NIST Handbook 44 Device Code Requirements for Non-Utility Electricity-Measuring Systems Initial Draft

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The Sub Group (SG) on Electric Watthour Meters of the "NIST U.S. National Work Group on Electric Vehicle Fueling & Submetering" has developed this early draft of a "Non-Utility Electricity-Measuring Systems – Tentative Code." The SG continues work on multiple areas of the code, which are identified with yellow highlighting. The SG is sharing this early draft with the weights and measures community to allow those interested in this work to begin providing comments and suggestions to the SG for possible revisions. These early comments will enable the SG to better refine the code and respond to input prior to submitting the code for formal action and possible adoption.

The SG is submitting this as part of NCWM S&T Agenda Item OTH-16.1 "Electric Watthour Meters Code Under Development" with the intent that the item remain in a "Developing" status until this initial period of review and comment is complete. The SG respectfully asks that the code be posted with other supporting documents on the NCWM S&T Committee's web page. The SG asks that comments be submitted directly to the NIST SG Chairman or Technical Advisor (see OTH-16.1) by March 2022. This timeline will allow the SG an opportunity to address the comments and prepare a final draft by August 2022 for consideration during the 2022-2023 NCWM cycle.

Section 3.XX. Non-Utility Electricity-Measuring Systems – Tentative Code

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 Non-Utility Electricity-Measuring System (NUEMS) are advised to see paragraph G-A.3. Special and Unclassified Equipment.

(Tentative Code Added 20XX)

NUEMS Acronym and Definition: As used throughout this code, a Non-Utility Electricity-Measuring System or "NUEMS" is defined as an electricity measuring system comprised of all the metrologically relevant components required to measure electrical energy, store the result, and report the result used in non-utility sales of electricity wherein the sale is based in whole or in part on one or more measured quantities.

Safety Note: This code does not specifically discuss Safety. It is essential that all personnel working with the devices covered by this code and associated electrical equipment be properly trained and adhere to all applicable safety standards, regulations, and codes. See also General Code Paragraph G-N.1. Conflict of Laws and Regulations.

A. Application

A.1. General. – This code applies to measuring systems used in non-utility sales of electric energy wherein the sale is based in whole or in part on one or more measured quantities.

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

(a) The use of any measuring system owned, maintained, and/or used by a utility.

(b) Measuring systems used solely for delivering electric energy in connection with operations in which the amount delivered does not affect customer charges or compensation.

(c) Electric vehicle fueling systems. (See 3.40. Electric Vehicle Fueling Systems Code)

(d) Transactions not subject to weights and measures authority.

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

A.4. Type Evaluation. – The National Type Evaluation Program (NTEP) will accept for type evaluation only those measuring systems that have received safety certification by a nationally recognized testing laboratory (NRTL) and shall issue an NTEP Certificate of Conformance only to those measuring systems that comply with all requirements of this code.

A.5. NUEMS Type Notation. – Code sections and subsections with an [EN] notation apply to electronic NUEMS only. Code sections and subsections with a [MN] notation apply to mechanical NUEMS only. Code sections and subsections without [EN] or [MN] notation apply to both NUEMS types.

S. Specifications

S.1. Indicating and Recording Elements.

S.1.1. Units. – Units for any indicated or recorded measurements shall be as follows:

- Active Energy: megajoules (MJ) or kilowatt-hours (kWh)

S.1.1.1. Numerical Value of Quantity-Value Divisions. – The value of an increment shall be equal to a decimal multiple or submultiple of 1.

Examples: quantity-value divisions may be 10; or 0.01; or 0.1; etc.

S.1.1.2. Digital Indications. – An indication shall include the display of a number for all places that are displayed to the right of the decimal point and at least one place to the left. Otherwise, leading zeros are not required.

S.1.2. Nominal Capacity. – A device shall have a minimum capacity indication of five digits of resolution. [Nonretroactive as of January 1, 20XX]

S.1.3. [MN] NUEMS Register, Primary Indicating Element. – A register shall have a primary indicating element visible and accessible after installation which clearly indicates the number of kilowatt-hours measured by the NUEMS. The register ratio shall be indicated on the front of the registers that are not an integral part of the NUEMS nameplate. Means shall be provided for the tenant to read the register.

S.1.4. [EN] NUEMS Indications.

S.1.4.1. Primary Indicating Element. – Each NUEMS shall be equipped with a primary indicating element that includes a display visible and accessible after installation.

S.1.4.2. Test Output. – Each NUEMS within a system shall have either an optical pulse output (visible and/or infrared pulse) or an electrical pulse output in the form of a closure (relay or electronic such as an open drain field effect transistor (FET)) which provides a pulse at an interval of K_t Watt-Hours per pulse. The value of K_t shall be such that the NUEMS's accuracy can be tested in 5 minutes or less for any specified test condition.

S.1.4.3. Segments. – A segmented digital indicating element shall have an easily accessible provision for checking that all segments are operational.

S.1.4.4. 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.1.4.5. – Multiple NUEMS**, Single Indicating Element (EM) –** A primary indicating, or combination indicating-recording element coupled to two or more NUEMS shall be provided with a means to easily, clearly, and definitely display information from a selected NUEMS and shall automatically indicate which NUEMS is associated with the currently displayed information.

S.2. Design of Measuring Elements and Measuring Systems.

S.2.1. Metrological Components. – A NUEMS shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy based on the specified installation locations for the NUEMS.

S.2.3. 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 undetected access to metrologically significant mechanisms and parameters is prevented. Specifically, after sealing no adjustment or change may be made to:

(a) any measuring element;

(b) any metrological parameter that affects the metrological integrity of the device or system; and

(c) any wiring connection which affects the measurement.

When applicable, any adjusting mechanism shall be readily accessible for purposes of affixing a security seal. Audit trails shall use the format set forth in Table S.2.3. Categories of Device and Methods of Sealing.

Table S.2.3.
Categories of Device and Methods of Sealing

Categories of Device	Method of Sealing
Category 1: No remote configuration capability.	Seal by physical seal or two event counters: one for calibration parameters and one for configuration parameters.
Category 2: Remote configuration capability, but access is controlled by physical hardware. 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.	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.
Category 3: Remote configuration capability access may be unlimited or controlled through a software switch (e.g., password). The device shall clearly indicate that it is in the remote configuration mode and record such message or shall not accumulate kWh while in this mode.	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. (**Note:** Does not require 1000 changes to be stored for each parameter.)

S.2.6. NUEMS Watthour Registration Retention. - The NUEMS shall retain the total accumulated watthour registration and 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. This also applies to other billable quantities.

S.3. 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.3.1. Location of Marking Information. - The marking information shall appear as follows:

(a) For devices with less than 480V service, either internally or externally (as specified in paragraphs S.3.2. Device Identification and Marking Requirements and S.3.3. External Sensor Identification) provided:

i. the information is permanent and easily read; and accessible for inspection; and

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

The use of a key or tool *(might want to consider whether this could be expanded to include the use of a smart phone or other mechanism to access this information)* to access internal marking information is

permitted for retail electricity-measuring devices. Where possible, clear covers should be used to enable viewing of internally-marked information.

(b) For devices with 480V service, either internally or externally (as specified in paragraphs S.3.2. Device Identification and Marking Requirements and S.3.3. External Sensor Identification) provided:

i. the information is permanent and easily read; and accessible for inspection; and

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

The use of a key or tool *(might want to consider whether this could be expanded to include the use of a smart phone or other mechanism to access this information)* to access internal marking information is permitted for retail electricity-measuring devices. Where possible, clear covers should be used to enable viewing of internally-marked information.

S.3.2. 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.

S.3.2.1. Device Identification and Marking Requirements of Meter with External Sensors - Sensor input connection with intended polarity shall be physically marked on the meter when direction-sensitive.

S.3.2.2. Device Identification and Marking Requirements, Mechanical NUEMS (MN). - The following markings shall be physically marked on a Mechanical NUEMS (MN):

(a) AC voltage range or rating in VAC;

(b) Watthour test constant (K_h) or Watthour test constant (K_t);

(c) Register ratio (R_r or K_r) and multiplier (if greater than one) preceded by "multiply by" or "mult by" or "K_r";

(d) Number of wires (W);

(e) Form designation (FM) (for A-base and socket NUEMS only); and

(f) Current Class (CL) or Sensor Primary Current Rating.

S.3.2.3. Device Identification and Marking Requirements of Meter, (EN). -
In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, Electronic NUEMS (EN) shall have the following legibly, and indelibly marked on the meter as shown in:

- Tables S.3.2.2.a. Device Identification and Marking Requirements of Meter – Electronic NUEMS; and
- Table S.3.2.2.b. Descriptors for Table S.3.2.2.a. Device Identification and Marking Requirements of Meter – Electronic NUEMS.

(a) service type or service configuration.

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Table S.3.2.3a.
Device Identification and Marking Requirements for Electronic NUEMS (EN)

	Physical Marking	Electronic Display*, **	Separate Document (Hard Copy or Electronic)***
Manufacturer name, initials, trademark (1)	**X**		
Model Prefix (2)	**X and/or**	**X and/or**	**X and/or**
Model (3)	**X**		
Serial Number Prefix "S/N" (4)	**X and/or**	**X and/or**	**X and/or**
Serial Number (5)	**X**		
NTEP CC Number with Prefix (6)	**X**		
Either Current Class (CL) or Meter Current Sensor Input (7)	**X**		
Sensor Primary Current Rating (for meters with external sensors) (8)	**X and/or**	**X and/or**	
K_h or K_t	**X and/or**	**X and/or**	
Control Power Voltage Input and/or Sensor Voltage Input (9)	**X**		
Bi-directional (10)	**X and/or**	**X and/or**	**X and/or**
Sensor Ratio	**X and/or**	**X and/or**	
Temperature Range (11)			**X**
Temperature Range if narrower than −20 °C to + 50 °C (- 4 °F to + 122 °F) (12)	**X and/or**	**X and/or**	**X and/or**

*"Electronic Display" includes, but is not limited to, displays of the required marking information through a NUEMS display, a mobile device, or other electronic means as specified by the manufacturer and retrievable through the NUEMS. This may include providing access directly from the meter to a webpage. If the information is provided via a mechanism other than the NUEMS display, the mechanism must be provided by the device owner/operator as specified in UR.2.4.10. Devices for Viewing Marking Information Provided Via an Electronic Display, Electronic NUEMS (EN).

**Instructions on how to view required markings shall be marked on the device or provided in the NTEP CC.

***A "separate document" is either hard copy or electronic copy that does not originate directly from the NUEMS.

General:

- Numbers appearing in parentheses (e.g., (1)) following each marking requirement above correspond to numbered descriptors in Table S.3.2.2.b. Descriptors for Table S.3.2.2.a. Device Identification and Marking Requirements of Meters (EN).
- For requirements and details on application, see Table S.3.2.2.b. Descriptors for Table S.3.2.2.a. Device Identification and Marking Requirements (EN).

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Table S.3.2.3.b.
Descriptors for Table S.3.2.3.a. Device Identification and Markings Requirement of Meters (EN)

1.	**Manufacturer's Identification.** Marked per General Code paragraph G-S.1. Identification.
2.	**Manufacturer's Model Prefix.** For an electronic NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the meter, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated NUEMS is not required to meet General Code paragraph G-S.1. Identification (b)(1).
3.	**Manufacturer's Model Identifier.** Marked per General Code paragraph G-S.1. Identification.

4.	**Serial Number Prefix.** For an electronic NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the meter, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated NUEMS is not required to meet General Code paragraph G-S.1. Identification (c)(1).
5.	**Serial Number.** Also see General Code paragraph G-S.1. Identification.
6.	**NTEP Certificate of Conformance Number and Prefix.** An electronic meter that has been evaluated separately by NTEP and has its own NTEP CC shall be marked per General Code paragraph G-S.1. Identification.
7.	Current Class (CL) or Current Sensor Input
8.	**Sensor Primary Current Rating.** The manufacturer shall supply instructions in customer documentation on how to access the area of the meter where sensor current ratings are programmed.
9.	**Bi-Directional.** Marking via a "Separate Document" is permissible only if instructions for accessing that information is described in an accompanying NTEP Certificate of Conformance.
10.	**Control Power Voltage Input and/or Sensor Voltage Input:** May be marked with "Control Power Voltage Input," "Sensor Voltage Input," or both.
11.	**Temperature Range:** The temperature range over which the device is rated for use must be specified in a separate electronic or hard copy document.
12.	**Temperature Range if Narrower Than − 20 °C to + 50 °C (- 4 °F to + 122 °F):** If the device is rated for use over a range that is narrower than and within − 20 °C to + 50 °C (- 4 °F to + 122 °F), this must be physically and/or electronically marked.

S.3.3. Device Identification and Marking Requirements – External Sensors. – In addition to all the marking requirements of Section 1.10 General Code, paragraph G-S.1. Identification, each external sensor that is non-integral with the meter shall have the following conspicuously, legibly, and indelibly marked on a permanent identification label as shown in Table S.3.3.a. Device Identification and Marking Requirements - External Sensors and in Table S.3.3.b. Descriptors for Table S.3.3.a. Device Identification and Marking Requirements - External Sensors.

Table S.3.3.a.
Device Identification and Marking Requirements - External Sensors

	Physical Marking	**Electronic Display**	**Separate Document** (Hard Copy or Electronic)
Manufacturer name, initials, trademark (1)	**X**		
Model Prefix (2)	**X and/or**	**and/or X**	**and/or X**
Model (3)	**X**		
Serial Number Prefix "S/N" (4)	**X and/or**	**and/or X**	**and/or X**
Serial Number (5)	**X**		
NTEP CC Prefix and Number (6)	**X**		
True Ratio; OR Primary Current Rating AND Secondary Voltage and/or Current Rating (7)	**X**		
Rated Frequency (Hz) (8)	**X**		
Maximum Safety Voltage Rating (9)	**X**		
Polarity (10)	**X**		

Notes:

- Numbers appearing in parentheses (e.g., (1)) following each marking requirement above correspond to numbered descriptors in Table S.3.3.b. Descriptors for Table S.3.3.a. External Sensor Marking Requirements.
- For requirements and details on application, see Table S.3.3.b. Descriptors for Table S.3.3.a. External Sensor Marking Requirements.
- "Electronic" includes, but is not limited to, displays of the required marking information through a NUEMS display, a mobile device, or other electronic means as specified by the manufacturer.

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Table S.3.3.b.
Descriptors for Table S.3.3.a. Device Identification and Marking Requirements - External Sensors

1.	**Manufacturer's Identification.** Marked per General Code paragraph G-S.1. Identification.
2.	**Manufacturer's Model Prefix.** The options to designate the model prefix electronically or in a separate document are only permissible for cases in which an external sensor has its NTEP number clearly identified, conspicuously and indelibly marked on the sensor(s), where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings). Alternative: The General Code paragraph G-S.1. Identification (b)(1) model prefix marking requirement for the sensor(s) may be met with a physical marking. Alternatively, the marking requirement may be satisfied through an electronic display or in a separate document accompanying the NUEMS provided that the NUEMS has its NTEP number clearly identified, conspicuously and indelibly marked on the meter, where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings).
3.	**Manufacturer's Model.** Marked per General Code paragraph G-S.1. Identification.
4.	**Serial Number Prefix.** For a NUEMS having its NTEP number clearly identified, conspicuously and indelibly marked on the sensor(s), where the NTEP certificate contains the complete marking details (including a description of the location and purpose of specific markings), the associated sensor is not required to meet General Code paragraph G-S.1. Identification (c)(1).
5.	**Serial Number.** Also see General Code paragraph G-S.1. Identification.
6.	**NTEP Certificate of Conformance Prefix and Number.** A current sensor that has been evaluated separately by NTEP and has its own NTEP CC shall be marked per General Code paragraph G-S.1. Identification.
7.	**True Ratio.** The True Ratio, in primary amperes or volts to secondary amperes or volts shall be physically marked on a sensor unless both the Primary Current Rating AND the Secondary Voltage and/or Current Rating are physically marked on the device. This is to be expressed as xxxA:yyyA; or xxxA:yyyV; or xxxV:yyyV and a unit-less ratio. The number of digits is the number needed to express the values. Examples of sensor ratio markings include: • 200A:5A • 400A:0.3V • 480V:120V • CT Turns Ratio 4:1 • VT Ratio 4:1 An example of a sensor ratio designation which includes a unit-less ratio: • 480V:120V = 4:1.
8.	**Rated Frequency.** A sensor shall be marked with its rated frequency if other than 40Hz to 400Hz.
9.	**Maximum Safety Voltage Rating.** A sensor shall be marked with a Maximum Safety Voltage Rating.

	Examples of sensor maximum safety voltage ratings: • 250 Vac • 250 VAC • 50 V AC rated transformers may instead be marked "V", "Vdc," or "Vac/Vdc." Note: The voltage safety rating marking may not be higher than the voltage to which the device was verified during type evaluation.
10.	**Polarity Marking.** The sensor shall be marked to indicate proper orientation when the accuracy of the NUEMS is affected by orientation.

S.3.4. Abbreviations and Symbols. – When using abbreviations or symbols on a meter , sensor, or indicator, the following shall be used.

(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 and = [EN] Watthour Test Constant; Revolution or Pulse

(g) Rr = Register Ratio

(h) CSR = Current Sensor Ratio (may also be referred to as "current transformer ratio" or "CTR")

(i) VTR or PTR = Voltage or Potential Transformer Ratio

(j) MULT BY = Multiply By

(k) W = wire (example: 240V 3W)

(l) Y = WYE Power Supply

(m) IEEE = Institute of Electrical and Electronics Engineers

(n) B = Burden

(o) BIL = Basic Lightning Impulse Insulation Factor

(p) Kt = [EN] Watthour Test Constant

(q) AC = Alternating Current (i.e., VAC)

(r) J = Joule

(s) MJ = Megajoule

(t) Wh = Watthour

(u) kWh = Kilowatt-hour

(v) Δ = Delta Power Supply

(w) SD = Soft Data

(x) PD = Printable Data

N. Notes

N.1. NUEMS No-Load Test. – A NUEMS no-load test shall be conducted by applying rated voltage to the NUEMS under test and no current load applied. This test shall be conducted during type evaluation and may be conducted during field testing as deemed necessary. The test duration shall be ten minutes.

N.2. NUEMS Starting Load Test. – A NUEMS starting load test shall be conducted by applying rated voltage at a load of 0.25% of the Current Class (CL) or the Sensor Primary Current Rating at unity power factor. The rated voltage test shall be conducted during type evaluation and may be conducted during field testing as deemed necessary.

N.3. Minimum Test Duration. – Full and light load tests shall require at least a one-minute test and at least one watthour test constant.

N.4. NUEMS Test Loads.

a) [MN] Mechanical self-contained NUEMS shall be balanced-load tested, and may be single-element tested, for NUEMS accuracy at full and light loads.

b) [MN] Sensor systems shall be single-element tested, and may be balanced-load tested, for system accuracy at full and light loads. NUEMS testing shall be accomplished by applying the test load to the sensor(s).

c) [EN] Sensor systems shall be single-element tested, for system accuracy at full and light loads. NUEMS testing shall be accomplished by applying the test load to the sensor(s) with the voltage circuits energized.

d) The reference voltage phases (A, B, or C) at the NUEMS shall be the same phase as the load.

N.5. Test of a NUEMS.

(a) Each NUEMS submitted for test shall have the necessary components required to test such as meter, sensor(s), indicators(s), system software, etc. Testing may be performed in the field.

(b) The test load applied for a full load test shall be 15% of the Current Class (CL) or the Sensor Primary Current Rating.

(c) The test load applied for a light load test shall be conducted at 1.5% to 3% of the Current Class (CL) or the Sensor Primary Current Rating.

(d) The test load applied for a full load test of a NUEMS for a 0.5 power factor lagging setting shall be 15% of the Current Class (CL) or the Sensor Primary Current Rating. This test shall be conducted during type evaluation and may be conducted during in-service (field) or laboratory testing as deemed necessary.

(e) The test load applied for a light load test of a for a 0.5 power factor lagging setting shall be conducted at 3% to 6% of the Current Class (CL) or the Sensor Primary Current Rating. This test shall be conducted during type evaluation and may be conducted during in-service (field) or laboratory testing as deemed necessary.

(f) All tests shall be made at the rated voltage ± 10%.

N.6. Repeatability Tests. – When conducted, tests for repeatability shall include a minimum of three consecutive tests at the same load, similar time period, etc. and be conducted under 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 electric energy measured at any load within the rated measuring range of the device.

(c) Where sensors or other components are used, the provisions of this section shall apply to the entire NUEMS.

T.2. No-Load Test.

T.2.1. [EN] No-Load Test. – For NUEMS with a K_t/K_h output, the NUEMS shall not emit more than one K_t/K_h pulse. For NUEMS without a pulse output, the register indication shall not change by more than 0.05% of the energy at Current Class (CL) or the Sensor Primary Current Rating at unity power factor and rated voltage. Also see Note N.1. NUEMS No-Load Test.

T.2.2. [MN] No-Load Test. – A NUEMS rotor shall rotate no more than one complete revolution. Also see Note N.1. NUEMS No-Load Test.

T.3. NUEMS Starting Load Test.

T.3.1. [EN] NUEMS Starting Load Test. – The watthour test constant (K_t or K_h) output indication or register indication shall continue to advance. The purpose of this section is to verify that the NUEMS accumulates energy at the starting load.

T.3.2. [MN] NUEMS Starting Load Test. – The ~~meter rotor~~ rotating disc? shall rotate continuously.

T.4. Load Test Tolerances.

T.4.1. Tolerances for Mechanical NUEMS. – For mechanical NUEMS, Acceptance Tolerance shall be 1.0 % and Maintenance Tolerance shall be 2.0 % for tests conducted at unity power factor.

T.4.2. Tolerances for All Other NUEMS. – Tolerances for all other NUEMS shall be as shown in Table T.4.2.

Table T.4.2.
Tolerances for All Other NUEMS

	Tests Conducted at Unity Power Factor	**Tests Conducted at 0.5 Lagging Power Factor**
Acceptance Tolerances	1.0%	2.0%
Maintenance Tolerance	2.0%	3.0%

T.5. Repeatability. – When multiple load 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.

UR. User Requirements

UR.1. Selection Requirements.

UR.1.1. Customer Indicating Element, Accessibility. – For systems in which the primary indicating element is not reasonably accessible to the customer, means such as one of the following shall be provided.

a) Console display which is accessible to the customer on which the customer can unambiguously select the NUEMS output associated with this load.
b) Remote display which is provided to customer as a part of the system.
c) At the option of the customer, through an internet application.

UR.1.2. 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 NUEMS that measures only the energy used at the discretion of the tenant shall be used.

UR.1.3. Suitability of Equipment. – A NUEMS shall be suitable for use on its electrical system.

UR.1.3.1. Service Applications. - A NUEMS 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 the wiring and its circuits used to provide power from the service panel to the tenant.

$$Annual\ Max = \sum_{phases} [(Phase\ Voltage * Current\ Class)/1000] * HoursPerYear$$

UR.1.3.2. Maximum Quantity-Value Division. - The maximum quantity-value division shall not exceed the minimum increment to be used in billing.

UR.1.4. Current Sensor. – The current sensor output shall be correctly matched to the meter current input.

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 maximum continuous ratings of the NUEMS. 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 National Electrical Code®, as amended and adopted by the Local Authority having Jurisdiction, the installation shall be in accordance with the National Electric Code.

The installer of any new NUEMS service shall obtain all necessary permits and shall conform to all applicable regulations.

UR.2.4. NUEMS Installation Requirements.

UR.2.4.1. Certification. – It is the responsibility of the owner of a NUEMS to obtain written certification for each device from the appropriate regulatory agency.

The required certification shall meet the requirements of that agency and should identify the address, space, or number, of the premise served by the NUEMS connection; be signed by an agency representative; and shall clearly state the:

- installation is on a tariff schedule that qualifies for NUEMS use,
- billing format, rates, and charges conform to all applicable tariff rules,
- date of such determination, and
- designee's name and title if performed by a designee, and

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

UR.2.4.2. NUEMS Test Features. – All NUEMS shall be provided with test features to facilitate common tests methods used in the electrical submetering industry.

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

UR.2.4.4. Test Switches. – NUEMS installations that are equipped with current transformers with a current output shall have a shorting mechanism such as a test switch installed to allow the meter to be removed for safe testing without the risk of dangerous voltages that can result from open circuit CTs.

UR.2.4.5. Circuit Closing Devices. – All self-contained NUEMS installations that cannot accept a short interruption of the electrical service, for the purpose of testing the NUEMS, 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 NUEMS installation.

UR.2.4.6. Metered Circuits (Submeter Load Service). – For NUEMS with separate line and load service connections, all electricity used by a tenant shall be taken exclusively from the load service of the tenant's NUEMS. This service and its associated NUEMS shall accurately measure the tenant's load and be capable of being used only at the discretion of the tenant.

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

UR.2.4.9. NUEMS Tenant Premise Identification. – Tenant premise identification shall be clearly and permanently shown on or at the NUEMS, and on all separate components of a NUEMS, including, but not limited to, current sensor(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. For field configured systems the information shall be after actual configuration is established.

UR.2.4.10. Devices for Viewing Marking Information Provided Via an Electronic Display, Electronic NUEMS (EN). – When required markings are provided via an electronic display other than the NUEMS display, the owner/operator of the NUEMS is responsible for providing the inspector with a mechanism for viewing this information on the site at the time of inspection. See also Table S.3.2.3.a. Device Identification and Marking Requirements for Electronic NUEMS (EN).

UR.2.X – External Sensors shall be installed in such a manner that they are within close enough proximity to the pulse output, that the use of a communication device such as a radio between two or more persons is not required in order to test the NUEMS.

UR.3. Use of Device.

UR.3.1. Recorded Representations. – A record, either printed or electronic, providing the following information on electrical energy usage shall be available at the end of the billable interval:

(a) the total quantity of the energy delivered with unit of measure;
(b) the total computed price of the energy sale;
(c) the unit price of the energy.

For systems capable of applying multiple unit prices for energy during the billable interval, the following additional information is required:

(1) A schedule of the rate time periods and the unit price applied for each
(2) the total quantity of energy delivered during each;
(3) the total purchase price for the quantity of energy delivered during each rate time period.

Appendix D. Definitions

The following definitions are proposed for addition to NIST Handbook 44 Appendix D, Definitions at the time when the status of this Tentative Code is changed from "tentative" to "permanent." Until such time that the status of the code is designated as "permanent," these proposed definitions will remain in this section of the Tentative Code.

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 Handbook 44.

A

active energy. – The integral of active power with respect to time. Typically measured in units of megajoules (MJ), kilowatt-hours (kWh), or watt-hours.

$$E(T) = \int_0^T v(t) \cdot i(t) \cdot dt \qquad \textit{Eq. 1}$$

Where T is much greater than the period of the AC line frequency.

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 x 10^{18} electrons. [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)

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)

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]

current class (CL). – The manufacturer's designated maximum rated current a meter and current sensor can measure continuously without damage and without exceeding limits of accuracy. (Example: CL 200)
Alternative:
The manufacturer's designated maximum rated current a NUEMS can measure continuously without damage and without exceeding limits of accuracy. (Example: CL 200) [3.XX]

current sensor. - A device able to measure and output analog or digital representations of one or more currents. Examples of current sensors are current transformers, low-voltage current transducers, and Rogowski coils. (National Electrical Manufacturers Association – Used with Permission). *(Must seek permission from NEMA to use this definition.)*

E

electronic NUEMS **[EN].** – An electric (solid state) watthour NUEMS that does not have a mechanical rotating disc. [3.XX]

element. – A combination of a voltage-sensing unit and a current-sensing unit, which provides an output proportional to the quantities measured. Meters can include multiple elements based on service type. For mechanical meters, this is also referred to as a "stator." (National Electrical Manufacturers Association – Used with Permission). *(Must seek permission from NEMA to use this definition.)* [3.XX]

energy flow. – The flow of energy between line and load terminals (conductors) of a NUEMS. 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)

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

form designation (FM). – [MN] An alphanumeric designation denoting the circuit arrangement for which the NUEMS is applicable and its specific terminal arrangement. The same designation is applicable to equivalent NUEMS 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]

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 (NUEMS) to the power source. [3.XX]

load service. – The service terminals or conductors connecting the (NUEMS) 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. – A (NUEMS) 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 NUEMS **[MN].** – A watthour NUEMS with a mechanical rotating disc. [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

non-utility electricity measuring system (NUEMS). – An electricity measuring system comprised of all the metrologically relevant components required to measure electrical energy, store the result, and report the result used in non-utility sales of electricity wherein the sale is based in whole or in part on one or more measured.

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 error. – Percent error is calculated as follows:

percent error = (NUEMS reading – standard reading)/standard reading x 100

[3.XX]

power factor (PF). – The ratio of "active power" to "apparent power" in an AC circuit. It describes the efficient use of available power. [3.XX]

primary indicating or recording elements. – The term "primary" is applied to those principal indicating (visual) elements and recording elements that are designed to, or may, be used by the operator in the normal commercial use of a device. The term "primary" is applied to any element or elements that may be the determining factor in arriving at the sale representation when the device is used commercially. (Examples of primary elements are the visual indicators for meters or scales not equipped with ticket printers or other recording elements and both the visual indicators and the ticket printers or other recording elements for meters or scales so equipped.) The term "primary" is not applied to such auxiliary elements as, for example, the totalizing register or predetermined-stop mechanism on a meter or the means for producing a running record of successive weighing operations, these elements being supplementary to those that are the determining factors in sales representations of individual deliveries or weights. (See "indicating element" and "recording element.") [1.10, 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_r) [MN]. – 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)

S

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

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

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

submeter. – A meter or meter system downstream of the electric master meter. [3.XX]

T

tenant. – The person or persons served electric energy from a non-utility electricity-measuring system (NUEMS). [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 NUEMS 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)

utility. – ~~A Regulated Public Utility or Municipal Corporation or Electric Membership Corporation/Cooperative.~~

Alternative Being Considered: An entity not subject to weights and measures authority as defined by state or local law or regulation. [X.XX]

V

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]

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]

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 test constant (K_h or K_t). – 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]