - b) Each 115 kV and above substation where two (2) or more line sections terminate with protective circuit interruption capability, such as a circuit breaker.

NOTE

The preferred measurement of bus voltage is phase-phase. In the event that phase-phase measurement is **not** provided, a phase-phase value calculated from a phase-ground measurement will be acceptable.

2. MW and MVAR from each terminal of all non-radial inter-LCC lines.
3. MW and MVAR from every terminal of all 230 kV and above lines and at least one end of each non-radial 115 kV line.
4. MW and MVAR from each transformer connected to 115 kV and above.
5. MW and MVAR from one end of each intra-LCC line which is necessary for reliable transmission operation, to support BPS transfers, or is otherwise needed.
6. The status of each breaker 115 kV and above.
7. Any transformer with voltage regulation capability that has a low side voltage of 115 kV or above shall provide the status of its voltage regulating state. This is commonly referenced as a load tap changer (LTC) AVR status.
8. The on-load tap changer (OLTC) tap positions of each autotransformer connected to 230 kV and above and each phase-shifting transformer connected to 115 kV and above.
9. Other telemetered data to be determined on a case-by-case basis which are required for ISO-NE BPS operation (i.e., synchronous condensers, HVDC terminals, SVC, capacitor/reactor status, frequency, FACTS devices, Northeast Power Coordinating Council Inc. [NPCC] Type I BPS SPS equipment and selected 69 kV switching devices). The determination of the data that must be telemetered will be made jointly by ISO, the LCC/SCADA CC and the MP.

C. TELEMETERED DATA SCAN RATES

The following minimum standards are established for the frequency at which telemetered quantities are to be scanned and made available to the local Inter-Control Center Communication Protocol (ICCP) Communication Network Processor (CNP) or ISO Communications Front End (CFE).

Frequency of Scanning (Seconds)

1. The data required for Automatic Generation Control (AGC) operation, which includes unit MW for AGC generators and ATRR Regulation Service providers, will be made available to the local ICCP CNP or ISO CFE within four (4) seconds. This four (4) second time interval is measured as the time the data is scanned at the remote terminal unit (RTU) until the time the data is received at the local ICCP CNP or ISO CFE.
2. The analog power system data, which includes all other analog data defined in Section V of this OP, shall be made available to the local CNP or ISO CFE within ten (10) seconds of a change in data at a RTU. For all DRAs, data shall be submitted in 5-minute intervals. For a DRR to provide TMSR or TMNSR, DRA telemetry values shall be submitted at least every one minute. This data requirement recognizes the change detection logic employed by some RTUs is telemetered to the SCADA system only after a change in the data is detected by the RTU, and that the amount of change may be different for each point in an RTU.
3. Telemetered status data will be made available to the local CNP or ISO CFE within four (4) seconds of a change reported by an RTU.

D. TELEMETERED DATA CRITERIA

The following communication paths shall be established to make the required telemetered data available. Some paths are dependent upon the Asset being defined as dispatchable per OP-14.

1. Generation data (Section V.A) shall be made available to the LCC or SCADA CC in which the Asset resides. The LCC/SCADA CC shall make this data available to the Intrapool ICCP network.
 - a. If the Asset is dispatchable the generation data shall also be made available to ISO via the CFE (see OP-18, Appendix F - ISO Communications Front End (CFE) Interface Specifications (App F). Some dispatchable types have additional data requirements as specified in OP-14 that shall also be provided to ISO. ISO will make all of this data available to the ICCP network.
 - b. If the Asset is dispatchable and the Asset nameplate generation capability as defined by the NX-12 technical data is less than 15 MW, the LCC/SCADA CC may request an exemption to providing this data. The LCC/SCADA CC should submit the exemption request to ISO and provide a technical explanation as to why the data **cannot** be obtained. ISO reserves the right to deny the exemption.
2. Transmission system data (Section V.B) shall be made available by the LCC/SCADA CC to the Intrapool ICCP network. This data shall also be made available to the ISO via the CFE if applicable.
3. The following Asset types from Section V.A shall connect directly to ISO per OP-18, App F or OP-18, App G requirements as applicable to supply data:
 - a. DARDs
 - b. ATRRs
 - c. DRAs

E. NON-TELEMETERED DATA CRITERIA

Additional data has been defined as necessary for the overall operation of the ISO/LCC/SCADA CC/TO/MP dispatch computer systems. This data will originate from, and be the responsibility of, the dispatch center which has jurisdiction over the data. This data will be made available for transmission as required to the ISO/LCC/SCADA CC/TO/MP dispatch computer systems.

Examples of this type of data include, but are **not** limited to, the following:

1. Generator limits and unit control modes (UCMs).
2. Text Messages.
3. Non-telemetered breaker and switching device status.
4. Calculated data including transfer limits and flows, interface limits and flows.
5. Economic dispatch basepoints/desired generations, and AGC setpoints.

F. TELEMETERED DATA IDENTIFICATION

NOTE

OP-18 App F is a Confidential document and distributed in accordance with the ISO New England Information Policy. If document access is required, contact ISO Customer Support as detailed on the ISO website.

ISO, each LCC/SCADA CC, each TO and each MP shall uniquely and correctly identify the data being supplied to the network using the format described in OP-18, App A for CNP sourced data and in OP-18, App F and OP-18, App G for ISO CFE data.

VI. METERING FOR POWER FACTOR MEASUREMENT PURPOSES

Each TO/MP shall submit to ISO the quantities necessary to calculate TO/MP lpf as prescribed in ISO New England Operating Procedure No. 17 - Load Power Factor Correction (OP-17). A sufficient number of the necessary quantities must be metered and recorded so that the resulting lpf is a valid calculation.

VII. EQUIPMENT STANDARDS FOR NEW AND UPGRADED INSTALLATIONS

This section specifies standards for metering, recording and telemetry equipment that each TO/MP installs in all new and upgraded installations. A TO/MP is **not** precluded from maintaining or repairing existing equipment with like or improved components, but each TO/MP is required to choose equipment that meets all standards of this OP and the ISO New England Inc. Transmission, Markets, and Services Tariff Section I - General Terms and Conditions Section I.3.9 Review of Market Participant's Proposed Plans when the equipment is replaced for purposes other than maintenance or repair (i.e., an upgraded installation).

A. ANSI STANDARDS

All metering devices used shall conform to applicable American National Standard Institute (ANSI) C-12 standards as amended from time-to-time. HVDC metering devices shall meet or exceed the accuracy requirements of ANSI standards as noted below in 1, 2, and 3.

1. Integrated metering quantities, such as watt-hours and the associated demand components should conform to ANSI standard C12.
2. Instruments or transducers for the analog or digital measurement of telemetered quantities, such as MW, should conform to ANSI standards C39.1, C39.5 and C37.90.
3. Instrument transformers should conform to ANSI standard C57.13.

B. SPECIFIC ISO NEW ENGLAND STANDARDS

1. The design accuracy of individual components as well as overall systems shall conform to the standards contained in App C.
2. Electro-mechanical Wh meters shall **not** be installed.
3. For all grounded wye system metering, three element meters and transducers shall be used. For all delta system (ungrounded) metering, two or three element meters and transducers may be used.
4. The requirement for data recorders and for integrated metering quantities shall be satisfied with the types of equipment listed below. Either type may be used internally or on interconnections with systems outside ISO.
 - A data recorder shall be installed at the metering location. Data shall be retrieved from recorders by on-site or remote interrogation. Where the TOs/MPs mutually agree to the need for joint access to this recorded data, remote communications equipment is recommended to be installed
 - A multifunction meter shall be equipped with an interval data recorder capable of storing at least 60 days of interval data and an internal clock. Data shall be retrieved from the meter by remote interrogation. Where the TOs/MPs mutually agree to a need for joint access to this recorded data, the meter program shall be secured appropriately.
 - The data recorder or multifunction meter equipped with an interval data recorder shall **not** be dependent on the alternating current (ac) voltage that it is metering as the sole power source if an alternative power source exists at the metering location (such as an ac station service emergency panel feed, a direct current (dc) battery or "street power").
5. All data recorders shall be synchronized in time, within an accuracy of +/- 15 seconds, with the National Institute of Standards and Technology (NIST) periodically and when they are installed or returned to service after maintenance or repair.
6. Compensation for line and/or transformer losses, when used, shall be accomplished by using Level I or Level II metering accuracy standards as defined in OP-18 Section IV.B.7.

VIII. REQUIREMENTS FOR DATA COMMUNICATIONS EQUIPMENT FOR TELEMETERING SYSTEMS

To ensure reliable data communications for telemetry, the telemetry equipment (RTU, Digital Metering, communication equipment etc.) located at and between stations [owned by an MP or Designated Entity (DE)], the LCCs/SCADA CCs and ISO, supporting telemetry data is required by this OP:

1. The equipment shall **not** be dependent on a single ac power source. The power source shall be a station battery or an uninterruptible power source capable of supporting the anticipated load for at least eight hours.
 - Communication only facilities (terminal or intermediate) should have a battery rated for at least eight (8) hours and a suitable backup power source for extended periods.
 - This includes telephone company equipment co-located with MP or DE equipment.
2. Dedicated communication circuits or a utility-owned communication network shall be used. Utility-owned communication facilities should be used as the preferred means of data communication. Tie-Line Asset telemetry with external ISO ties must use “electric utility-owned” communication facilities.
 - The intent of “electric utility-owned” is to exclude commercial telecom providers for Tie-Line Asset communication circuits. Tie-Line Asset communication circuits, if redundant, shall have at least one (primary or backup) that must be electric utility-owned.
 - “Electric utility-owned” may also be jointly owned as a communication circuit that may traverse multiple utility service territories.
 - “Communication facilities” noted above refer to all components (i.e.,: terminal & intermediate equipment & communication media)
3. At stations where two battery systems are provided, it is desirable that each should be made capable of being a power source for the equipment.
4. The equipment shall be capable of operating in a temperature range of -20°C to +50 °C for equipment within the control building or -40 °C to +50 °C for equipment installed in other outdoor enclosures. This temperature range is based upon the conditions that could exist when the ac power source is lost and as a result, air conditioning or heating is lost.
5. The configuration/connection of communication circuits should be designed so that a problem on one circuit does **not** cause a problem on another (should **not** be propagated).
6. Alarms shall be provided to the appropriate LCC/SCADA CC indicating the status of equipment covered by this section.

IX. TESTING, CALIBRATION AND MAINTENANCE STANDARDS

A. OVERALL REQUIREMENTS

Each TO/MP is responsible for properly maintaining its metering, recording and telemetry equipment in accordance with applicable ANSI standards as amended from time-to-time. The specific standards for testing, calibration and maintenance are put forth in this section. The accuracy standards to be observed are summarized in App C.

B. OVERALL TELEMETRY SYSTEM TEST

Whenever transducers and/or telemetry systems are tested, an overall system test shall also be conducted. This system test includes the use of the calibrated transducers output as an input to the telemetry system. All receiving devices shall

be verified against the applied input.

C. TELEMETRY COMPONENT TESTS

To ensure the accuracy of telemetered data, each TO/MP shall do one of the following:

1. Use manual or computerized routines to check telemetered quantities (MW, MVAR & kV) against each other, revenue meter quantities and/or against derived values of an SE, to identify unreasonable values at least one day once a calendar month as detailed in Section IX.C.1.a below. This option can only be used for equipment after the initial installation (or replacement) test where IX.C.2 (below) would apply for initial installation (or replacement).
 - a. Each single day check shall include 24 data samples for each telemetered point, 1 for each hour of the day.
 - o While individual hour samples might have variations that exceed tolerances, noted below, where six or more consecutive samples exceed the tolerance in 1-day appropriate calibration, repairs or replacement actions shall be taken.
 - o Each sample may be from a single point in time within the hour or averaged/integrated over the hour interval.
 - o Voltage variance, as compared against below tolerances, is each telemetered phase-phase voltage compared against at least one of the two below:
 - The SE resultant bus voltage associated with the telemetered voltage, given in, or corrected to, phase-phase

NOTE

Concerning average of telemetered voltages, when less than three voltages (of comparable phase relationship) are measured at the same substation bus, additional points of reference are needed for comparison. Other points of reference could include, but are **not** limited to, adjacent bus voltages, nearby scheduled voltages, or bus voltage in an SE.

- The average of all non-zero telemetered voltages that are phase-phase on the same nominal voltage level at the substation. Busses at the same voltage level that are **not** tied should be treated separately.
- b. The tolerances for acceptable MW, MVAR and kV telemetered quantities are as follows:
 - o Watts: +/- 10 MW or +/- 4.5% of the largest fiducial value (whichever is smaller)
 - o VArS: +/- 30 MVAR
 - o Voltage: +/- 5 kV for 345 kV systems
 +/- 4 kV for 230 kV systems
 +/- 3 kV for 115 kV systems
 +/- 2 kV for 69 kV systems

- c. MVAR quantities will **not** require the above check if the MVAR quantities are measured from the same device that measures the telemetered MW quantities.
 - o The purpose for this is that measurement drift of a device measuring both would cause errors in both MW and MVAR. Also MVAR variances are often obscured by transformer losses or SE solutions that are **not** perfect.
 - o With the bus-net method, MVAR quantities that originate from a different device than the associated MW telemetry would **not** be exempt from a MVAR bus-net even if the other telemetry on the bus had its MW and MVAR quantities measured from the same device.
 - o If a MVAR bus-net is needed, VAR losses can be estimated based upon transformer test data to mitigate bus-net VAR error.
2. Calibrate or test the accuracy of transducers and telemetry systems according to manufacturer's procedures, on the following schedule:

Transducers:	at least once every four years
Analog Telemetry:	at least once every twelve months
Digital Telemetry:	at least once every four years

When tests are performed on transducers, errors should **not** exceed accuracy limits stated in App C. If during the test, errors exceed this value the device shall be recalibrated, repaired or replaced as necessary to attain that accuracy.

Digital Telemetry employing analog to digital converter(s) (ADC), the gain and offset characteristics of which are continuously monitored, and reported to SCADA, by ADC reference values that are within accuracy limits stated in App C, shall be exempt from periodic calibration requirements. When accuracy limits stated in App C are exceeded, the equipment shall be recalibrated, repaired or replaced as necessary to attain that accuracy. This digital telemetry test exemption can only be used for equipment after the initial installation (or replacement) accuracy test.

D. WATT-HOUR METERS

1. All Wh meters shall be tested by comparison to a solid-state Wh standard that is traceable to the NIST as outlined in Section IX.F of this document. Testing should include an inspection, verification, and analysis of the metering system excluding instrument transformers.
2. DC Wh meters - dc Wh metering equipment utilizing voltage inputs for current and voltage sensing shall conform to the following requirements. See Figure 9-1.
 - a. DC test voltage source equipment for generating current and voltage inputs to the meter shall be traceable to NIST for accuracy.
 - b. Voltmeters used for monitoring the input voltages to the dc meter during the test shall be traceable to NIST for accuracy.
 - c. Meter nominal test voltage shall be the meter input voltage corresponding to the nominal operating voltage of the metered line.
 - d. Meter "full load test amperes" shall be the meter input voltage corresponding to the nominal operating current of the metered line.

- e. The test points for the meter shall be as follows:
 - o Full load test amperes
 - o 10% of full load test amperes
 - o 50% of full load test amperes
 - o 150% of full load test amperes
- f. Where meter pulse outputs are compared to calculated target values, and pulses from a standard, to determine meter accuracy, worksheets detailing the test conditions and target pulse counts will be made available prior to testing the meter. See Table 9-1, below.
- g. If the meter is compensated to account for different operating modes of the metered circuit the meter shall be tested with compensation activated at each of the test points defined above. The operating modes that represent the normal operating conditions shall be tested as a part of periodic testing. All operating modes shall be tested upon commissioning.
- h. For engineered (custom) metering systems a hard copy of the current meter program will accompany the meter test documentation.
- i. Where both revenue meter data and telemetry data are provided by the same meter, provision must be made to continue the telemetry while the meter is out of the measurement circuit during the test.
- j. Where redundant meter schemes are utilized the generation of any alarms or status flags due to differences in measurement between the meters caused by the testing must be documented. Where redundant recorders are used differences in recorded pulse totals due to the testing must also be documented.
- k. Where redundant meter schemes are utilized the start and stop time as well as the accumulated test energy for the meter under test will be documented. Likewise, the start and stop time as well as the accumulated energy during the test period will be noted for the in-service meter.
- l. A field standard meter that has been programmed identical to the meter under test may be used for certification provided that it meets the accuracy and certification requirements of Section IX.F.

Example Test Scheme for a DC Meter with Voltage Inputs.

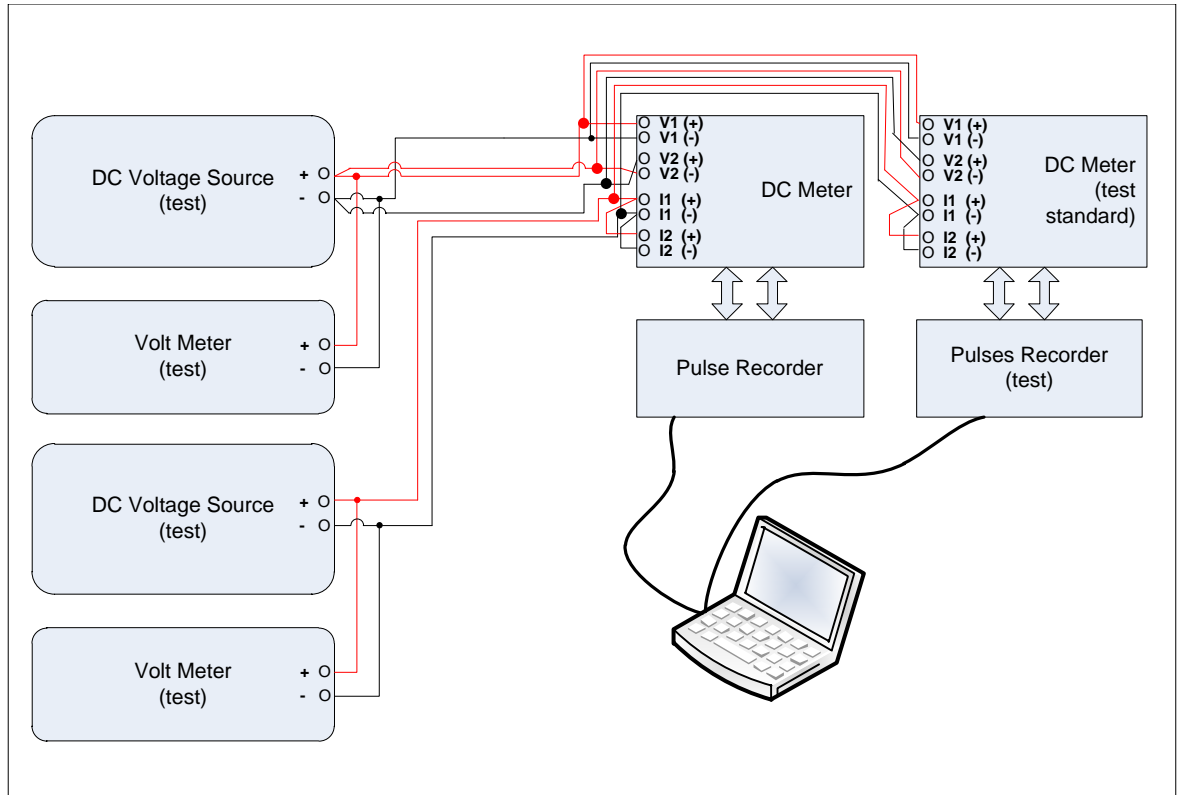


Figure 9-1

Example Pulse Target Worksheet

Test Conditions - Equation 1 (Import / South)		Uncompensated Reference Energy	Meter Reading	Meter Standard Reading	Meter error
Voltage	Current	Pulses*	Pulses*	Pulses*	(%)
V1: 5V(450kV) V2:-5V(-450kV)	I1:0.5V(225A) I2:0.5V(225A)	506.25			
V1: 5V(450kV) V2:-5V(-450kV)	I1:2.222(1000A) I2:2.222(1000A)	1125			
V1: 5V(450kV) V2:-5V(-450kV)	I1:5V(2250A) I2:5V(2250A)	2531.25			
V1: 5V(450kV) V2:-5V(-450kV)	I1:7.5V(3375A) I2:7.5V(3375A)	3796.88			

* Pulses are 0.2 MWh / pulse. 225A (10%) test uses pulse over 30 min, all other test conditions use pulses for 15 min.

Table 9-1

3. As a minimum, watt-hour meters shall be tested by one of the following two methods:
 - a) Series test with external loads applied [permitted for testing either induction or solid-state watt-hour meters].
 - i. "As-Found" series tested at operating or nameplate voltage under the following three conditions:
 - Full Load (FL) at the meter Test Ampere (TA) rating and unity power factor
 - Light Load (LL) at 10% of the meter TA rating and unity power factor
 - Power Factor (PF) at the meter TA rating and 0.5 power factor lag

NOTE

Meters used in bi-directional applications shall be tested for both forward (delivered) and reverse (received) accuracy.

The series test results must be within the following accuracy limits:

<u>Test Condition</u>	<u>Accuracy Limit</u>
FL	+/- 0.2% error
LL	+/- 0.3% error
PF	+/- 0.5% error

- ii. In addition to the "As-Found" series tests, all induction Wh meters shall have an "As-Found" individual element balance test performed. The individual elements shall be tested at operating or nameplate voltage, at FL test amps, and unity power factor. The individual element test results must be within 1.0% of each other.
 - iii. If the "As-Found" test results are outside the stated accuracy limits, then the meter shall be adjusted as closely as practical to 0.0% error. The final "As-Left" test results shall be within the stated accuracy limits.
 - iv. Any induction Wh meter found outside of +/- 2.0% error or any other Wh meter found outside the +/- 0.5% error (at any test condition) shall be adjusted and scheduled for replacement as soon as practical.
- b) Single point three-phase test using the actual in-service load and meter uncompensated [**not** permitted for testing induction type Wh meters].
 - i. "As- Found" three-phase tested at actual in-service voltage, current, and power factor; provided:
 - voltage is within the range specified by the meter manufacturer
 - current is within the meter's load range between light-load (LL) and Class Amps of the meter, and
 - power factor is between unity and 0.5 lagging or leading

The single point three-phase test results must be within the following accuracy limits:

<u>Test Condition</u>	<u>Accuracy Limit</u>
Actual In-service Load	+/- 0.2% error

- ii. If the "As-Found" test results are outside the stated accuracy limits, then the meter shall be adjusted as closely as practical to a 0.0% error or promptly replaced. The final "As-Left" test results shall be within the stated accuracy limits.
 - iii. Any solid-state Wh meter found outside the +/- 0.5% error shall either be adjusted and scheduled for replacement as soon as practical; or, promptly replaced.
4. Meters with compensation for line and/or transformer losses shall be either one or the other of the following:
 - Series tested with and without the compensation activated at the test points as defined in Section IX.D.2.a.
 - Single point tested with compensation checked by comparison of compensated and uncompensated pulse data channels.
 5. In-service testing of Wh meters shall be tested at a frequency in accordance with the local state utility control and distribution utility requirements for retail loads such as Asset Related Demands (ARDs). All other Assets, with noted exception, shall be tested at the frequency specified as follows: All Wh meters must be tested at least once a calendar year with the exception that non-induction type Wh meters, the operation of which is monitored daily, must be tested at least once every two calendar years. The exception is Generator Assets registered as "Settlement Only Generators" whose registered summer and winter claimed capability is less than 1 MW of which shall be tested at a frequency in accordance with the local state utility control and distribution utility requirements for retail loads.
 6. Periodic Energy Comparison
 - a) Data recording equipment external to the meter shall be checked monthly by comparing a summation of the hourly demand readings with the kWh registered on the Wh meters for the same period of time. When only small quantities (less than 7,200 MWh in one month) have been registered, comparison is required every two months using two months of data. The difference in the sum of hourly demand readings and the kWh registered on the Wh meter should be less than the value of the Wh meter transformer ratio multiplier. When this difference is greater, the installation shall be reviewed and tested if the discrepancy is **not** explainable.
 - b) For DRAs, data recording equipment external to the meter shall be checked at least annually by comparing a summation of the hourly demand readings with the kWh registered on the Wh meter for at least one month. If hourly data is available from the pulse source meter, then comparison should take place at the hourly level.
 7. The continuity of meter readings should be maintained during tests either by use of a portable meter or other suitable methods. Note: use of the single point test

method will insure continuity of both readings and data. A Wh meter test may be made during a period of **no** load or when the load is constant and the reading adjusted upon completion of the test. Pulse data should likewise be adjusted upon completion of the test. When this is **not** practical, other methods must be used to segregate pulses registered due to the test from pulses based on registration of power flow.

E. INSTRUMENT TRANSFORMERS

Scheduled tests of instrument transformers are **not** required unless all other tests fail to explain a discrepancy; then testing shall be performed. The testing procedure shall conform to the manufacturer's specifications and ANSI C57.13.

F. TEST EQUIPMENT

Test equipment used in the calibration of instrument transformers or transducers should be certified to values of accuracy and precision which are at least twice as accurate as the required accuracy of the equipment under test. Non-induction type Wh standards of 0.1% or better accuracy shall be used in the testing of Wh meters. All Wh standards shall be certified correct every twelve months.

NOTE

Traceability refers to relating individual measurement results to NIST measurement systems through an unbroken chain of comparisons.

All Wh standards should be certified by comparison with laboratory standards whose accuracy is traceable to NIST. The standard certification values may be determined by the use of data obtained through round-robin procedures between TOs/MPs, provided that at least one of the laboratories maintains standards traceable to NIST. Standards utilized for the purpose of calibrating voltage and current transducers should be of the same sensing type (e.g., Root Mean Square (RMS) or average) as the transducers under test. All telemetry standards shall be certified at least once every 24 calendar months.

The tests and calibrations should be performed at ambient temperatures recommended by the manufacturers of the test equipment and the equipment under test.

Instrumentation used to check the tone modulating frequency for data transmission should have a minimum definition of 0.001 Hertz. The dc ammeter or voltmeter used to measure input signals shall have a minimum accuracy of +/- 0.05%.

G. RECORD KEEPING AND AUDITING

Each TO/MP is to maintain records of the testing, calibration and verification of all metering and telemetry equipment which is required to be installed according to the provisions of this OP. The records are to include:

- Entity name
- Element (line, bus, transformer, etc.) name covered by telemetry
- Name of telemetry device (or system)
- The dates of testing, calibration or verification
- % error of as-found (and as-left if recalibrated or replaced)

- A note, if as-found is **not** within accuracy tolerance
- Action(s) taken (if applicable) including date(s) of action(s)

These records are to be retained for a minimum of the two most current testing (or verification) cycles or since the last audit (whichever is greater) and are to be available to ISO and the LCC upon request.

H. NOTIFICATIONS

When metering and telemetry equipment associated with TO/MP interconnections is scheduled for maintenance, test or upgrade, interconnected TOs/MPs shall be notified at least two weeks in advance in order to have the opportunity to participate in or witness the maintenance, test or upgrade.

X. SECURITY OF METERED AND RECORDED DATA

Security shall be addressed to prevent unlawful, unintentional or unauthorized access to those portions of the firmware, software and data being collected that would have an effect on the metered and recorded quantities.

XI. COMPLIANCE

Periodically, ISO may conduct an audit survey of metering, recording devices and telemetry criteria to determine the degree of TO/MP compliance with all OP-18 requirements.

XII. DEFINITIONS

- **Fiducial Value** - A value to which reference is made in order to specify the accuracy of a transducer. The Fiducial Value is the span except for transducers having a symmetrical reversible input and output. In this case, the Fiducial Value is half the span. (Reference: ANSI/IEEE 460-1988, lapsed) Examples below:
 - Above the term "symmetrical reversible" means that the positive and negative full scale are equal in magnitude while opposite in polarity and halfway in the span is zero (0).
 - An ac Watt and/or VAR transducer where the inputs (voltage and current) are bidirectional (due to their nature of being ac) and where the values Watts and VARs that would be derived from them based upon magnitude and angle difference are also bidirectional would therefore mean the Fiducial Value half span (the value of positive full scale). Given an example scale of -810 MW to 0 to +810 MW and an absolute error of 7 MW would yield a % error of 0.86% (7 MW / 810 MW) meaning the Fiducial Value would be 810 MW.
 - A transmitter device (such as the RFL 9800 series transmitter) that takes a signal representing a telemetered MW and outputs a frequency shifted by the input would have a Fiducial Value of the full span independent of the input since the output is between a min and max frequency. Given an example input scale of -300 MW to 0 to +300 MW via a -5V to 0 to +5V input signal and the associated output scale being 10 Hz to 20 Hz to 30 Hz, because the output is **not** reversible the Fiducial Value of the output is 20 Hz (Span = 30 Hz – 10 Hz). In that example if the absolute error in frequency was 0.5 Hz, the % error would be 2.5% (0.5 Hz / 20 Hz). The Receiver would similarly have its input as **not** being

symmetrically reversible and so the Fiducial Value would be the full span.

- An ac Volt transducer has a symmetrical reversible input due to it being ac but the output would be unidirectional (zero to full scale) and as such, the Fiducial Value would be the full span but in that case, the full span is equal to the positive full scale as there is **no** negative side to the scale. Therefore, effective accuracy is similar to the Watt/VAr transducer example where the positive full scale ends up being in the denominator.
- **Telemetry (telemetry)** - Transmission of measurable quantities using telecommunication techniques. (reference: IEEE 610.2-1987, including analog and digital below)
 - **Analog** - Telemetry in which some characteristic of the transmitter signal is proportional to the quantity being measured.
 - **Digital** - Telemetry in which a numerical representation is generated and transmitted, the number being representative of the quantity being measured.
- **Transducer** - A device that takes a signal or signals (Volts, Amps, etc.,) and converts it into another signal or signals (milli-Amps, Volts, etc.). Most often used to convert secondary Volts and/or Amp quantities into a scaled signal usable by an RTU (mA or Volt) representing system Volts, Amps, Watts, VArS or Frequency values. Digital meters and digital relays that convert signals into numerical values used for OP-18 compliance will be treated as transducers for this OP.

OP-18 Revision History

Document History (This Document History documents action taken on the equivalent NEPOOL Procedure prior to the RTO Operations Date as well revisions made to the ISO New England Procedure subsequent to the RTO Operations Date.)

Rev. No.	Date	Reason
--	04/10/17	For previous revision history, refer to Rev 10 available through Ask ISO;
Rev 11	08/03/12	Biennial review by procedure owner; Change font to Arial, changed pagination to "X of Y" and added Hardcopy disclaimer in footer; Added "Confidential to titles of Appendices F & G; Globally used defined acronyms RCA/BAA, BES and MVAr; Added NOTES in Section V on how to request access to confidential Appendices F & G ; Section IV deleted superseded reference to Manual 35; Globally added a dash between OP and procedure number; Section V.B.2 replaced "bulk power system" with "Bulk Electric System (BES)"; Global replaced "Real Time Demand Response Resource Assets" with Real-Time Demand Response Assets"; Global Capitalized "Asset" in Real-Time Emergency Generator asset";
Rev 12	08/06/13	Created cover page and inserted standard Hardcopy disclaimer ; In Appendices section retired Appendix B and deleted the OP-18 App B reference in Section IX.A;
Rev 13	05/02/14	Biennial review completed by procedure owner; Added language to Section V.A.1.e to address ATRR telemetry requirements; Globally added responsibilities for Transmission Owners (TO); Minor editorial changes for consistency with current practices and management expectations and administrative changes required to publish a new Revision;
Rev 14	10/05/15	Revised per review by OP-18 working group. Reviewed from Section I "purpose" through Section V "INTERNAL NEW ENGLAND METERING AND TELEMETERING FOR DISPATCH, MARKET, AND RELIABILITY PURPOSES" subsection V.C "Telemetered Data Scan Rates" as well as targeted subjects such as: <ul style="list-style-type: none"> IX.C.1 to note that it is only for systems already in service. Initial installation requires a calibration test (IX.C.2) IX.C.2 revised language to be more in-line with current equipment and practices as well as referring to Appendix C for accuracy limits instead of having redundant language. IX.D.4 the exception for SOGs <1 MW to this subsection was added XII "Definitions" was added to clarify the applicability of "transducer" and "analog" vs "digital" telemetry equipment
Rev 15	04/10/17	Biennial review completed by procedure owner; Added required corporate document identity to all page footers; updated title of OP-18 Appendix A; Revised per review by OP-18 working group. Various small revision plus more significant revisions in the following sections: <ul style="list-style-type: none"> o Added specifications for HVDC metering to sections VII & IX.D o Communication data paths clarified in new Section V.D o VIII section brought up to date with current practices and terminology o IX.C revised with specific testing instructions for manual or computerized routines o IX.G expanded with more specific record keeping instructions XII added Fiducial Value definition Truncated the Revision History per SOP-RTMKTS.0210.0010 Section 5.6;
Rev 16	12/08/17	Updates related to subhourly settlements: Section IV updated with references about a 5-minute subhourly option. Section VII.B updated time synching accuracy requirements;
Rev 17	06/01/18	References Section, deleted LCC Instructions; Appendices Section, updated Appendix G title; Section V.A.f made additional clarification; Section V.C.2, modified (clarified required and optional DRA telemetry timing); Globally updated due to PRD project, where applicable deleted Real-Time Emergency Generation (RTEG) Assets, replaced "RTDR" and "RTEG" terminology and with "DR";