\NYISO REVENUE METERING REQUIREMENTS MANUAL

1.0 Operating Procedures

The operating practices presented herein include:

- Meter Certification for Participants of the NYISO
- NYISO Guidelines for The Installation, Operation and Maintenance of Data Acquisition Equipment
- New York State Electric Meter Engineer Committee Guide for Uniform Practice in Inter Utility Metering
- Metering and Data Accuracy Analysis

1.1 Meter Certification for the Participants of the NYISO

This policy provides metering standards for any participant of the NYISO, including loads, generators, etc. The NYISO requires accurate metering from all NYS Power System Generators, Loads, and Transmission Owners (TOs) to ensure the reliable and economic operation of the NYS Power System and the proper settlement of accounts. These standards provide minimum guidelines for the installation and maintenance of all equipment utilized for data acquisition to insure that the data requirements of the NYISO are met.

The standards stated in this document are "minimum standards" and do not supersede other agreements. In cases in which standards differ, the most restrictive criteria shall be used.

1.1.1 Definitions

Listed below are selected definitions of capitalized terms in this policy: others can be found in the ***NYISO Filing Definitions Document*** and the ***NYISO Definitions Manual***.

Data Concentrator – Equipment which acts as a Data Hub providing convenient connection points for external interfaces to the system. This is particularly important in the case where the RTUs are distributed around the substation and a central connection point is necessary to facilitate interfacing.

- ***Data Problem*** — One where the quality of a data item, either telemetered or obtained by other means at a Data Concentrator (DC), has become suspect so as to affect the operation of the power system or settlement of the NYISO markets and the cause has been traced to computer programming, communications limitations, computer equipment configuration or field metering equipment.
- ***Data Quality*** — The measure of the reliability and accuracy of a data item transmitted to the

ISO Control Center (NYISO).

- ***Metering Authority*** — The entity responsible for the meter(s) accuracy and transmission of meter data in accord with NYISO meter standards, tariff and/or TO contract agreements.
- ***Metering Problem —*** One where the quality of an item of telemetered data is suspect so as to affect the operation of the power system or settlement of the NYISO Markets and the cause of such poor quality has been traced to the metering equipment installed.
- ***Revenue Quality Real Time Metering*** — An accurate metering system that satisfies ANSI C12 requirements for electrical energy billing purposes; approved for use by both the Transmission Owner and the NYS PSC and is capable of providing instantaneous and/or stored energy readings.

1.1.2 Policy Guidance

The requirements of this document are applicable to all metering systems and equipment whose data are used for NYISO system operation and billing. Concerning the November 1999 NYISO online date, to allow for timely and economical implementation of the NYISO Market, existing metering currently in operation for the NYISO (formerly NYPP), TO's, Eligible Customers and other applicable Participants, although not conforming to these requirements, need not be upgraded until such time that the need for upgrade or replacement is demonstrated to be operationally and economically required, or if required by the NYISO or TO Tariff.
For any customer who is obtaining their full power requirement from a single TO other than from the TO in whose load area the customer is located, the TO supplying the generation to this customer will provide 24hourly intervals of load profile data, for this customer, transmitted once per day to the NYISO and the other appropriate TO.

All Meter Authorities that report data for Sub-Zonal Ties and Generators used in the calculation of the NYISO market settlements shall also include hourly load profile data. These values are used for NYISO Invoicing.

All Revenue Meter points for Subzonal Ties and Generators must also have backup data for the Revenue grade metering. Although revenue quality metering is not required, the TO must be able to use metering for revenue purposes.

Except as provided in the preceding paragraphs, all metering systems for customers must meet the requirements of the NYISO and of the Transmission Owner of the facilities in which they attach to the NYS Power System.

All metering systems whose data is used for NYISO systems operation or NYISO Billing must have a designated Meter Authority.

All metering systems will adhere to the document entitled "NYISO Guidelines for the Installation, Operation and Maintenance of Data Acquisition Equipment" (Section 1.2).

All metering systems will adhere to the document entitled, "New York State Electric Meter Engineers Committee Guide for Uniform Practices in Revenue Quality Metering (Section 1.3).

The Metering Authority will provide instantaneous and stored metered data which meets the

NYISO (and Transmission Owner) requirements to the TO Control Center.

Any Load that is not metered on an hourly or instantaneous basis will have its Load determined by the Transmission Owner in whose Load Subzone they are located, until such time that the Meter Point is upgraded and in compliance with this document.

Ancillary Service suppliers, as defined in the ***NYISO Ancillary Services Manual,*** shall provide metering as determined by the NYISO to meet all appropriate service performance tracking requirements.

The Transmission Owner may require that the Eligible Customer install an approved remote terminal unit (RTU) or analog telemetry equipment for the accurate and economical transmission of their data to the Transmission Owner Control Center.

Metering for use in revenue and/or interchange metering must accurately measure energy while minimizing the influence of voltage variation, power factor, burden, temperature, frequency and harmonics. Instrument transformers must be suitable for use in revenue and interchange metering and shall comply with the minimum acceptable accuracy standards listed in Section 1.3.

In order for a Market Participant to qualify as a NYISO Meter Authority they are required to comply, participate, and practice all requirements, practices, processes and procedures, etc. as defined in this manual.

1.1.3 Revenue Metering Data

All revenue metering data supplied for final balancing and billing purposes must be based on energy measurements made with instruments that are traceable to the National Institute of Standards and Technology (NIST) and approved for billing purposes within New York State. Revenue metering data should be accessible for transmission by the next business day. .

Generation meters will be compensated to the high side of the Generator Step-Up Transformer (GSU), subzonal TIE lines to the appropriate boundary point between sub-zones.

1.1.4 Metering Equipment Standards and Specifications

Specifications for metering equipment and functionality can be found in the following documents:

1. Applicable standards published by the TO of the facilities in which the Eligible Customer is attached to the NYS Power System, obtainable through the Transmission Owner.

2. NYISO Guidelines for the Installation, Operation and Maintenance of Data Acquisition Equipment presented in Section 1.2.

3. New York State Electric Meter Engineers Committee Guide for Uniform Practices in Revenue Quality Metering presented in Section 1.3.

1.1.5 Maintenance and Calibration

Each Participant (not a retail customer) is responsible for the cost assumed with purchase, installation and appropriate maintenance of meters, wiring, communications equipment and all components essential to their accurate and reliable operation, including spare equipment, if

applicable, in accordance with the requirements of the NYISO and the appropriate TO.

All metering shall be calibrated within the guidelines of this document and in accordance with the Transmission Owner requirements. Maintenance and calibration shall be performed by the metering authority or its designated representative, who will maintain control over the equipment in accordance with NYS PSC rules and regulations as stated in Section 1.3

1.1.6 Audits

Beyond any NYS PSC rules, each metering system will be subject to periodic testing and inspection by the NYISO, TO, and/or Market Participant at the request of any of the three aforementioned parties. To initiate an audit see Section 1.4. If any inspection request is initiated, other than periodical routine testing, the nature and magnitude of the suspected accuracy problem must be stated. If after inspection and testing it is determined that the suspected metering is within specifications, the requestor will be responsible for testing expenses incurred.

The ISO will maintain documentation for all test and calibration records. If it is determined that the suspected metering equipment is not within specifications, the Meter Authority will submit an action plan, addressing the situation, to the NYISO .

1.1.7 Scan Data List (is this an xx data file? , should this be removed)

Any entity supplying scanned data to the NYISO must supply that data in accordance with existing NYISO database requirements. Each entity must also maintain a data coordinator who will be responsible to communicate proposed scan data changes to the NYISO data coordinator. Reconciliation of scan data lists will take place every April and October.

1.1.8 Loss of Metering or Telecommunications (is this CDAS?)

If data is lost due to a meter or communications failure, the Meter Authority will use the best available information (e.g., logs, schedules, combinations of other meter readings, etc.) to fill in values for data lost. If the data transmission is delayed due to a telemetry failure, the Meter Authority will make its best effort to transmit the data using some electronic means acceptable to the NYISO billing staff. All failed telemetry, metering and communications equipment will be rendered operable in the shortest practical time and calibration compliance must be reported to the NYISO. In all cases, relevant NYS PSC rules will be enforced.

1.1.9 Procedures for Dispute Resolution of Data Issues

For a reported meter data dispute, see Section 1.4.3.

If after a proper audit, an entity (any Market Participant) is suspected of manipulating metering or metering data or it has been determined an entity has exhibited continued negligence in performing required duties or submitting required data, all details will be turned over to the NYISO Market Monitoring Unit for further investigation. A response from the NYISO to the complaint should be available to all affected Market Participants within 30 days of receipt. In all cases, relevant NYS PSC rules will be enforced.

1.2 NYISO Guidelines for the Installation, Operation and Maintenance of Data Acquisition Equipment

1.2.1 Introduction and Background

This document provides guidelines for analysis and procedures for the maintenance and calibration of data acquisition equipment.

1.2.2 Present Design Overview

Analog metering transmits selected line megawatt flows, generator megawatts and bus voltages directly from the source to the New York Independent System Operator. Primary transducers are installed in the stations and connected to current and voltage transformers. The output of the transducer is input to the telemetering systems. The telemetering equipment is connected via a leased telephone line to the NYISO where telemetering receivers are installed.

Digital data is transmitted to NYISO via computer-to-computer data links between the NYISO and the Transmission Owners computer. The above link is established using a frame relay network. Digital data expands the NYISO data base to include all major transmission MW and MVAR flows, generator MWs and MVARs, tie line MWs, MVARS and MWHRS; substation breaker status, frequency and voltage. These data points are gathered by the Transmission Owner from local substation Supervisory Control and Data Acquisition (SCADA) terminals to their Control Center Computers.

Digital Data is used as the primary information source with Analog Data as its back up. Final settlement must be based on revenue quality metering data as described in Section 1.1.

1.2.3 Calibration and Maintenance

Periodic calibration of existing metering installations must be made to achieve performance, as defined in Section 1.3.

1. ***Calibration Interval*** — Calibration of equipment shall be performed in accordance with manufacturers' recommended intervals and procedures. Where a manufacturer does not provide calibration interval recommendations, the interval shall be based on equipment stability as demonstrated by historic data. In no case, however, shall the calibration interval exceed the standards established in Section 1.3 .

2. ***Test Range Increments*** — Checks shall be made in 20% increments for Transducers from zero to 100%, inclusive, of rated input, or as specified by the manufacturer if more stringent. Test range increments for revenue grade metering devices shall reflect those specified in ANSI C12.1 - American National Standard Code for Electricity Metering.

3. ***Maximum Errors*** — Transducer error shall not exceed 0.25% of full scale or manufacturer's specifications, whichever is less. Errors exceeding the above, after calibration, indicate that the transducer should be replaced or returned for repair and recalibration. If replacement is required, a new state-of-the-art transducer shall be used.

   If Digital Telemetry error is found to be more than 0.1% ± the least significant bit or outside

the manufacturer's specifications, whichever is less, the cause shall be determined and the error reduced to specifications.

Analog Telemetry found to be outside accuracy specifications, the cause shall be determined and the error corrected to specifications. The error should not exceed ± 0.1% of reading or as state of the art permits.

4. ***Overall Tests*** — Each data point shall be calibrated from source (transducer) to NYISO in 20% increments from zero to 100% of rated input. Using a calibrated power supply input to the transducer, the final NYISO reading shall not exceed 0.25% deviation.
   Where the same data is telemetered in both Analog and Digitals form, the calibration shall be performed at the same time and the data received at NYISO must be within the ±1% range of each other. The comparison shall also be performed using actual live data.

5. ***Test Equipment*** — All test equipment shall be traceable to the National Institute of Standards of Technology (NIST). Test equipment shall conform to the requirements of Section 4.3.(No section 4.3 found) Calibration intervals shall be in accordance with manufacturer recommendations or specifications.

6. ***Maintenance*** — If periodic maintenance or failures indicate poor reliability, the equipment shall be replaced with equipment meeting standards of Section 1.3. If errors exist, the defective component shall be isolated and remedial action taken.

1.2.4 Metering Improvement Priorities

The various data types transmitted to NYISO shall be prioritized on the basis of electric system costs, flow limits, operating limits and security considerations. These priorities shall determine the basis on which metering replacements and improvements are to be completed. The priority classes are as follows:

1. Subzonal TIEs Transmission Lines Megawatts/MWHRs Inter-NYCA Transmission Lines Megawatts and Megavars
2. Generator Megawatts/MWHRs and Megavars
3. Bus Voltages
4. Transmission Lines Megawatts and Megavars

1.2.5 NYISO Data Requirements (is this Cdas)

The following guidelines shall be used for the determination of NYISO minimum data requirements resulting from changes being made to the NYS Power System. They are intended to cover the normal requirement but may be superseded by special situations.

Analog Telemetering (Delete ??????)

Analog Telemetering is provided to enable the NYISO to coordinate operation of the NYS Power System when the NYISO computer system is out of service or when any of the computer-to-computer data links between the NYISO and TOs is not functioning.

1. MW telemetering will be required:

   a. On each interconnection to adjacent areas outside the New York Control Area (NYCA). These should be from the billing meter end to the NYISO independent of the TO Control Center.

b. On all circuits that are part of an internal NYISO interface for which transfer limits are observed, from one end to the NYISO independent of the TO Control Center.

c. For generation at units 500 MW and above or complexes where the total generation is 500 MW or above where loss of the complex is determined by the NYISO Staff to have a significant impact on NYS Power System security. Generator MW readings may be obtained from the TO Control Centers, but should be independent of the TO's computer.

d. For TO total area net generation which may be computed by the TO's computer, but should be independent of the TO to NYISO computer data link.

2. Voltage:

Voltage telemetering shall be required on busses 230 kV and above when the need is indicated by a review of transmission configuration changes or operating practices.

3. Frequency:

Frequency telemetering shall be required when the need is indicated by a review of transmission configuration or operating practices.

Digital Telemetering (Delete ??????)

Digital data is presently obtained by the NYISO computer via the data links between various Market Participants and the NYISO. The NYISO Operations Staff will designate the required data. Telemetering (and a backup metering source~~?~~) will be required on all sub-zonal Ties and Gens as outlined below.

1. MW and MVAR will be required:
   a. On all transmission circuits, 230 kV and higher and on designated critical lower voltage circuits.
   b. On all transformer banks whose high voltage side is 230 kV or higher and on designated critical lower voltage equipment.
2. MW, MVAR and MWh will be required on all inter-NYCA ties.
3. MW, MVAR and MWh will be required on all ties between TO Control areas.
4. MW will be required on all generators above 1 MW. Non Dispatchable generation may be provided in the form of plant total or group total dependent on how owner intends to bid generation. MWs will be measured with net injections on the high side of the Generation Step-up Transformer (GSU).
5. MVAR will be required on designated generators. If generator MW is provided in the form of plant total or group total, as allowed in item 4, then MVAR output may also be provided in that form.
6. MVAR will be required on designated synchronous condensers, generators that can be operated as synchronous condensers, and SVCs.
7. Voltage will be required from strategic locations throughout the NYCA sufficient to provide a voltage profile of the 230 kV and higher voltage systems and also to provide critical lower transmission system voltages.
8. Tap position will be required on all load tap changing transformers and all voltage regulating transformers whose high side voltage is 230 kV and higher and on designated critical lower

voltage equipment.

9. Frequency will be required from strategic locations that could reasonably end up as an island.
10. Status will be required on breakers that affect facilities 230 kV and higher, and on designated critical lower voltage facilities. Circuits supplying radial load will be exempt.
11. Status will be required on designated synchronous condensers, generators that can be operated as synchronous condensers, and SVCs.
12. Status will be required on switchable capacitor banks and reactors whose voltage is 230 kV and higher and on designated critical lower voltages.
13. Status on disconnects or a combination of NYISO breaker and disconnects will be provided such that the NYISO can determine the status of facilities 230 kV and higher, and on designated critical lower voltage facilities. Circuits supplying radial load will be exempt.
14. Data quality status is an indication of the currency of the analog data values being sent from each TO to the NYISO computer. Data quality status reporting is accomplished by requiring that every analog data point have a corresponding data quality bit. When "set", this quality bit indicates to NYISO programs that the corresponding analog point is not being updated.

    Failures of this type may be handled at the TO by substitution of a manually entered value, or by switching to a back-up source. At the NYISO, such data failures may be handled with manual substitution, or with Analog data substitution. Where Analog back-up exists, the quality bit controls its automatic substitution. If a TO dispatcher replaces a failed point, or switches to an alternate source, then the corresponding quality bit should be restored to normal since the condition is being managed.

Data Quality Indication (Delete ??????)

Data quality is an indication of the currency of the MW, MWh, MVAR, voltage, and frequency values exchanged among the Market Participants and the NYISO. Each value must be accompanied by a data quality flag. When the flag is set to true, the corresponding value is not being updated by its source. When set false (the expected or “normal” state), the value is considered valid and represents the real-time condition of the value to the best ability of the source. Only the source of the value may set the quality indication.

Invalid (flag = false) data may be handled at its source by substitution (by an operator) of a manually entered value or by switching to a back-up source. At the NYISO, such data failures may be handled with manual substitution or by the substitution of analog data. Where analog back-up exists, the quality bit controls its automatic substitution. If a Transmission Owner dispatcher replaces a failed value or switches to an alternate source, then the corresponding quality bit should be restored to normal since the condition is considered managed.

Revenue Metering Data

All revenue metering data supplied for final balancing and billing purposes must be based on energy measurements made with instruments that are traceable to the National Institute of Standards and Technology (NIST), meet specifications of Section 1.3, and are approved for billing purposes within New York State. The use of SCADA data for final settlement will be precluded if revenue grade data is available. In the event revenue quality metering data is not available for a final settlement, the NYISO will consult with ALL affected parties and at that time it will be determined the best data to be used in the final settlement

Metering Specifications

The following is the design for equipment that will meet the requirements of minimal error necessary to affect efficient computer operation at both the TOs and the NYISO. For detailed specifications on meters, Transducers, VTs, and CTs see the New York State Electric Meter Engineers Committee Guide for Uniform Practices in Revenue Quality Metering.

1. ***Voltages for Transmission to NYISO*** — The transducers shall be of the RMS type and have no external adjustments or external mechanical variable resistors. Any internal adjustments shall only be available through the removal of the case or a port capable of being sealed.

   Voltages of 230 kV and higher shall be metered by 3 phase-to-ground voltage transducers. The outputs may be transmitted individually or averaged back to the TO control center. NYISO will require an average value for their calculation. The VT shall be a wound or cascade type. For Voltage Measurement sources the CCVT type shall not be used on new installations.

2. ***Data Transmission to NYISO*** — Digital data transmission with a maximum error of + 0.1% of reading, or as state of the art permits, is the preferred means from the remote terminal for both Analog and Digital Data telemetry. However, where analog data transmission must be used, the system shall have a combined error of less than 1.0% of full scale reading, or state of the art accuracies, end to end for the telemetering oscillator and converter. End to end is defined as including all equipment from the input terminals of the telemetering oscillator to the output ends of the telemetry converter.

3. ***General Specifications***
   a. Metering and data transmission equipment shall be powered by the station DC bus or an uninterruptible power supply, with sufficient capability to support the metering for a minimum of eight (8) hours.
   b. Multiple Parameters measured at generating plants or critical transmission stations (KW, KWH, etc.) shall be from the same CTs, VTs, and transducers so that data used at the plant, the operating headquarters, and the NYISO are common. Analog metering shall have the same data quality as Digital metering.
   c. Metering connection drawings, schematics and documentation shall be maintained by the Metering Authority in conformance with the New York State Electric Meter Engineers Committee Guide for Uniform Practices in Revenue Quality Metering as well as this manual.

1.3 New York State Electric Meter Engineers' Committee Guide for Uniform Practices in Revenue Quality Metering:

The Guide for Uniform Practices in Revenue Quality Metering outlines procedures and practices that should result in optimum metering accuracy and uniformity of Revenue Quality Metering.

This document is maintained by the New York State Meter Engineers' Committee.

Attachment A:

New York State Electric Meter Engineers' Committee

Guide for Uniform Practices in Revenue Quality Metering

- Rev. 1: October 22, 1982
- Rev. 2: May 25, 1984
- Rev. 3: May 14, 1998
- Rev. 4: August 20, 2003

Approved by the New York State Electric Meter Engineers Committee, August 20, 2003.

New York State Electric Meter Engineers' Committee

Guide for Uniform Practices in Revenue Quality Metering

1.0 Purpose

1.1 The main purpose of this guide is to identify accepted practices for revenue quality metering systems that will result in optimum accuracy and in cases where required, to provide the minimum functional requirements to deliver revenue grade load profile data to end users.

1.2 The scope of this guide is limited to the measurement of revenue grade, gross watt-hour values. This guide may also be applicable to measurements intended for local monitoring, power system control and operation. It does not include processes that may be used by Meter Authorities or others beyond the validation of gross watt-hour values and is not applicable to measurements intended for station relaying applications.

1.3 Equipment, if any, necessary to telemeter non-billing or instantaneous measurements to remote locations is not covered by this guide. This includes metering data collected by SCADA remote terminal units (RTU's) for control and operational reasons or measurements of instantaneous quantities that are transmitted directly to the end user.

1.4 This guide is intended to apply to new or completely revised metering installations. Its application when upgrading the capabilities of existing installations is encouraged.

2.0 General

2.1 The revenue metering installation may also be the source for supplying SCADA with real time or instantaneous values (i.e. metering data collected by SCADA RTU's for operational reasons). Metered quantities that are used for the purpose of operating or controlling the "power system" may also be derived from discrete transducers.

2.2 Data supplied to an end user for revenue purposes should at minimum be based on measurements made with "instruments" that are in compliance with the requirements detailed in this manual. These instruments shall be traceable to NIST standards, approved for revenue purposes by the NYPSC and meet or exceed all applicable ANSI C12 Series (Code for Electricity Metering) requirements in effect at the time of their design.

2.3 Instrument transformers should meet or exceed ANSI standard C57.13 and all applicable ANSI C12 Series standards that are in effect at the time of design.

2.4 The revenue quality installation should conform to Blondel's measurement theorem that states: "In a system of N conductors, N-1 meter elements, properly connected, will measure the power or energy taken. The connection must be such that all voltage coils have a common tie to the conductor in which there is no current coil." A neutral conductor that is grounded through high impedance so that the "system" becomes effectively ungrounded can be excluded from the conductor count. Compliance to Blondel's measurement theorem precludes the use of two and one-half element (i.e. FM 6) meters in applications involving grounded Wye connected sources.

2.5 The revenue metering installation should be designed in a manner that minimizes the effects of scaling and resolution errors.

2.6 Each revenue meter and instrument transformer should be provided with a nameplate that lists the manufacturer's name, serial number, and type of device as well as class accuracy and pertinent input and output ratings including impulse levels, where applicable, and necessary connection diagram and polarity designations.

2.7 Wiring connections between the instrument transformers and the metering devices should conform to standards specified in Sections 3.0 and 4.0 of this guide.

3.0 Current Transformers (CT's)

3.1 All CT's should conform to the ANSI standard accuracy class for metering service of 0.3 or better and shall be provided with certificates of test stipulating the ratio and phase angle corrections at 10% and 100% of rating with the standard ANSI burden nearest to the actual "inservice" burden.

3.2 Where the secondary circuit will impose different burdens on the individual current transformers, certificates shall be provided showing ratio and phase angle corrections for the ANSI burdens nearest to the highest and the lowest "in-service" burden.

3.3 The metering CT burden in the secondary circuit should be kept as small as practicable and should be limited to those measurement devices requiring a highly accurate current source. Relays, meters and other devices intended mainly for local control and operation should not be connected to these transformers.

3.4 Other than a test block or switch that is specifically designed for the purpose of testing meters, no other switch(es), test block(s), fuse(s), or other quick disconnecting means should be placed in the secondary circuits of the CT's.

3.5 All secondary wiring connected to the CT's should be a minimum of #1OAWG copper and should be limited to the minimum length necessary to complete the circuit to the

revenue meter. Short lengths of smaller conductors on switchboard panels may be utilized providing the additional burden imposed by these conductors is negligible when compared to the overall circuit burden.

3.6 The wiring for the secondary circuits of metering CT's should utilize separate leads from each secondary terminal of the CT to the meter test block. When a common CT secondary return conductor is utilized, the conductor should be separate from the common return of the voltage transformers. Regardless of which method is used (i.e. separate leads or a common return conductor); the CT and voltage transformer commons shall be grounded at only one point, preferably at the test switch near the meter.

3.7 Secondary circuits should be routed so as to avoid the possibility of induced voltages and the effects of ground faults. Where this is not practical, the secondary circuit should be designed to minimize these effects. In those circuits involving solid state metering, suitable protection against the effects of fault and switching generated over-voltages should be provided (refer to ANSI C37.90a).

3.8 CT secondary windings should not be connected in parallel.

3.9 Whenever practical, the CT's should be designed to withstand continuous operation and maintain class 0.3 or better metering accuracy at twice or more of rated current (ex. Transformer thermal rating factor greater than or equal to 2). In these cases, the nominal primary rating of the CT should be one-half, or the nearest standard rating above one-half, of the long-term emergency rating of the tie.

4.0 Voltage Transformers (VT's)

4.1 All VT's should conform to the ANSI standard accuracy class for metering service of 0.3 or better and be provided with certificates of test stipulating the ratio and phase angle corrections at 100% rating with zero burden and with the rated maximum standard burden.

4.2 The VT burden in the secondary circuit should be limited to those measuring devices that require a highly accurate voltage source. Relays, meters, and other devices intended mainly for local control and operation should not be connected to these transformers.

4.3 Where the VT has multiple secondaries, the revenue measuring devices requiring a highly accurate voltage source should be connected to a separate secondary winding from that supplying the remaining burdens. Care should be exercised not to overburden the windings where non revenue grade devices are connected since this can affect the accuracy of the voltage supplied by the windings that are dedicated to revenue measurement devices.

4.4 Secondary fuses, if any, should be of a high speed, high-current interrupting construction with current ratings sufficient to assure low electrical impedance and the mechanical ruggedness to resist the effects of corrosion and vibration. In no case should fuses be placed in the common secondary return or the ground circuit of instrument transformers.

4.5 All test switches, fuse blocks, and fuses in the secondary voltage circuit should be designed to introduce as small an impedance as practical to the secondary circuit. The overall resistance and reactive impedance of the secondary circuit should be measured. These values should be multiplied phasorially by the burden current to determine the in-phase and quadrature components of the lead voltage drop. These values should be utilized to calculate the overall voltage transformer corrections to be applied to the metering circuit, if instrument transformer correction is used.

4.6 All secondary wiring supplying voltage to the revenue meters should be a minimum of #12 AWG copper and should be limited to the minimum length necessary to complete the circuit to the metering device.

4.7 Where a common VT secondary return conductor is utilized, the conductor should be separate from the common return of the CT's. The VT and CT common return should be grounded at only one point, preferably at the test switch near the meter.

4.8 Secondary circuits should be routed so as to avoid the possibility of induced voltages and the effects of ground faults. Where this is not practical, the secondary circuit should be designed to minimize these effects. Suitable protection against the effects of faults and switching generated overvoltages should be provided.

4.9 VT's should be of a wound or cascade type. Coupling capacitor voltage transformers (CCVT's) should not be used for revenue metering purposes.

5.0 Revenue Meters

5.1 The revenue meters should be digital, true RMS measuring devices that meet or exceed ANSI C12.20 that is in effect at the time of design and in cases where required, they shall have the ability to record load profile data.

5.2 Where applicable, the revenue meter may be used as a source for measurement of instantaneous values. The interface between the revenue meter and SCADA RTU may be through an analog current loop or a digital, real time metering port using DNP 3.0 or other suitable communication protocol and having an RS-232 or RS-485 interface.

5.3 To facilitate the transfer of revenue quality, register and load profile data, the revenue meters should be remotely accessible through use of conventional dial up or other communication technology.

5.4 Where there is need for a revenue meter to measure, display and/or record time differentiated usage, its primary time base should be synchronized with the line frequency. Its secondary time base should have an accuracy that meets or exceeds +/- 0.02% (ANSI C12.13). In cases where revenue data is retrieved by a translation system through remote dial up or other communication means, the translation system should be synchronized to a national time standard on a daily basis. Meter time should be adjusted if it exceeds the time reference of the translation system by more than an "allowable" tolerance. While this "allowable" tolerance varies between Meter Authorities, it should be kept as small as practicable. As a target, Meter Authorities should try to maintain meter time to within a +/- 15-second window from the translation system reference.

5.5 Compensation for line and transformer losses, when utilized should be accomplished in accordance with procedures defined in the latest edition of Edison Electric Institute's "Handbook for Electricity Metering". Compensation should be effected by applying a correction for copper losses that are proportional to the square of the current and a correction for transformer core losses or line energization losses that are proportional to the square of the voltage. These corrections should be continuous and should be added to (or subtracted from) the watt-hours and reactive volt-ampere-hours (if metered) passing through the electrical point of measurement.

5.6 Compensation for instrument transformer errors, when utilized should be accomplished in accordance with procedures defined in the latest edition of Edison Electric Institute's "Handbook for Electricity Metering". The calculation of Final Correction Factor (FCF) should be based on ratio and phase angle error measurements made with instruments that are traceable to NIST standards and at minimum, are more accurate than the equipment under test by a factor of four.

5.7 Test blocks or switches should be located at or near the revenue meter. These test blocks should be designed to provide a means to measure the input quantities from the current and/or voltage transformers and to allow the application of test quantities. Where the output quantity is electrical rather than visual, provisions should be made for the convenient and efficient measurement of these quantities.

5.8 The revenue meters should be located inside a building or structure that provides adequate protection of the equipment and maintenance personnel from the weather. Adequate lighting should be provided in the area as required for testing, maintenance, and adjustment.

6.0 Validation of Revenue Data

6.1 Revenue quality (register and profile) data should be retrieved and validated by an industry-approved translation billing system. On occasion, visual register reads may also be needed to perform validations upon request.

6.2 Where applicable, SCADA data may be checked against revenue data for validation reasons. Revenue information that is collected by the translation system should be compared against SCADA integrated instantaneous and accumulated hourly pulse values. The source for final revenue reconciliation should be from the revenue quality installation and data collection system.

7.0 Backup Revenue Meter

7.1 Where a backup meter is used, it should meet or exceed all of the requirements described in this guide and have all pertinent functional capabilities of the primary meter. To minimize common mode failure, primary and backup meters should be of a different type and manufacturer.

7.2 If a backup meter is used, the revenue meters should be designated and marked as primary and backup. The transfer of revenue quality, register and hourly profile data for billing purposes should be restricted to the primary metering source. The revenue quality

data from the backup meter should be used for billing purposes only during periods of time when the primary metering has experienced a failure.

8.0 Testing and Calibration

8.1 Test equipment and test standards intended for testing and calibration of revenue meters should be certified to values of accuracy and precision, which are better than the required accuracy of the equipment under test by a factor of at least four.

8.2 Test equipment and test standards intended for the testing of new instrument transformers should be certified to values of accuracy and precision that are better than the required accuracy of the equipment under test by a factor of at least four.

8.3 All test standards used for revenue meter testing should be supplied with certified corrections that have been derived no longer than one year prior to their use.

8.4 All test standards used for instrument transformer testing for revenue quality installations should be supplied with certified corrections that have been derived no longer than four years prior to their use.

8.5 All certified corrections should be obtained by comparison against laboratory standards whose accuracies are traceable to the National Institute of Standards and Technology.

8.6 Standards utilized for the purpose of checking instantaneous voltage and current to the revenue measurement devices should be of the RMS sensing type.

8.7 Except in those cases where the involved parties agree to the contrary, the Meter Authority is responsible for any maintenance and calibration. All stakeholders affected by the measurements may request to be notified of pending calibrations and may be present during maintenance and calibration proceedings. In any case, copies of the maintenance and calibration record should be forwarded to all stakeholders upon request.

8.8 Where a dispute over the accuracy or performance of a revenue meter exists, the stakeholders may request a comparison of standards and/or a separate calibration of the revenue meter.

8.9 New revenue meters should be acceptance tested. All tests should be made at nominal nameplate rating. The series test points should be at Full Load (FL), Light Load (LL) and Power Factor (PF). FL is at 5 amperes at unity power factor. LL is at 0.5 amperes (10% of FL) at unity power factor and the PF test point is at 5 amperes at 0.5 power factor.

8.10 In-service revenue meters shall be periodically tested at the above test points. The revenue meters should be adjusted to bring the registration at all test points within the accuracy specifications defined in ANSI C12.20.

8.11 It is considered good practice to periodically field check the condition of metering instrument transformers. The condition of in-service CT's can be periodically checked by use of one of two methods. The preferred method for the detection of abnormal conditions is to monitor the CT's admittance. An increase of sufficient magnitude would indicate an abnormal condition such as an error or fault that may affect billing accuracy.

The other method involves burden testing where external burdens are added in steps to the secondary loop of the CT. The change in secondary current is monitored during each step and compared against the value of secondary loop current without the external burden added. The stepped decreases in secondary current are then compared against those of the other CT's in the same installation. A difference in the magnitude of current decreases within each step and between CT's would indicate an abnormal condition that may affect billing accuracy.

8.12 Where possible, a periodic functional inspection of the VT's should be made. This involves making voltage measurements near the VT secondary terminals and at the meter test block. An excessive drop in voltage may indicate the presence of an abnormal condition. During planned outages involving older installations, consideration should be given to high pot testing the secondary wiring of VT's.

8.13 Revenue meters should be tested in both directions if used in a bi-directional manner for revenue purposes.

8.14 If the revenue meters are compensated for line and/or transformer losses, they should be tested both with and without loss compensation to determine the accuracy of the compensation at each test point (i.e. FL, LL and PF). Since this requires access to an accurate and stable voltage and current source, it should be done prior to installation. The intent of subsequent in-service testing is not to verify accuracy but rather the presence of the compensation.

8.15 Revenue meters that have both an analog output and an integrated pulse output should be tested for the accuracy of both outputs.

8.16 The integrity of the meter readings should be maintained. A meter test should be made during a period of no load or when the load is constant so that the reading can be adjusted upon completion of the test. The I/O circuits should be made inoperative during the test.

9.0 Test Schedules and Records

9.1 Revenue meters should at minimum be tested once every two years.

9.2 Test records should be maintained for a period of at least six years. Copies of all tests should be forwarded to all the stakeholders that are interested in receiving such information.

10.0 Exchange of Information

10.1 Upon installation, the metering authority should furnish all stakeholders with pertinent metering information that includes the following:

a. Connection diagram(s).

b. Type and rating of revenue meters, current and voltage transformers, and other associated devices.

c. Copies of certificates of test for the metering current and voltage transformers. When certificates are not available, a typical curve for the type of transformers should be furnished, and the parties should agree on the transformer correction, if any, to be applied.

d. Secondary burdens applied to the voltage and current transformers.

e. The resistance and reactive impedance of the voltage transformer secondary leads.

f. The derivation of compensated metering correction, if used, and the method of compensation.

10.2 The forms upon which the above are reported should include the Company's name, the location of the installation, identification numbers of the meters and instrument transformers, feeder identification, and direction of flow being measured.

10.3 All stakeholders shall be advised of proposed changes in the metering equipment or circuits which could affect the accuracy of the measurement(s).

11.0 Definitions

11.1 Where there is a question on the meaning of terms used in this guide, the definitions in Section 2 of ANSI Standard C12 should be used. If ANSI Standard C12 does not address the question, the definition, by order of priority, should be obtained from the following:

a. IEEE Standard Dictionary of Electrical and Electronic Terms.

b. McGraw Hill Dictionary of Scientific and Technical terms.

c. Webster’s Unabridged Dictionary.

11.2 The following definitions are terms used throughout this guide. These definitions are limited to this document:

a. Instruments – All devices that make up the revenue metering installation. This includes but is not limited to meters, instrument transformers, demand recorders, totalizers, etc.

b. SCADA: System Control And Data Acquisition system.

c. RTU: Remote Terminal Unit

d. ANSI: American National Standards Institute

e. NIST: National Institute of Standards and Technology

f. NYPSC: New York State Public Service Commission

g. RMS: Root Mean Square

h. Stakeholder: Parties or entities that have direct involvement with points of interchange.

1.4 Metering and Data Accuracy Analysis

1.4.1 Purpose

This procedure provides:

- A method to monitor the quality of NYISO data so that problems can be analyzed, and
- A communications procedure between the Participants and the NYISO staff, whereby data and metering problems can be addressed and resolved.

1.4.2 Administration

1. The Information Technology Staff of the NYISO is responsible for analyzing all metering and data accuracy anomalies as reported to them by NYISO Staff or Participants staff.

1.4.3 Procedure

1. If NYISO's Staff or any Market Participant representative determines that a potential metering or data problem exists, an investigation into the cause of the problem will be initiated through NYISO Customer Relations who will coordinate problem analysis with NYISO Information Technology Staff and representatives of all affected parties.
2. The Participants representative receiving the request must respond by the next working day supplying the following information:
    a. Probable cause of the data or metering problem;
    b. Expected time frame in which the problem will be resolved.
3. Long Term Metering or Data Problems are those for which the time frame specified in 2b above is not acceptable to the NYISO or Participant and will be resolved in the following manner:
    a. Reasons and potential alternatives for problem solution shall be supplied, in writing, by the Participants receiving representative to the NYISO initiating representative and representative of any affected Market Participant;
    b. The NYISO initiating representative will respond in writing to all affected parties, analyzing the alternatives presented, indicating their effects on their respective operations.

1.4.4 Reporting

A report will be issued semi-annually by the Information Technology Staff, of the NYISO, and will be posted on the NYISO Website. The report shall include:

a. A summary of problems and resolutions during the report period;

b. Details of unresolved problems.