

## Appendix H

### NIST Handbook 44 – Developing Items

#### Item 360-3:

##### Electric Vehicle Fueling and Submetering

This draft code is currently under development by the USNWG; this draft is NOT yet ready for consideration by the NCWM. Updated versions will be posted on the NIST website as work by the USNWG progresses.

#### **Draft NIST Handbook 44 Device Code Requirements for Electric Vehicle Fueling and Submetering**

This tentative code has only a trial or experimental status and is not intended to be enforced. The requirements are designed for study prior to the development and adoption of a final code. Officials wanting to conduct an official examination of a device or system are advised to see paragraph G-A.3. Special and Unclassified Equipment.

(Tentative Code Added 20XX)

#### **A. Application**

**A.1. General.** – This code applies to electronic and mechanical devices, accessories, and systems used for the measurement of electricity dispensed as a vehicle fuel and in other commercial electricity sub-metering applications wherein a quantity determination or statement of measure is used wholly or partially as a basis for sale or upon which a charge for service is based.

**A.2. Exceptions.** – This code does not apply to:

- (a) This code does not apply to the use of any measure or measuring device used by a public utility in connection with measuring electricity subject to the jurisdiction of the Public Utilities Commission.
- (b) Devices used solely for dispensing a product in connection with operations in which the amount dispensed does not affect customer charges.
- (c) The wholesale delivery of electricity.

**A.3. Additional Code Requirements.** – In addition to the requirements of this code, Electricity-Measuring Devices shall meet the requirements of Section 1.10. General Code.

**A.3.1. Dual-Purpose Electric Vehicle Supply Equipment (EVSE) and Timing Devices.** – A device that is used for both the sale of electricity as vehicle fuel and the sale of other separate time-based services (e.g., vehicle parking) shall meet the requirements Section 5.55. Timing Devices. in addition to the requirements of this code.

**A.4. Type Evaluation.** – The National Type Evaluation Program (NTEP) will accept for type evaluation only those devices that comply with all requirements of this code.

**A.5. Meter Type Notation.** – Code sections and subsections with an [EM] notation apply to electronic meters only. Code sections and subsections with a [MM] notation apply to mechanical meters only. Code sections and subsections without [EM] or [MM] notation apply to both meter types.

## S. Specifications

### S.1. Indicating and Recording Elements.

**S.1.1. Electric Vehicle Supply Equipment (EVSE).** – A device used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each delivery.

**S.1.2. EVSE Indicating Elements.** – A device used to charge electric vehicles shall include an indicating element that continuously displays measurement results relative to quantity and total price. Indications shall be clear, definite, accurate, and easily read under normal conditions of operation of the device. All indications and representations of electricity sold shall be clearly identified and separate from other time-based fees indicated by a dual-purpose device that is used for both the sale of electricity as vehicle fuel and the sale of other separate time-based services (e.g., vehicle parking).

#### S.1.3. EVSE Units.

**S.1.3.1. EVSE Units of Measurement.** – Deliveries used to charge electric vehicles shall be indicated and recorded in megajoules (MJ) or kilowatt-hours (kWh) and decimal subdivisions thereof.

**S.1.3.2. Numerical Value of Quantity-Value Divisions.** – The value of an interval (i.e., increment or scale division) shall be equal to:

- (a) 1, 2, or 5; or
- (b) a decimal multiple or submultiple of 1, 2, or 5.

Examples: quantity-value divisions may be 10, 20, 50, 100; or 0.01, 0.02, 0.05; or 0.1, 0.2, or 0.5; etc.

**S.1.3.3. Maximum Value of Quantity-Value Divisions.** – The maximum value of the quantity-value division shall not be greater than 0.5% of the minimum measured quantity.

**S.1.3.4. Values Defined.** – Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof. An indication of “zero” shall be a zero digit for all displayed digits to the right of the decimal mark and at least one to the left.

**S.1.4. EVSE Value of Smallest Unit.** – The value of the smallest unit of indicated delivery by an EVSE, and recorded delivery if the EVSE device is equipped to record, shall not exceed the equivalent of 3.6 MJ or 1 kWh.

**S.1.5. [MM] Submeter Register.** – A meter register shall clearly indicate the number of kilowatt-hours measured by the meter. The register ratio shall be indicated on the front of the registers that are not an integral part of the meter nameplate. Means shall be provided for the tenant to read the meter register.

#### S.1.6. [EM] Submeter Watthour Indications.

**S.1.6.1. Customer Indicating Element.** – All submeters in a service system shall have an individual customer indicating element on or at the meter and the minimum value shall not exceed one kilowatt hour.

**S.1.6.2. Test Constant.** – All submeter systems shall be capable of indicating at least one watthour test constant ( $K_t$ ) output indication but not more than 20 watthour test constant output indications.

Means for indicating watthour test constant output indications include but are not limited to: decimal point, contrasting display colors, shorting link, or a means for visual flashing pulse counts.

**S.1.6.3. Indicating Element Value.** – The minimum indicating element value (unit of measure) shall be conspicuously identified on or near the customer indicating element.

**S.1.6.4. Segments.** – A segmented digital indicating element shall have an easily accessible provision for checking that all segments are operational.

**S.1.6.5. Real-time Indicating Element.** – If the indicating element is not on continuously, it shall be accumulated continuously so that real-time measurement is indicated during activation.

**S.1.7. Multiple Submeter Indicating Elements.** – An indicating or combination indicating-recording element coupled to two or more meter systems shall be provided with means to prohibit indication of information from any meter system not selected, and shall be provided with automatic means to indicate clearly and definitely which meter system is associated with the indication.

## **S.2. EVSE Operating Requirements.**

### **S.2.1. EVSE Return to Zero.**

(a) The primary indicating and the primary recording elements of a device used to charge electric vehicles, if the device is equipped to record, shall be provided with a means for readily returning the indication to zero either automatically or manually.

(b) It shall not be possible to return primary indicating elements, or primary recording elements, beyond the correct zero position.

**S.2.2. EVSE Indicator Reset Mechanism.** – The reset mechanism for the indicating element of a device used to charge electric vehicles shall not be operable during a delivery. Once the zeroing operation has begun, it shall not be possible to indicate a value other than the latest measurement, or “zeros” when the zeroing operation has been completed.

### **S.2.3. EVSE Provision for Power Loss.**

**S.2.3.1. Transaction Information.** – In the event of a power loss, the information needed to complete any transaction in progress at the time of the power loss (such as the quantity and unit price, or sales price) shall be determinable for at least 15 minutes at the device or at the console if the console is accessible to the customer.

**S.2.3.2. User Information.** – The device memory shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

### **S.2.4. EVSE Indication of Unit Price and Equipment Level Identity.**

**S.2.4.1. Unit Price.** – A computing or money-operated device shall be able to indicate on each face the unit price at which the device is set to compute or to dispense.

**S.2.4.2. Equipment Level.** – A device shall be able to conspicuously indicate on each side the equipment level (i.e., Level 1, Level 2, or Level 3) of the device.

**S.2.4.3. Selection of Unit Price.** – When a product is offered for sale at more than one unit price through a computing device, the selection of the unit price shall be made prior to delivery using controls on the device or other customer-activated controls. A system shall not permit a change to the unit price during delivery of a product.

**S.2.4.4. Agreement Between Indications.** – All quantity, unit price, and total price indications within a measuring system shall agree for each transaction.

**S.2.5. EVSE Money-Value Computations.** – A computing device shall compute the total sales price at any single-purchase unit price for which the product being measured is offered for sale at any delivery possible within either the measurement range of the device or the range of the computing elements, whichever is less.

**S.2.5.1. Money-Value Divisions, Digital.** – A computing type device with digital indications shall comply with the requirements of paragraph G.S.5.5. Money-Values, Mathematical Agreement, and the total price computation shall be based on quantities not exceeding 0.36 MJ or 0.1 kWh.

**S.2.5.2. Auxiliary Elements.** – If a system is equipped with auxiliary indications, all indicated money value and quantity divisions of the auxiliary element shall be identical with those of the primary element.

**S.2.5.3. Indication of Quantity and Total Price.** – When a delivery is completed, the total price and quantity for that transaction shall be indicated on the face of the device for at least five minutes or until the next transaction is initiated by using controls on the device or other user-activated controls.

**S.2.6. EVSE Recorded Representations.** – Except for fleet sales and other price contract sales, a printed receipt providing the following information shall be available through a built-in or separate recording element for all transactions conducted with point-of-sale systems or devices activated by debit cards, credit cards, and/or cash. The printed receipt shall contain the following information for electricity delivered by the device:

- (a) the total quantity of the delivery;
- (b) the unit price;
- (c) the total computed price of the electricity sale;
- (d) the EVSE level (i.e., Level 1, Level 2, or Level 3) by name, symbol, abbreviation, or code number;
- (e) any additional separate charges included in the transaction (e.g., charges for parking time); and
- (f) the final total price of the complete transaction including all items.

For systems equipped with the capability to issue an electronic receipt, the customer may be given the option to receive the receipt electronically (e.g., via cell phone, computer, etc.).

**S.2.7. Indication of Delivery.** – The device shall automatically show on its face the initial zero condition and the quantity delivered (up to the capacity of the indicating elements).

**S.3. Design of Measuring Elements and Measuring Systems.** – Except as otherwise noted within NIST Handbook 44, meters shall meet all applicable design requirements of the latest published ANSI C12.1 Code for Electricity Metering.

**S.3.1. Metrological Components.** – A meter system shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy. Components shall be designed to prevent undetected access to adjustment mechanisms and terminal blocks by providing for application of a physical security seal or an Audit Trail.

**S.3.2. Terminals.** – The terminals of the meter shall be arranged so that the possibility of short circuits while removing or replacing the cover, making connections, or adjusting the meter, is minimized.

**S.3.3. Adjustment Means.** – A measuring system shall be provided with means to change the ratio between the indicated quantity and the quantity of electricity measured by the meter.

**S.3.4. Provision for Sealing.** – Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or physically applying security seals in such a manner that no adjustment may be made of:

- (a) each individual measurement element;
- (b) any adjustable element for controlling voltage or current when such control tends to affect the accuracy of deliveries;
- (c) any zero adjustment mechanism; and
- (d) any metrological parameter that detrimentally affects the metrological integrity of the device or system.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.3.4. Categories of Device and Methods of Sealing.

<b>Table S.3.4. Categories of Device and Methods of Sealing</b>	
<b>Categories of Device</b>	<b>Method of Sealing</b>
<p><b>Category 1:</b> No remote configuration capability.</p>	<p>Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.</p>
<p><b>Category 2:</b> Remote configuration capability, but access is controlled by physical hardware.</p> <p>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</p>	<p>The hardware enabling access for remote communication must be on-site. The hardware must be sealed using a physical seal or an event counter for calibration parameters and an event counter for configuration parameters. The event counters may be located either at the individual measuring device or at the system controller; however, an adequate number of counters must be provided to monitor the calibration and configuration parameters of the individual devices at a location. If the counters are located in the system controller rather than at the individual device, means must be provided to generate a hard copy of the information through an on-site device.</p>
<p><b>Category 3:</b> Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password).</p> <p>The device shall clearly indicate that it is in the remote configuration mode and record such message if capable of printing in this mode or shall not operate while in this mode.</p>	<p>An event logger is required in the device; it must include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter. A printed copy of the information must be available through the device or through another on-site device. The event logger shall have a capacity to retain records equal to 10 times the number of sealable parameters in the device, but not more than 1000 records are required. (<b>Note:</b> Does not require 1000 changes to be stored for each parameter.)</p>

**S.3.5. [EM] Meter-Control Program.** – The meter-control program shall be an integral part of the meter's firmware read-only memory that cannot be changed in its operating environment. This section does not apply to electronic meters that do not utilize a meter-control program.

### **S.3.6. [EM] Data Storage and Retrieval.**

Wathour data accumulated and indicated shall be permanent and accessible.

- (a) Values indicated or stored in memory shall not be affected by electrical, mechanical or temperature variations, radio-frequency interference, power failure, or any other environmental influences to the extent that accuracy is impaired.
- (b) Memory and/or display shall be recallable for the life of the meter. A replaceable battery shall not be used for this purpose.

**S.3.7. Temperature Range for Metering Components.** - Meters shall be accurate and correct over the temperature range of  $-20\text{ }^{\circ}\text{C}$  to  $+50\text{ }^{\circ}\text{C}$  ( $-4\text{ }^{\circ}\text{F}$  to  $122\text{ }^{\circ}\text{F}$ ). If the meter or any measuring system components are not capable of meeting these requirements, the temperature range over which the system is capable shall be stated on the NTEP CC, marked on the device, and installations shall be limited to the narrower temperature limits.

**S.3.8. Zero-Set-Back Interlock, Retail EVSE Devices.** – A device shall be constructed so that:

- (a) when the device is shut-off at the end of a delivery an automatic interlock prevents a subsequent delivery until the indicating element and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and
- (b) it shall not be possible to return the vehicle connector to its starting position unless the zero-set-back interlock is engaged or becomes engaged.

For systems with more than one device supplied by a single measuring element, an effective automatic control in each device prevents product from being delivered until the indicating elements on that device are in a correct zero position; or

For systems with more than one connection supplied by a single measuring element, effective automatic means must be provided to prevent product from being delivered until the indicating element(s) corresponding to each connection are in a correct zero position.

## **S.4. Connections.**

**S.4.1. Diversion of Measured Electricity.** – No means shall be provided by which any measured electricity can be diverted from the measuring device.

**S.4.2. Directional Control.** – If a reversal of energy flow could result in errors that exceed the tolerance for the minimum measured quantity, effective means, automatic in operation to prevent or account for the reversal of flow shall be properly installed in the system. (See N.7. Minimum Measured Quantity)

**S.5. Markings.** – The following identification and marking requirements are in addition to the requirements of Section 1.10 General Code, paragraph G-S.1. Identification.

**S.5.1. Location of Marking Information; EVSE.** – The marking information required in General Code, paragraph G S.1. Identification shall appear as follows:

- (a) within 60 cm (24 in) to 150 cm (60 in) from ground level;
- (b) either internally and/or externally provided the information is permanent and easily read; and accessible for inspection; and

- (c) on a portion of the device that cannot be readily removed or interchanged (e.g., not on a service access panel).

**Note:** The use of a key or tool to access internal marking information is permitted for retail electricity-measuring devices.

**S.5.2. Device Identification and Marking Requirements.** – In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, each device shall have the following information conspicuously, legibly, and indelibly marked on the nameplate or register, if applicable:

- (a) the accuracy class of the device as specified by the manufacturer consistent with Table T.4. Accuracy Classes and Load Test Tolerances for Electricity-Measuring Devices;
- (b) AC voltage rating;
- (c) Test amperes (TA);
- (d) Meter class (CL);
- (e) Watthour or rotor constant ( $K_h$ );
- (f) [MM] Register ratio ( $R_r$  or  $K_r$ ) and multiplier (if greater than one) preceded by “multiply by” or “mult by” or “ $K_r$ ”;
- (g) Frequency rating (Hz);
- (h) Number of meter stator(s) or element(s);
- (i) Watthour meter or other descriptive term;
- (j) [MM] Number of wires (W);
- (k) [MM] Form designation (FM);
- (l) [EM] Watthour test constant ( $K_t$ );
- (m) Minimum measured quantity (MMQ).

Instrument transformer-rated meters shall contain the following additional information:

- (n) Instrument transformer ratio or transformer model number;
- (o) [MM] Primary watthour constant ( $PK_h$ );
- (p) Temperature Limits, if narrower than and within  $-20\text{ }^{\circ}\text{C}$  to  $+50\text{ }^{\circ}\text{C}$  ( $-4\text{ }^{\circ}\text{F}$  to  $122\text{ }^{\circ}\text{F}$ ).

**S.5.3. Instrument Transformer Identification.** – Each instrument transformer that is non-integral with the meter shall have the following conspicuously, legibly, and indelibly marked on a permanent identification label:

- (a) Manufacturer's name, type designation, and non-repetitive serial number;
- (b) True ratio, primary versus secondary, ampere or voltage values;
- (c) Accuracy class;

- (d) Burden designation (B);
- (e) Basic lightning impulse insulation level (BIL);
- (f) Rated Frequency (HZ).

Note: If evident by the method of integration that instrument transformers are not intended to be detachable or replaceable, the required information may be located on the meter.

**S.5.3.1. Polarity Marking.** – A permanent mark indicating proper installation orientation is required on the instrument transformer when the accuracy of the meter is affected.

**S.5.4. Abbreviations and Symbols.** – The following abbreviations or symbols may appear on a meter, instrument transformer, or indicator.

- (a) FM = Form
- (b) CL = Class
- (c) V = Volts;
- (d) Hz = Hertz, Frequency or Cycles Per Second;
- (e) TA = Test Amperes;
- (f) Kh = Watthour Constant Per Rotor Revolution or Pulse;
- (g) PKh = Primary Watthour Constant;
- (h) Rr = Register Ratio;
- (i) CTR = Current Transformer Ratio;
- (j) VTR or PTR = Voltage or Potential Transformer Ratio;
- (k) MULT BY = Multiply By;
- (l) W = Wire (example: 240V 3W);
- (m) Y = WYE Power Supply;
- (n) ANSI = American National Standards Institute;
- (o) B = Burden;
- (p) BIL = Basic Lightning Impulse Insulation Factor;
- (q) Kt = [EM] Watthour Test Constant;
- (r) AC = Alternating Current (i.e. VAC);
- (s) J = Joule;
- (t) MJ = Megajoule;



- (u) Wh = Watthour;
- (v) kWh = Kilowatt-hour;
- (w)  $\Delta$  = Delta Power Supply.

**S.6. Printer.** – When an assembly is equipped with means for printing the measured quantity, the printed information must agree with the indications on the device for the transaction and the printed values shall be clearly defined.

**S.6.1. Printed Receipt.** – Any delivered, printed quantity shall include a device identification number that uniquely identifies the device from all other devices within the seller’s facility, the time and date, and the name of the seller. This information may be printed by the device or pre-printed on the ticket.

**S.7. Totalizers for EVSE Devices.** – EVSE devices shall be equipped with a nonresettable totalizer for the quantity delivered through each separate measuring device.

**S.8. Minimum Measured Quantity.** – The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:

Measuring systems shall have a minimum measured quantity not exceeding 3.6 MJ or 1.0 kWh.

## N. Notes

**N.1. Meter Creep Test.** – A meter creep test shall be conducted by applying rated voltage to the meter under test and no load applied.

**N.2. Meter Starting Load.** – A meter starting load test shall be conducted by applying rated voltage and 0.5-ampere load.

**N.3. [MM] Test Revolutions.** – Full and light load tests shall require 8 or more revolutions of the test standard and at least one revolution of the meter under test.

**N.4. [EM] Meter Test Constant Output Indications.** – Full and light load tests shall consist of 8 or more watthour test constant ( $K_t$ ) output indications of the test standard and at least one watthour test constant ( $K_t$ ) output indication of the meter under test. Test standards that read out directly in watthours shall meet the watthour equivalent of eight or more watthour test constant ( $K_t$ ) output indications.

**N.5. Meter and System Test Loads.**

- (a) [MM] Mechanical self-contained meters shall be balanced load tested, and may be single element tested, for meter accuracy at full and light loads.
- (b) [MM] Instrument transformer rated systems shall be single element tested, and may be balanced load tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the current transformer(s).
- (c) [EM] Instrument transformer(s) rated systems shall be single element tested, for system accuracy at full and light loads. Meter testing shall be accomplished by applying the test load to the instrument transformer(s) with the voltage circuits energized.
- (d) The reference voltage phases (A, B, or C) at the meter shall be the same phase as the load.

## **N.6. Test of a Meter System.**

- (a) Each meter submitted for test shall be a complete system. For example: a meter body and any necessary instrument transformer(s), indicator(s), system software, etc., required to make up a complete system.
- (b) The test load applied for a full load test shall be the marked test amperes (TA) on the nameplate of the meter under test.
- (c) The test load applied for a light load test shall be conducted at not less than 10 % of the marked (TA) test amperes on the nameplate of the meter under test.
- (d) The test load applied for a full load test of a meter for a 0.5 power factor setting shall be the marked (TA) test amperes of the nameplate of the meter under test.
- (e) The test load applied for a light load test of a meter for a 0.5 power factor setting shall be conducted at not less than 20 % of the (TA) test amperes of the meter.
- (f) All tests shall be made at the rated voltage  $\pm 10$  %.

## **N.7. Minimum Measured Quantity.** – The minimum measured quantity shall be specified by the manufacturer.

**N.7.1. Minimum Measured Quantity Test.** – The device shall be tested for a delivery equal to the declared minimum measured quantity when the device is likely to be used to make deliveries on the order of the declared minimum measured quantity.

**N.8. Repeatability Tests.** – Tests for repeatability should include a minimum of three consecutive tests at the same load and be conducted under controlled conditions where variations in factors are reduced to minimize the effect on the results obtained.

## **T. Tolerances**

### **T.1. Tolerances, General.**

- (a) The tolerances apply equally to errors of underregistration and errors of overregistration.
- (b) The tolerances apply to all deliveries measured at any load within the rated measuring range of the device.
- (c) Where instrument transformers or other components are used, the provisions of this section shall apply to all metering components.

### **T.2. Meter Creep Test.**

**T.2.1. [EM] Meter Creep Test.** – The meter indicating element shall not change by more than one least significant digit with the voltage circuit(s) energized and current circuit(s) not energized for a duration of one hour using the watt-hour test constant ( $K_t$ ) output indications.

**T.2.2. [MM] Meter Creep Test.** – A meter rotor shall rotate no more than one complete revolution in 10 minutes with the meter voltage circuit(s) energized and the current circuit(s) not energized.

### **T.3. Meter Starting Load Test.**

**T.3.1. [EM] Meter Starting Load Test.** – The watt-hour test constant ( $K_t$ ) output indication shall continue to advance when a load of 0.5 amperes is applied.

**T.3.2. [MM] Meter Starting Load Test.** – The meter rotor shall rotate continuously when a load of 0.5 amperes is applied.

**T.4. Load Test Tolerances.** – The tolerances for electricity-measuring device load tests are listed in Table T.2. Accuracy Classes and Tolerances for Electricity-Measuring Devices. (Proposed tolerance values are based on ANSI C12.1 Code for Electricity Metering Section 5 Standards for In-Service Performance paragraph 5.1.2.2 Acceptable Performance for Maintenance Tolerances and on ANSI C12.20 Electricity Meters-0.2 and 0.5 Accuracy Classes Section 5 Acceptable Performance of New Types of Electricity Metering Devices and Associated Equipment paragraph 5.5.4.3 Test No. 3: Load Performance for Acceptance Tolerances.)

<b>Table T.4.</b>			
<b>Accuracy Classes and Load Test Tolerances for Electricity-Measuring Devices</b>			
<b>Accuracy Class</b> (ANSI C12.20 designation)	<b>Application or Commodity</b> <b>Being Measured</b>	<b>Acceptance</b> <b>Tolerance</b>	<b>Maintenance</b> <b>Tolerance</b>
0.2	Electricity as vehicle fuel	0.2 %	2.0 %
0.5	Electricity as vehicle fuel	0.5 %	2.0 %
All Others	Electricity as vehicle fuel	1.0 %	2.0 %
<b>Instrument Transformers Not Integral to the Meter</b>			
0.3 or superior	Electricity as vehicle fuel	0.3 %	2.0 % as part of system

**T.4.1. Tolerance Values.** – Maintenance and acceptance tolerances for electric watt-hour meters shall be as shown in Table T.4. for full and light load tests of Accuracy Class 0.2 and 0.5 meters. For all other Accuracy Class meters tolerances shall be as follows:

- (a) Maintenance tolerance shall be 2 % for full and light loads.
- (b) Acceptance tolerance shall be 1 percent for full and light loads.

**T.4.2. Power Factor Tests.** – Power factor tests shall be conducted at 0.5 power factor setting:

- (a) Maintenance tolerance shall be 2 % for full and light loads.
- (b) Acceptance tolerance shall be 1 % for full and light loads.

NOTE: 0.5 power factor light load tests shall be conducted at 20 % of the Test Amperes (TA).

**T.5. Repeatability.** – When multiple tests are conducted at the same load condition, the range of the load test results shall not exceed 25 % of the absolute value of the maintenance tolerance and the results of each test shall be within the applicable tolerance. (Indiana Code 170 IAC 4-1-8).

**T.6. Instrument Transformer Accuracy Class.** – An instrument transformer that is not an integral part of the meter and is used for revenue metering shall be rated 0.3 accuracy class or more accurate for the burden of a particular meter type. If a meter system requires an instrument transformer more accurate than 0.3 accuracy class, the limitations shall be stated on the meter.

**T.7. Tolerance Application in Type Evaluation Examinations for Devices.** – For type evaluation examinations, the acceptance tolerance values shall apply under the following conditions:

- (a) at any temperature, voltage, load, and power factor within the operating range of the device, and
- (b) regardless of the influence factors in effect at the time of the conduct of the examination, and
- (c) for all quantities greater than the minimum measured quantity.

## **UR. User Requirements**

### **UR.1. Selection Requirements.**

**UR.1.1. Meter Class (CL).** – The marked CL shall equal or exceed the total capacity in amperes of the EVSE or the thermal overload protectors of the tenant.

**UR.1.2. Suitability of Equipment.** – A meter shall be suitable for use on its electrical system. A three-wire two-phase load which is connected to a 120 to 208 volt network service shall be metered by a two-stator or two-element meter.

A meter shall accurately measure all loads 5 percent or greater of the electric service capacity of the tenant. Service capacity shall be determined by the master thermal overload protectors to the tenants' service or by the rated capacity of an electric cord and its connector used to provide power from the service panel to the tenant.

**UR.1.3. Instrument Transformer Ratio.** – The instrument transformer shall be correctly matched to the meter indicator and multiplier.

**UR.1.4. Computing-Type Device; Retail EVSE Device.** – A device used to charge electric vehicles shall be of the computing type and shall indicate the electrical energy, the unit price, and the total price of each delivery.

**UR.1.5. Connection Line-Length.** – The impedance of the connection line on a retail EVSE device shall not result in losses in excess of the tolerance. The length of the connection line:

- (a) shall not exceed 4.6 m (15 ft) unless it can be demonstrated that a longer line is essential to permit deliveries to be made to receiving vehicles;
- (b) shall be measured from its connection to the EVSE to the inlet of the vehicle connector; and
- (c) shall be measured with the connection line fully extended if it is coiled or otherwise retained or connected inside a housing.

An unnecessarily remote location of a device shall not be accepted as justification for an abnormally long connection line.

### **UR.2. Installation Requirements.**

**UR.2.1. Manufacturer's Instructions.** – A device shall be installed in accordance with the manufacturer's instructions, and the installation shall be sufficiently secure and rigid to maintain this condition.

**UR.2.2. Load Range.** – A device shall be installed so that the current and voltage will not exceed the rated maximum values over which the meter class designation is designed to operate continuously within the specified accuracy. Means to limit current and/or voltage shall be incorporated in the installation if necessary.

**UR.2.3. Regulation Conflicts and Permit Compliance.** – If any provision of this section (UR.2. Installation Requirements) is less stringent than that required of a similar installation by the serving utility, the installation shall be in accordance with those requirements of the serving utility.

The installer of any new EVSE or electric watt-hour submeter service shall obtain all necessary permits and shall conform to all applicable regulatory utility commission's or commissioner's requirements.

**UR.2.4. Submeter Installation Requirements.**

**UR.2.4.1. Certification by Serving Utility or Utilities Commission.** – It is the responsibility of the owner of a submeter system to obtain written certification for each submetered service connection from the serving utility or from a person designated as qualified by either the serving utility or by the Utilities Commission (UC).

- (a) The required certification shall identify the address, space, or number, of the premise served by the submeter connection; be signed by an authorized serving utility representative or by a designee; and shall clearly state:
- (b) the installation meets all serving utility installation and accessibility requirements for similar installations served directly by the serving utility,
- (c) the installation is on a tariff schedule that qualifies for submeter use,
- (d) the billing format, rates, and charges conform to all applicable serving utility tariff rules,
- (e) the date of such determination, and
- (f) if performed by a designee, the designee's name and title, and the name and title of the serving utility company or Public Utilities Commission representative authorizing the designee to make the determination.

The certification shall be provided prior to a submeter being used for commercial purposes.

**UR.2.4.2. Submeter Test Facilities.** – All submeters shall be provided with the same test facilities required of a similar meter by the serving utility.

**UR.2.4.3. [MM] Test Blocks.** – All three-phase self-contained submeter installations shall be equipped with test blocks, which are approved by the serving utility, for safe meter testing.

**UR.2.4.4. [MM] Test Switches.** – Submeter installations that are equipped with current or potential transformers, or both, shall have test switches installed, which are approved by the serving utility, for safe meter testing.

**UR.2.4.5. [MM] Circuit Closing Devices.** – All self-contained submeter installations that cannot accept a short interruption of the electrical service, for the purpose of testing the meter, shall be equipped with a manual circuit closing device as approved by the serving utility. Automatic circuit closing devices shall not be used on any submeter installation.

**UR.2.4.6. Metered Circuits (Submeter Load Service).** – All electricity used by a tenant shall be taken exclusively from the load service of the tenant's meter. This service and its associated meter shall accurately measure the tenant's load and be capable of being used only at the discretion of the tenant.

**UR.2.4.7. Unmetered Circuits (Submeter Line Service).** – The tenant's electric circuit shall not be taken from the line terminals of the meter, meter socket, or line service. The owner of the submeter system may utilize this service.

**UR.2.4.8. Dedicated Tenant Submeter Service.** – A meter shall serve only the space, lot, building, room, suite, stall, slip, or premise occupied by the tenant.

**UR.2.4.9. Submetered Tenant Premise Identification.** – Tenant premise identification shall be clearly and permanently shown on or at the submeter, and on all separate components of a meter system, including, but not limited to, instrument transformer(s), modem(s), and transmitter(s) if equipped. Remote indications and all printed indications shall be readily identifiable and readily associated with the tenant’s premise. Printed indications shall also include time and date information.

### **UR.3. Use of Device.**

**UR.3.1. Unit Price for Retail EVSE Devices.** – The unit price at which the device is set to compute shall be conspicuously displayed or posted on the face of a retail EVSE device used in direct sale.

**UR.3.2. Return of Indicating and Recording Elements to Zero.** – The primary indicating elements (visual) and the primary recording elements shall be returned to zero immediately before each delivery.

**UR.3.3. Printed Ticket.** – The total price, the total quantity of the delivery, and the price per unit shall be printed on any ticket issued by a device of the computing type and containing any one of these values.

**UR.3.4. Steps After Charging.** – After delivery to a customer from a retail device:

- (a) the device shall be shut-off at the end of a charge, through an automatic interlock that prevents subsequent charging until the indicating elements and recording elements, if the device is equipped and activated to record, have been returned to their zero positions; and
- (b) the vehicle connector shall not be returned to its starting position unless the zero set-back interlock is engaged or becomes engaged by the act of disconnecting from the vehicle or the act of returning the connector to the starting position.

**UR.3.5. Submeter Required.** – When a tenant is not directly served by the serving utility, and charges for electric energy are not included in the fixed periodic rent charges, a dedicated electric watt-hour submeter that measures only the energy used at the discretion of the tenant shall be used.

## **Appendix D. Definitions**

The specific code to which the definition applies is shown in [brackets] at the end of the definition. Definitions for the General Code [1.10] apply to all codes in NIST Handbook 44.

### **A**

**accuracy class, instrument transformers.** – A performance specification for instrument transformers which expresses the maximum deviation from the true value of a measured quantity. (Instrument Transformer Accuracy Class) Example: a 0.2 accuracy class transformer would be more accurate than a 0.3 accuracy class transformer.[3.XX]

**active (real) power.** – The component of electric power that performs work, typically measured in kilowatts (kW) or megawatts (MW). Also known as “real power.” The terms “active” or “real” power are used to modify the base term “power” to differentiate it from reactive and apparent power. The active power ( $P_{ac}$ ) or real power measured by a meter, is the product of voltage (E) times current (I) times the cosine of the angle by which the current lags the voltage ( $\cos \phi$ ) or power factor (pf).  $P_{ac} = (E) (I) (\cos \phi)$  where  $\phi$  is the phase angle of the lag.[3.XX]

**alternating current (AC).** – An electric current that reverses direction in a circuit at regular intervals.[3.XX]

**ampere.** – The practical unit of electric current. It is the quantity of current caused to flow by a potential difference of one volt through a resistance of one ohm. One ampere is equal to the flow of one coulomb of charge per second. One coulomb is the unit of electric charge equal in magnitude to the charge of  $6.24 \times 10^{18}$  electrons.[3.XX]

**apparent power.** – The product of the RMS current (I) and the RMS voltage (E) in a circuit.[3.XX]

**audit trail.** – An electronic count and/or information record of the changes to the values of the calibration or configuration parameters of a device.[1.10, 2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]  
(Added 1993)

## B

**balanced load.** – Balanced load is used to indicate equal currents in all phases and relatively equal voltages between phases and between each phase and neutral (if one exists); with approximately equal watts in each phase of the load.[3.XX]

**basic lightning impulse insulation level (BIL).** – A specific insulation level expressed in kilovolts of the crest value of a standard lightning impulse. (Example: BIL = 10 Kv)[3.XX]

**burden (B).** – The impedance of the circuit connected to the instrument transformer's secondary winding. (Example: B = 21 Ohms Max.)[3.XX]

## C

**calibration parameter.** – Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy (e.g., span adjustments, linearization factors, and coarse zero adjustments).[2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]  
(Added 1993)

**central location.** – A laboratory or meter shop used for the testing of meters to measure in-service accuracy.[3.XX]

**certified meter type.** – A metering device which is tested and certified to meet the certification testing as specified in the ANSI C12 standard for a specific meter type. It shall include any optional circuit boards, devices, or modules enclosed within the meter cover as a part of this certified meter type.[3.XX]

**configuration parameter.** – Any adjustable or selectable parameter for a device feature that can affect the accuracy of a transaction or can significantly increase the potential for fraudulent use of the device and, due to its nature, needs to be updated only during device installation or upon replacement of a component (e.g., division value [increment], sensor range, and units of measurement).[2.20, 2.21, 2.24, 3.30, 3.37, 3.XX, 5.56(a)]  
(Added 1993)

**connection line impedance.** – The impedance of the circuit used to convey energy sold from a fueling device to the storage of an electric vehicle.[3.XX]

**creep.** – A continuous apparent measurement of energy indicated by a meter with operating voltage applied and no power consumed (load terminals open circuited).[3.XX]

**current.** – The rate of the flow of electrical charge past any one point in a circuit. The unit of measurement is amperes or coulombs per second.[3.XX]

## E

**electric vehicle, plug-in.** – A vehicle that employs electrical energy as a primary or secondary mode of propulsion. Plug-in electric vehicles may be all-electric vehicles (EVs) or plug-in hybrid electric vehicles (PHEVs). All-electric

vehicles are powered by an electric motor and battery at all times. All-electric vehicles may also be called battery-electric vehicles (BEVs). Plug-in hybrid electric vehicles employ both an electric motor and an internal combustion engine that consumes either conventional or alternative fuel or a fuel cell. In a parallel type hybrid-electric vehicle, either the electric motor or the engine may propel the vehicle. In a series type hybrid-electric vehicle, the engine or fuel cell generates electricity that is then used by the electric motor to propel the vehicle. EVs, BEVs, and PHEVs are capable of receiving and storing electricity via connection to an external electrical supply. Not all hybrid-electric vehicles are of the plug-in type. Hybrid-electric vehicles that do not have the capability to receive electrical energy from an external supply (HEVs) generate electrical energy onboard with the internal combustion engine, regenerative braking, or both.[3.XX]

**electric vehicle supply equipment (EVSE).** – The conductors, including the ungrounded, grounded, and equipment grounding conductors; the electric vehicle connectors; attachment plugs; and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of measuring, delivering, and computing the price of electrical energy delivered to the electric vehicle.[3.XX]

**electricity sold as vehicle fuel.** – Electrical energy transferred to and/or stored onboard an electric vehicle primarily for the purpose of propulsion.[3.XX]

**electricity meter.** – A device that measures and registers the integral of an electrical quantity with respect to time.[3.XX]

**electronic meter [EM].** – An electric (solid state) watt-hour meter that does not have a rotor.[3.XX]

**element (stator).** – A combination of a voltage-sensing unit and a current-sensing unit, which provides an output proportional to the quantities measured.[3.XX]

**energy.** – The integral of active power with respect to time.[3.XX]

**energy flow.** – The flow of energy between line and load terminals (conductors) of an electricity meter. Flow from the line to the load terminals is considered energy delivered. Energy flowing in the opposite direction (i.e., from the load to line terminals) is considered as energy received.[3.XX]

**equipment, commercial.** – Weights, measures, and weighing and measuring devices, instruments, elements, and systems or portion thereof, used or employed in establishing the measurement or in computing any basic charge or payment for services rendered on the basis of weight or measure. As used in this definition, measurement includes the determination of size, quantity, value, extent, area, composition (limited to meat and poultry), constituent value (for grain), or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award.[1.10, 2.20, 2.21, 2.22, 2.24, 3.30, 3.31, 3.32, 3.33, 3.34, 3.35, 3.38, 3.XX, 4.40, 5.51, 5.56(a), 5.56(b), 5.57, 5.58, 5.59]

(Added 2008)

**equipment level.** – A designation given to different categories of EVSEs that conveys the general speed with which charging will occur.[3.XX]

**event counter.** – A nonresettable counter that increments once each time the mode that permits changes to sealable parameters is entered and one or more changes are made to sealable calibration or configuration parameters of a device.[2.20, 2.21, 3.30, 3.37, 3.39, 3.XX, 5.54, 5.56(a), 5.56(b), 5.57]

(Added 1993)

**event logger.** – A form of audit trail containing a series of records where each record contains the number from the event counter corresponding to the change to a sealable parameter, the identification of the parameter that was changed, the time and date when the parameter was changed, and the new value of the parameter.[2.20, 2.21, 3.30, 3.37, 3.39, 3.XX, 5.54, 5.56(a), 5.56(b), 5.57]

(Added 1993)



## F

**face.** – That portion of a computing-type pump or dispenser which displays the actual computation of price per unit, delivered quantity, and total sale price. In the case of some electronic displays, this may not be an integral part of the pump or dispenser.[3.30, 3.XX]

(Added 1987)

**fixed service.** – Service that continuously provides the nominal power that is possible with the equipment as it is installed.[3.XX]

**form designation (FM).** – [MM] An alphanumeric designation denoting the circuit arrangement for which the meter is applicable, and its specific terminal arrangement. The same designation is applicable to equivalent meters for all manufacturers. (Example: FM 2S)[3.XX]

## H

**hertz (Hz).** – Frequency or cycles per second. One cycle of an alternating current or voltage is one complete set of positive and negative values of the current or voltage.[3.XX]

## I

**instrument transformer.** – A transformer that reproduces in its secondary circuit, in a definite and known proportion, the voltage, or current of its primary circuit, with the phase relation preserved. Sometimes these devices may be referred to as VTs (Voltage Transformers) or CTs (Current Transformers).[3.XX]

**instrument transformer-rated meter.** – A metering system with terminals arranged for connection to the secondary windings of external instrument transformers.[3.XX]

**instrument transformer ratio.** – The stated ratio of the primary circuit current or voltage compared to the secondary circuit current or voltage. (Example: CTR = 200 : 0.1)[3.XX]

## J

**megajoule (MJ).** – An SI unit of energy equal to 1 000 000 joules.[3.XX]

## K

**kilowatt (kW).** – A unit of power equal to 1 000 watts.[3.XX]

**kilowatt-hour (kWh).** – A unit of energy equal to 1 000 watthours.[3.XX]

## L

**line service.** – The service terminals or conductors connecting the meter to the power source.[3.XX]

**load service.** – The service terminals or conductors connecting the meter to the electrical load (e.g., vehicle, tenant, etc.)[3.XX]

**load, full.** – A test condition with rated voltage, current at 100 % of test amps level, and power factor of 1.0.[3.XX]

**load, light.** – A test condition with rated voltage, current at 10 % of test amps level, and power factor of 1.0.[3.XX].

## M

**master meter, electric.** – An electric watthour meter owned, maintained, and used for commercial billing purposes by the serving utility. All the electric energy served to a submetered service system is recorded by the master meter.[3.XX]

**mechanical meter [MM].** – A watthour meter with a rotor.[3.XX]

**meter class designation (CL).** – The manufacturer’s designated maximum amperes a meter can measure continuously without damage or exceeding limits of accuracy. (Example: CL 200)[3.XX]

**meter, electricity.** – An electric watthour meter.[3.XX]

**metrological components.** – Elements or features of a measurement device or system that perform the measurement process or that may affect the final quantity determination or resulting price determinations. This includes accessories that can affect the validity of transactions based upon the measurement process. The measurement process includes determination of quantities; the transmission, processing, storage, or other corrections or adjustments of measurement data or values; and the indication or recording of measurement values or other derived values such as price or worth or charges.[3.XX]

## N

**nominal power.** – Refers to the “intended” or “named” or “stated” as opposed to “actual” rate of transfer of electrical energy (i.e., power).[3.XX]

**nonresettable totalizer.** – An element interfaced with the measuring or weighing element that indicates the cumulative registration of the measured quantity with no means to return to zero.[3.30, 3.37, 3.39, 3.XX]

## O

**ohm.** – The practical unit of electric resistance that allows one ampere of current to flow when the impressed potential is one volt.[3.XX]

## P

**percent registration.** – Percent registration is calculated as follows:

$$\text{Percent Registration} = \frac{\text{Wh measured by METER}}{\text{Wh measured by STANDARD}} \times 100 [3.XX]$$

**percent error.** – Percent Error = Percent Registration – 100. A meter is said to be “slow” that has percent registration below 100 % and negative percent error.[3.XX].

**point-of-sale system.** – An assembly of elements including a weighing or measuring element, an indicating element, and a recording element (and may also be equipped with a “scanner”) used to complete a direct sales transaction.[2.20, 3.30, 3.32, 3.37, 3.39, 3.XX]

(Added 1986) (Amended 1997)

**power factor.** – The ratio of the active power to the apparent power in an AC circuit. The power factor is a number between 0 and 1 that is equal to 1 when the voltage and current are in phase (load is entirely resistive).[3.XX]

**primary watthour constant (PK<sub>h</sub>) [MM].** – The meter watthour constant per revolution or pulse (K<sub>h</sub>) multiplied by the product of the current and/or voltage transformer ratio(s):

$PK_h = K_h$  (Current Transformer Ratio X Voltage Transformer Ratio).[3.XX]

## R

**reactive power.** – For sinusoidal quantities in a two-wire circuit, reactive power is the product of the voltage, the current, and the sine of the phase angle between them, using the current as the reference.[3.XX]

**register ratio (R<sub>r</sub>) [MM].** – The number of revolutions of the gear meshing with the worm or pinion on the rotor shaft per complete rotation of the fastest (most sensitive) wheel or dial pointer.[3.XX]

**remote configuration capability.** – The ability to adjust a weighing or measuring device or change its sealable parameters from or through some other device that is not itself necessary to the operation of the weighing or measuring device or is not a permanent part of that device.[2.20, 2.21, 2.24, 3.30, 3.37, 3.39, 3.XX, 5.56(a)]

(Added 1993)

**retail device.** – A measuring device primarily used to measure product for the purpose of sale to the end user.[3.30, 3.32, 3.37, 3.39, 3.XX]

(Amended 1987 and 2004)

**revolution equivalent.** – The number of watthours represented by one increment (pulse period) of serial data.[3.XX]

**root mean square (RMS).** – The mathematical convention used to describe the average quantity of a property (such as current) that is varying as a sine wave.[3.XX]

## S

**serving utility.** – The utility distribution company that owns the master meter and sells electric energy to the owner of a submeter system.[3.XX]

**side.** – That portion of a pump or dispenser which faces the consumer during the normal delivery of product.[3.30, 3.XX]

(Added 1987)

**starting load.** – The minimum load above which the device will indicate energy flow continuously.[3.XX]

**stator [MM].** – The unit which provides the driving torque in a watthour meter. It contains a voltage coil, one or more current coils, and the necessary steel to provide the required magnetic paths.[3.XX]

**submeter.** – A meter furnished, owned, installed, and maintained by the customer who is served through a utility owned master meter.[3.XX]

## T

**tenant.** – The person or persons served electric energy from a submetered service system.[3.XX]

**test accuracy – in-service.** – The device accuracy determined by a test made during the period that the meter is in service. It may be made on the customer's premises without removing the meter from its mounting, or by removing the meter for testing either on the premises or in a laboratory or meter shop.[3.XX]

**test amperes (TA).** – The full load current (amperage) specified by the device manufacturer for testing and calibration adjustment. (Example: TA 30)[3.XX]

**test block.** – Device that facilitates safe meter testing by disconnecting the meter from the circuit without interrupting the service to the tenant.[3.XX]

**thermal overload protector.** – A circuit breaker or fuse that automatically limits the maximum current in a circuit.[3.XX]

## U

**unit price.** – The price at which the product is being sold and expressed in whole units of measurement.[1.10, 3.30, 3.XX]

(Added 1992)

## V

**variable service.** – Service that may be controlled resulting in periods of reduced, and/or interrupted transfer of electrical energy.[3.XX]

**volt.** – The practical unit of electromotive force. One volt will cause one ampere to flow when impressed across a resistance of one ohm.[3.XX]

**voltage transformer.** – A device that provides a secondary voltage that is a precise fraction of the primary voltage.[3.XX]

## W

**watt.** – The practical unit of electric power. In an alternating-current circuit (AC), the power in watts is volts times amperes multiplied by the circuit power factor.[3.XX]

**watthour (Wh).** – The practical unit of electric energy, which is expended in one hour when the average power consumed during the hour is one watt.[3.XX]

**watthour meter.** – An electricity metering system comprised of components functioning together that measures and registers the integral, with respect to time, of the active or real power of the circuit in which it is connected. This power integral is the energy delivered to the circuit during the interval over which the integration extends. The unit in which this integral is measured is usually the kilowatt-hour.[3.XX].

**watthour meter – field standard.** – A portable meter that is traceable to NIST and is used as a standard meter to test meters in commercial applications. This meter is also known as a portable standard or working standard.[3.XX]

**watthour meter – self-contained.** – A meter in which the terminals are arranged for connection to the circuit being measured without using external instrument transformers.[3.XX]

**watthour meter constant ( $K_h$ ).** – The expression of the relationship between the energy applied to the meter and one rotor revolution, or output indication, expressed as watthours per revolution or, watthours per output indication.[3.XX]

**watthour meter – test constant ( $K_t$ ) [EM].** – The expression of the relationship between the energy applied to the meter system and corresponding occurrence of one test output indication expressed as watthours per test output indication.[3.XX]