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Examination Procedure Outlines (EPOs) for Commercial Weighing and Measuring Devices

EPO No. 30

Retail Electric Vehicle Fueling Systems

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EPO No. 30
NIST Examination Procedure Outline (EPO) for
Retail Electric Vehicle Fueling Systems

1. Scope.

It is recommended that this outline be followed as minimum criteria for examining retail electric vehicle fuel dispensers and consoles. The criteria are based on legal metrology requirements in the 2025 edition of the National Institute of Standards and Technology (NIST) Handbook (HB) 44 *Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices*. Nonretroactive requirements are followed by the applicable date in parentheses. Procedures that apply to corresponding requirements in multiple specific codes with similar paragraph designations are distinguished by that particular code section number followed by the appropriate paragraph designation, those from the Electric Vehicle Fueling Systems (EVFS) Code are preceded by 3.40, whereas those that apply to specific requirements in the Timing Devices Code are preceded by 5.55 and the letter "G" applies to requirements from the General Code which are preceded by 1.10. General Code criteria apply to equipment that is designed to be used for the sale of electrical energy and time related services. Code section 5.55 applies when the EVFS is used in conjunction with other equipment in the EVFS to assess fees for time-based services such as parking in addition to those fees that are associated with the sale of electrical energy in units of the kilowatt-hour.

This EPO applies to vehicle-fuel dispensing systems/devices designed both to measure, register, and to deliver accurately electrical energy as a vehicle fuel and assess fees for that fuel and when applicable assess fees for services related to the fueling operation. The fuel and other related services offered for sale may be provided in either a fixed or variable manner due to the reduced or intermittent rate or level of their delivery. These systems/devices are primarily used to measure product and services to the end user and are therefore categorized as a "retail" system/device.

The design of the vehicle fuel-dispensing system for electrical energy will depend on a number of marketing factors, to include but not limited to features such as self-service (e.g., kiosk), remote payment centers/cashiers, the capability to offer for sale fuel products and related services at more than one price based on factors such as speed of delivery or power level for portions or the entire charging session to include the equipment that authorizes and/or ends a transaction through a variety of payment methods.

A retail electric vehicle fueling system is more commonly referred to in the marketplace or known as "electric vehicle supply equipment" or by the acronym EVSE. This reference to EVSE is defined and also occurs throughout NIST Handbook code requirements for this vehicle fueling device application and therefore the term will be used throughout EPO 30 to outline the steps in the inspection and test of this equipment for compliance to legal metrology standards. EVSE code requirements apply to all devices, systems, components, and accessories to include but not limited to the connector(s), the apparatuses in use for the purpose of measuring, delivering, displaying, and computing the price in the sale of electrical energy and services related to the delivery of fuel to an electric vehicle (EV).

2. Safety Notes.

When excerpting this EPO for duplication, the NIST EPO Safety Annex (Safety Considerations and Glossary of Safety Key Phrases) should be duplicated and included with this outline.

Safety policies and regulations vary among jurisdictions. It is essential that inspectors and servicepersons be aware of all safety regulations and policies in effect at the inspection site and to practice their employer's safety policies. The safety reminders included in this EPO contain general guidelines useful in alerting inspectors and servicepersons of the importance in taking adequate precautions to avoid personal injury.

These guidelines can only be effective in improving safety when coupled with training in hazard recognition and control.

Prior to beginning any inspection, the inspector should read and be familiar with the NIST EPO Safety Annex - "Safety Considerations and Glossary of Safety Key Phrases." The terms and key phrases in each safety reminder of this outline are found in the glossary of the EPO Safety Annex. The inspector is reminded of the importance of evaluating potential safety hazards prior to an inspection and taking adequate precautions to avoid personal injury or damage to the device. As a minimum, the following safety precautions should be noted and followed during the inspection:

- **Clothing**
- **Electrical Hazards**
- **Emergency Action Plan/Procedures**
- **Eye Protection**
- **Fire Extinguishers**
- **First Aid Kit**
- **Grounding**
- **Ignition Sources**
- **Lifting**
- **Location**
- **Nature of Product**
- **Obstructions**
- **Personal Protection Equipment**
- **Safety Cones/Warning Signs**
- **Traffic**
- **Transportation of Equipment**
- **Weather**
- **Wet/Slick Conditions**

SAFETY REMINDER!!!

- **Check the inspection site carefully for safety hazards and take appropriate precautions.**
- **Learn the nature of hazardous products at, or near, the inspection site.**
- **Know the emergency procedures and location and operation of fire extinguishers and emergency shut offs.**
- **Post safety cones/warning signs and be aware of vehicular and pedestrian traffic patterns.**
- **Use caution when moving in wet, slippery areas.**
- **If leaks, spills, or exposed wiring cause hazardous testing conditions, it is recommended that the testing be discontinued until the unsafe conditions are corrected.**
- **Use personal protective equipment appropriate for the inspection site.**
- **Be sure that a first aid kit is available and that the kit is appropriate for the type of inspection activity.**
- **Use correct connections appropriate for interface with the device under test.**

3. Equipment List.

The following criteria should be considered when selecting equipment for the test.

3.1. Test Standard - Electric Vehicle Charging System Test Standard.

Ensure the field standard is of a capacity and type of voltage that is capable of meeting the parameters of the EVSE under test. NIST HB 44, General Code paragraph G-N.3. Test Methods, the test methods for determining compliance to NIST HB 44 Sections 1.10 and 3.40, and, where applicable, Section 5.55 outlined in this document do not preclude the use of additional or other methods and apparatus approved by the Director as outlined in Appendix A. Fundamental Considerations Section 3. Testing Apparatus paragraph 3.2. Tolerances for Standards. The tolerances for the combined error and uncertainty of any standard used for testing must be less than one-third the applicable device tolerance. Measurements from the test standards must be metrologically traceable to the International System of Units (SI) through NIST or other National Measurement Institute signatory of International Committee of Weights and Measures (CIPM) Mutual Recognition Arrangement (MRA) for accuracy. A Type 2 Transfer Standard (as defined in NIST HB 44 Appendix A-Fundamental Considerations, Section 3 and Appendix D-Definitions) is not recommended for use in testing EVSEs.

3.2. Test Standard - Field Standard Stopwatch or Interval Timer.

The test standard used in the verification of the EVSE commercial time measuring element shall conform to NIST HB 105-5 *Specifications and Tolerances for Field Standard Stopwatches* or other suitable designated standards. NIST HB 105-5 is available on the NIST Office of Weights and Measures (OWM) website at: **www.nist.gov/pml/owm/nist-handbooks**. In accordance with NIST HB 44, Fundamental Considerations Section 3 paragraph 3.2, the combined error and uncertainty of any standard used for testing must be less than one-third the applicable device tolerance.

A timing device shall be tested with a timepiece with an error of not greater than plus or minus 15 seconds per 24-hour period. In the test of timing devices with a nominal capacity of 1 hour or less, stopwatches with a minimum division of not greater than 0.2 second shall be used. In the test of timing

devices with a nominal capacity of more than one hour, the value of the minimum division on the timepiece shall be not greater than 1.0 second. Time pieces and stopwatches shall be calibrated with standard time signals as described in NIST Special Publication 432 *NIST Time and Frequency Services*, or any superseding publication.

3.3. Optional Equipment.

A method to activate the EVSE to initiate a transaction. This may be an application associated with the device, a card used for payment (e.g., credit card, cash value card, debit card, etc.), or a remote mechanism such as a Radio Frequency Identification Device (RFID) or another wireless interface technology.

SAFETY REMINDER!!!

- **Assess the overall safety condition of the EVSE.**
- **Report loose, exposed, frayed, or worn EVSE charge cables and damaged or worn connectors to the designated local responsible party.**
- **Avoid tests while standing on wet surfaces or in environments that expose the EVSE to damp or wet conditions.**
- **Ensure unobstructed access to the EVSE for the field examination process.**
- **Identify the EVSE's power capacity, voltage, type of current, amperage, and system's power transfer method, and verify compatibility with the test standard.**
- **For EVSEs equipped with an integral timing device, verify the timing test standard is appropriate.**
- **Identify the method of generating a transaction receipt onsite is accessible and determine it provides for safe access to the transaction receipt.**
- **Verify that the method of activating the EVSE is available for conduct of the test.**
- **Do not leave an activated dispenser unattended!**
- **Ground the test equipment.**

4. Definitions.

4.1. Control Pilot (CP) Signal.

An electrical signal that is sourced by the EVSE. Control Pilot is the primary control conductor and is connected to the equipment ground through control circuitry on the vehicle and performs the following functions:

a. Verifies that the vehicle is present and connected
b. Permits energization/de-energization of the supply
c. Transmits supply equipment current rating to the vehicle
d. Monitors the presence of the equipment ground
e. Establishes vehicle ventilation requirements

[Source for this definition: SAE J1772-2024: Electric Vehicle and Plug In Hybrid Electric Vehicle Conductive Charge Coupler 3.8 Control Pilot]

4.2. interference test.

A test intended to determine the operation of the measuring and indicating elements of an EVSE designed to assess time fees associated with the fees for the delivery of electrical energy to an EV automatically, accurately, clearly, and separately provide all required transaction information for the sale as set forth in NIST Handbook 44 Sections 3.40 and 5.55.

4.3. maximum current deliverable (MCD).

The maximum current that the EVSE can deliver as installed under optimum conditions. [NIST Handbook 44]

4.4. maximum deliverable amperage (MDA).

The maximum current available from the EVSE at the time of the test as determined by the Control Pilot Pulse Width Modulation signal or via digital communication between the EVSE and EV or test equipment. [NIST Handbook 44]

4.5. Proximity Pilot (PP) Signal.

An electrical signal used in the communication between the EVSE and EV to confirm the presence and proper connection prior to delivery of electrical energy.

5. Inspection.

NOTE: Code references used throughout the document are drawn from NIST HB 44 General Code (Section 1.10), Electric Vehicle Fueling Systems Code (Section 3.40), and Timing Devices Code (Section 5.55). The relevant code section(s) is cited by its numerical designation and the applicable requirement(s) from that code section is identified by letter-number designation only. The code section and paragraph designation(s) are then shown immediately after the corresponding line item or task listed in the procedure. For example, NIST HB 44 General Code (Section 1.10) is designated as "1.10:" followed by the paragraph designation(s) relevant to the line item.

5.1. Accessibility and Assistance in Inspecting, Testing, and Sealing.

Code Reference: 1.10: G-UR.2.3., G-UR.4.4.

Device must be readily accessible for purposes of testing. Assistance shall be provided by the firm if needed.

5.2. General Considerations.

5.2.1. Selection and Suitability.

Code Reference: 1.10: G-S.3., G-S.5.4., G-UR.1.1., G-UR.1.2., 3.40: S.3.1., S.3.4.

System materials; design elements (to include computing capability, the details of its indicating and recording elements, and value of its smallest unit and unit prices); and construction must be suitable for the service and environment in which it is used. These elements must also ensure accuracy is maintained, parts function as intended, appropriate data storage and retrieval, and adjustments are reasonably permanent under conditions of normal use.

5.2.2. Installation.

Code Reference: 1.10: G-S.2., G-UR.2.1., G-UR.2.2., 3.40: S.4.2., UR.2.1., UR.2.2., UR.2.3., UR.2.4.

The system and any associated equipment ensure the assembly, installation, and construction do not facilitate fraud.

A system shall be installed according to manufacturer's instruction and when installed in a fixed location its operation and performance will not be adversely affected by the foundation, supports, or any other details of the installation or exceeding the rated maximum electrical energy capacity or load.

A system is installed so that there is no obstruction between the primary indicating or recording element and the measuring element.

A system is installed so that any reversal of energy flow does not result in errors exceeding tolerance.

5.2.3. Position of Equipment.

Code Reference: 1.10: G-UR.3.3.

A device or system equipped with a primary indicating element and used in direct sales shall be positioned so that its indications may be accurately read and the measuring operation may be observed from some reasonable "customer" and "operator" position. The positioning shall be determined on a case-by-case basis, considering the individual circumstances including the size and character of the indicating element.

5.2.4. Use and Maintenance.

Code Reference: 1.10: G-UR.3.1., G-UR.4.1., G-UR.4.2., 3.40: UR.3.5.

The system and any associated equipment are to be operated and maintained as intended by the manufacturer.

Unstable indications or other abnormal equipment performance observed during operation shall be corrected and, if necessary, brought to the attention of the firm.

5.2.5. Computing Capability.

Code Reference: 3.40: S.1.1., UR.1.1.

5.3. Indicating and Recording Elements.

5.3.1. Design.

Code Reference: 1.10: G-S.5.1., G-S.5.2.2., 3.40: S.1.2., S.1.2.1., S.2.4.4., 5.55: S.3.

Indicating and recording elements must be clear, definite, and easily read. All digital values of like value in a system must agree. The design shall be such that indications are clear and there is no interference between time measurements (when applicable) and electrical energy measurement. Multiple EVSEs may use a single indicating element that clearly and definitely displays information for each individual EVSE.

5.3.2. Units.

5.3.2.1. Units – EVSEs.

Code Reference: 3.40: S.1.3.1., S.1.3.2.

For AC systems, the value of the smallest units shall not exceed 0.0001 kWh.

For DC systems, the value of the smallest units shall not exceed 0.001 kWh.

5.3.2.2. Units – Integral Time-Based Systems.

Code Reference: 5.55: S.1.1.2., S.1.1.3.

Integral time-based indications (where applicable).

5.3.3. Readability.

Code Reference: 1.10: G-S.5., G-S.6. (1/1/77), G-S.7., 3.40: S.1.3.3., UR.3.4., 5.55: S.2.

Indicating and recording elements, operational controls must be adequately defined, clear, definite, and easily read.

5.3.4. Values of Intervals.

Code Reference: 1.10: G-S.5.3., G-S.5.3.1., 3.40: S.1.3.3.

Values of the graduated intervals must be uniform throughout the series of indicating elements or if equipped recording elements.

5.3.5. Indication of delivery.

Code Reference: 3.40: S.1.1., S.2.7. (S.2.7. becomes retroactive 1/1/28 for DC Systems placed into service before 1/1/25)

5.3.6. In-Service Indicator Light (if applicable).

Code Reference: 5.55: S.1.1.5.

When so equipped, an in-service indicator light shall be operative only during the operation of the integral time feature of the EVSE.

5.3.7. Money-Value Divisions.

Code Reference: 3.40: S.2.5.2.

All money value divisions indicated on the primary and auxiliary indicating elements shall be identical.

5.3.8. Unit Price and Product Identity.

Code Reference: 3.40: S.2.4.1., S.2.4.3., UR.1.1., UR.3.1., 5.55: UR.1.

Electrical energy or associated time-based services offered for sale at more than one unit price through an EVSE shall be displayed and selectable prior to delivery.

Pricing shall not change during a transaction, except when the conditions for variable pricing are approved by the customer prior to the sale.

5.3.9. Multiple Unit Price Dispensers.

Code Reference: 1.10: G-S.5.3.1., 3.40: S.1.1., , S.2.4.3., UR.3.1., 5.55: UR.1.

A device capable of charging multiple unit prices over a single transaction and/or for time-based services shall indicate the specified transaction information and appropriately identify the unit prices which are selectable by the customer.

Statement of rates in units of time (where applicable) for the service is clear and prominently displayed.

5.3.10. Advancement and Return to Zero.

Code Reference: 3.40: S.2.1., S.2.2., UR.3.2., UR.3.5., 5.55: S.1.1.4.

Indicating and recording elements readily return to zero and it is not possible to return beyond the correct zero position. Zeroing operation not possible during delivery.

Timing element advances only during operation of the device.

5.3.11. Display of Zero.

Code Reference: 1.10: G-S.5.2.2.(d) (1/1/86), 3.40: S.1.3.3.

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.

5.3.12. Values Defined.

Code Reference: 1.10: G-S.5.2.3., 3.40: S.1.3.3.

Indicated values shall be adequately defined by a sufficient number of figures, words, symbols, or combinations thereof.

5.3.13. Recorded Representations.

5.3.13.1. General.

Code Reference: 1.10: G-S.5.6., 3.40: S.2.6., UR.3.3., 5.55: S.1.4.1.

5.4. Provision for Sealing.

Code Reference: 1.10: G-S.8. (1/1/90), 3.40: S.3.3., Table S.3.3., 5.55: S.4.

Adequate provision shall be made for an approved means of security (e.g., data change audit trail) or for physically applying a security seal in such a manner that requires the security seal to be broken before an adjustment or interchange can be made of:

- any measuring or indicating element;
- any adjustable element for controlling voltage and current when such controls tend to affect the accuracy of deliveries;
- any adjustment mechanism that corrects or compensates for energy loss between the system and vehicle connection; and
- any metrological parameter that will affect the metrological integrity of the EVSE.

5.4.1. Physical Means of Security.

For devices designed with a physical means of security, check for:

5.4.1.1. Accessibility of the Adjusting Mechanism.

Code Reference: 3.40: S.3.3., 5.55: S.4.

When applicable, the adjusting mechanism shall be readily accessible for purposes of affixing a security seal.

5.4.1.2. Presence of Security Seals.

Code Reference: 1.10: G-UR.4.5., 3.40: S.3.3., 5.55: S.4.

Check for the presence of security seals on the device. A security seal shall be affixed to any adjustment mechanism designed to be sealed. Document missing seals on the official report and apply new seals as needed.

5.4.2. Audit Trails.

5.4.2.1. Audit Trails - Format.

Code Reference: 1.10: G-S.8. (1/1/90), 3.40: S.3.3., Table S.3.3.

For devices using an audit trail(s) as a means of security, the audit trail(s) shall use the format set forth in Table S.3.3. Categories of Devices and Methods of Sealing.

5.4.2.2. Audit Trail Information.

Code Reference: 1.10: G-S.8. (1/1/90), 3.40: S.3.3., Table S.3.3.

If the system is equipped with an audit trail, note the event counter settings on the report form for future reference. If equipped with an event logger, print a copy of the event log and attach it to the report form for future reference. Note that on some systems an electronic copy of the event log may also be available. Examine these records for any signs of misuse of adjustments.

5.4.2.3. Event Logger.

Code Reference: 3.40: S.3.3., Table S.3.3.

If security is provided using an event logger, the event logger shall include an event counter (000 to 999), the parameter ID, the date and time of the change, and the new value of the parameter.

The event logger information shall be available at the time of inspection either as a printed copy or in electronic format. The information may be printed by the device, printed by another on-site device, or transmitted electronically.

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.)

5.4.3. Adjustments Using Removable Digital Storage Devices.

Code Reference: 1.10: G-S.8.2., 3.40: S.3.3., Table S.3.3., 5.55: S.4.

For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device*, such as a secure digital (SD) card, USB flash drive, etc., security shall be provided for those parameters using either:

a. an event logger in the device; or
b. a physical seal that must be broken in order to remove the digital storage device from the device (or system).

* This applies only to removable digital storage devices that must remain in the device or system for it to be operational.

5.4.4. Multiple Elements that Share a Common Provision for Sealing.

Code Reference: 1.10: G-S.8.1. (1/1/10)

For multiple measuring elements with a single provision for sealing, a change to the adjustment of any measuring element must be individually identified.

5.4.5. Metrologically Significant Software Updates.

Code Reference: 1.10: G-S.9.

A metrologically-significant software change is a sealable event.

5.4.6. Automatic Timeout, Pay-At-EVSE.

Code Reference: 3.40: S.2.8. (1/1/20)

After authorization, the device must de-authorize in two minutes if not activated. If the time limit to deauthorize the device is programmable, it shall not accept an entry greater than two minutes.

5.5. Marking.

5.5.1. General Markings:

Code Reference: 1.10: G-S.1.

5.5.1.1. Identification – General.

Code Reference: 1.10: G-S.1.

- Name or ID of manufacturer.
  Code Reference: 1.10: G-S.1.(a)
- Model designation.
  Code Reference: 1.10: G-S.1.(b)
- Model designation identifier and abbreviations.
  Code Reference: 1.10: G-S.1.(b)(1) (1/1/03)
- Nonrepetitive serial number.
  Code Reference: 1.10: G-S.1.(c) (1/1/68)
- Serial number identifier and abbreviations.
  Code Reference: 1.10: G S.1.(c)(1) (1/1/86), G-S.1.(c)(2)(1/1/01)

5.5.1.2. Identification – Software Version Markings.

- Software version or software revision identifier for:
  Code Reference: 1.10: G-S.1.(d) (portions Nonretroactive)

  As of 2004 the current software version or revision identifier for not-built-for-purpose software-based devices.
  Code Reference: 1.10: G-S.1.(d) (1/1/04)

  As of 2022 the current software version or revision identifier for all software-based devices.
  Code Reference: 1.10: G-S.1.(d) (1/1/22)

- Preface identifying it as such.
  Code Reference: 1.10: G-S.1.(d)(1)i. (1/1/07)

- Continuous display or accessible via the display instructions.
  Code Reference: 1.10: G-S.1.(d)(1)ii. (1/1/22)

- Abbreviations for “version.”
  Code Reference: 1.10: G-S.1.(d)(2) (1/1/07)

5.5.1.3. Other Markings.

- National Type Evaluation Program (NTEP) Certificate of Conformance (CC) Number.
  Code Reference: 1.10: G-S.1.(e) (1/1/03)

- NTEP CC Number identifier.
  Code Reference: 1.10: G-S.1.(e)(1) (1/1/03)

- Remanufactured as of 1/1/02.
  Code Reference: 1.10: G-S.1.2.

- Name and ID of remanufacturer or distributor.
  Code Reference: 1.10: G-S.1.2.(a)
- Model number if different from original number.
  Code Reference: 1.10: G-S.1.2.(b)

5.5.1.4. Device-Specific EVSE Additional Identification and Marking Information.
Code Reference: 3.40: S.5.2.

- Voltage rating.
  Code Reference: 3.40: S.5.2.(a)
- Maximum current deliverable (MCD).
  Code Reference: 3.40: S.5.2.(b)
- Type(s) of current.
  Code Reference: 3.40: S.5.2.(c)
- Minimum measured quantity (MMQ).
  Code Reference: 3.40: S.5.2.(d)
- Temperature limits, if narrower than – 40 °F to 185 °F.
  Code Reference: 3.40: S.5.2.(e)
- Accuracy Class 5* for DC systems placed into service prior to 2025.
  Code Reference: 3:40: S.5.2.1.

  Where the information is visible to a person accessing a device or system charging port.

  When the information is provided via the indicating element, the information shall be visible prior to the start of the transaction.

  *All DC EVSEs placed in service prior to 2025 are exempt until January 1, 2028 from the provisions of the corresponding tolerances of T.2.2.(a) EVSE Accuracy Test Tolerances for DC Systems which apply to Class 5 EVSEs. For those Class 5 DC Systems the tolerances of T.2.2.(a) expire January 1, 2034, then the tolerances of T.2.2.(b) will apply. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

5.5.2. Location of Marking Information, Not-Built-For Purpose, Software-Based Devices.
Code Reference: 1.10: G-S.1.1. (1/1/04)

5.5.3. Visibility of Required Markings After Installation.
Code Reference: 1.10: G-UR.2.1.1.

5.5.4. Location of Marking Information, Retail EVSE.
Code Reference: 3.40: S.5.1.

5.5.5. Responsibility, Money-Operated Devices, Unattended EVSE.
Code Reference: 1.10: G-UR.3.4., 3.40: UR.2.5.

5.5.6. Limitation on Use.
Code Reference: 3.40: S.5.2., UR.2.1., UR.2.3.

5.5.7. Equipment Capacity.
Code Reference: 3.40: S.2.4.2.

5.6. Measuring Elements.

5.6.1. Security Seals.

5.6.1.1. General.
Code Reference: 1.10: G-S.8. (1/1/90), G S.9., 3.40: S.3.3., Table S.3.3., 5.55: S.4.

Security seal required on adjusting mechanism.
Code Reference: 1.10: G-UR.4.5., 3.40: S.3.3., 5.55: S.4.

Check for the presence of security seals on the device. A security seal shall be affixed to any adjustment mechanism designed to be sealed. Document missing seals on the official report and apply new ones as needed.

5.7. Connection Cord.
Length and Protection.
Code Reference: 3.40: UR.1.2.

5.8. Facilitation of Fraud.
Facilitation of Fraud, General.
Code Reference: 1.10: G-S.2.

5.9. Totalizers for EVSE Systems.
Code Reference: 3.40: S.7.

6. Pretest Determinations.

NOTE: Code references used throughout the document are drawn from NIST HB 44 General Code (Section 1.10), Electric Vehicle Fueling Systems Code (Section 3.40), and Timing Devices Code (Section 5.55). The relevant code section(s) is cited by its numerical designation and the applicable requirement(s) from that code section is identified by letter-number designation only. The code section and paragraph designation(s) are then shown immediately after the corresponding line item or task listed in the procedure. For example, NIST HB 44 General Code (Section 1.10) is designated as "1.10:" followed by the paragraph designation(s) relevant to the line item.

6.1. Test Methods.
Code Reference: 1.10: G-N.3., Appendix A, Section 3. Testing Apparatus.
This EPO does not preclude the use of test methods and test standard apparatus that have been approved by the Director as described in NIST HB 44, Appendix A, Section 3. Testing Apparatus. If other test standards, apparatus, or equipment is used, corresponding adjustments to the test procedures described in this EPO may be needed to reflect the use of that test standard or other equipment.

6.2. Overview of the EVSE and EV Communications that Facilitate a Charging Session.

Not unlike other vehicle fueling systems the EVSE includes control mechanisms which communicate and regulate the rate of electrical energy delivery to the EV. EPO 30 includes the following general overview of the communications covered in two SAE standards that address the interfaces, function, and performance of the EVSE and EV during the transfer of electrical energy from the supply equipment to the vehicle. This overview does not prescribe any one method of communication and will be updated to include the latest version of information as technology and standards evolve to address the functioning of communications for use in the authentication, authorization, and regulation of the fuel delivery operation.

Safe and reliable EV charging requires two-way communication between the EV and the EVSE. In North America, several connector standards (i.e., SAE J1772 *Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler* and SAE J3400 *North American Charging System (NACS) for Electric Vehicles*) and associated communication protocols enable this necessary communication. These standards provide physical specifications, electrical specifications, and communication protocols for connectors utilized on EVSE in North America. The J1772 plug (same name as the standard that defines it) provides for Level 1 and Level 2 AC charging. The J1772 standard also provides for higher power DC fast charging through the Combined Charging System Combo 1 connector (CCS1). SAE J3400 offers a single connector (also known as the North American Charging Standard (NACS) connector) that can enable both Level 2 AC charging and DC fast charging in the same connector. All of these connectors incorporate physical pins that carry the CP and PP bi-directional digital communication signals.

The PP informs the EV's on-board charger (OBC) that the plug is present in addition to inhibiting vehicle motion while connected to the charging station. The CP signaling determines AC/DC mode, charging status, maximum current available, and other more advanced features (e.g., Plug and Charge, V2G).

In the marketplace you may observe dispenser markings and advertised information on the Charging Level (i.e., Level 1, Level 2) for EVSEs in connection with the voltage rating of the system and time it necessary to charge an EV. Although charging levels were acknowledged and discussed by the developers of the NIST HB 44 Section 3.40 EVFS Code, the developers agreed that an EVSE must only provide the dispenser's fuel rating information as required in 16 CFR 309 – *FTC Labeling Requirements for Alternative Fuels and Alternative Fueled Vehicles* and specified in paragraph S.2.4.2. Equipment Capacity and Type of Voltage.

6.3. Pretest Determination Notes.

Before testing the EVSE, verify the following.

1) The system is safe, legal, and suitable with respect to the installation for commercial use.
2) The jurisdiction permits the sale of electrical energy as a vehicle fuel.
3) If charges are also assessed for time related services, verify these additional fees are:
   (1) associated with an EV charging session;
   (2) calculated based on a recognized unit of time; and
   (3) separate from fees assessed for the sale of electricity that is based on a recognized unit of electrical energy.
4) If specific tariff rules apply, they are:
   - properly interpreted,
   - itemized in printed and/or electronically recorded representations and/or posted,
   - accurately calculated, and

- where applicable, coordinated with other agencies that overlap in their authority over parking or other services directly connected with fueling the vehicle with emphasis on those addressed in HB 44.

6.4. Tolerances.

6.4.1. Acceptance/Maintenance Tolerances.
Code Reference: 1.10: G-T.1., G-T.2.

6.4.2. Application.
Code Reference: 1.10: G-T.3., 3.40: T.1., T.4., 5.55: T.1.

6.4.3. Basic Values.
Code Reference: 3.40: T.2., 5.55: T.1.3., Table T.1.3.

Code Reference: 1.10: G-A.3., 3.40: T.2.1., T.2.2. (becomes retroactive 1/1/28 for DC Systems placed into service before 1/1/25). All DC EVSEs placed into service prior to January 1, 2025 are exempt from T.2.2. EVSE Accuracy Test Tolerances for DC Systems (3.40) until January 1, 2028. For those Class 5 DC Systems the tolerances of T.2.2.(a) expire January 1, 2034, then the tolerances of T.2.2.(b) will apply. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

6.4.4. Repeatability.
Code Reference: 1.10: G-S.5.4., 3.40: N.4., T.3.

6.4.5. Digital Indications and Representations.
Code Reference: 5.55: T.2.

To the tolerances that would otherwise be applied add an amount one-half the minimum value that can be indicated or recorded.

6.5. Statement of Rates.
Code Reference: 5.55: UR.1., UR.1.(a)

Where time fees are assessed in association with the electrical energy charging session, the pricing for time rates are clearly, prominently, and conspicuously displayed. The price shall be in terms of money per unit or units of time for the service dispensed.

6.6. Test Load.
Code Reference: 1.10: G-A.3., 3.40: N.2., N.3.1., N.3.3.

Identify the test site conditions under which testing will be conducted on an EVSE.

When conducting any tests on an EVSE, verify that the test standard(s) are appropriate for the EVSE under test based on the EVSE's power capacity, voltage, type of current, amperage, and system's power transfer method, and whether the system includes an integral timing device. Determine that the prescribed load can be met when an EV is used as the test load for a DC system. As a minimum, a "light load test," "midrange load test," and a "full load test" shall be conducted on an AC EVSE. As a minimum, a "light load test," and a second test at a point between the "midrange load" up to but not exceeding a "full load" shall be conducted on a DC EVSE. All DC EVSEs placed into service prior to January 1, 2025 are exempt from the tests as specified in N.3.3. Performance Verification in the Field of a DC EVSE (3.40) until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

6.7. Test Draft Size Electrical Energy Test.

Code Reference: 1.10: G-A.3., 3.40: N.1., N.3.1., N.3.3.

The MMQ marked by the manufacturer determines the size of the minimum test draft.

"Light Load" tests shall be conducted at a quantity as close as practical, but never at a quantity of electrical energy less than the MMQ declared by the manufacturer.

Midrange Load tests, Full Load tests, and tests at other points shall be conducted at a quantity of at least the MMQ declared by the manufacturer.

All DC EVSEs placed into service prior to January 1, 2025 are exempt from the provisions of N.3.3. Performance Verification in the Field of a DC EVSE until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

6.8. Duration of the Test.

Determine the duration of the test time for a test load and interference time tests which is representative of the time lapsed during typical charging sessions for that business type or based on the posted rates.

6.8.1. Electrical Energy Equation for Use to Establish the Duration of the EVSE Electrical Energy Test.

The time will vary to complete the delivery of the required minimum test draft and the steps necessary to verify and document the indicated and recorded transaction information over the specified operating range of an EVSE. Using the basic electrical formulas related to Ohm's Law [I = V/R] shown below, the official/servicepersons can calculate the approximate time for the delivery of the required minimum quantity of electrical energy for each test point specified in the Notes paragraphs in Code Section 3.40 for the accuracy compliance testing of an EVSE.

Electrical energy rating information for an EVSE (as required by 3.40: S.5.2. to be identified and marked on the EVSE) must be determined to make these calculations. In this example the system's ratings information representative for an AC system is listed below and is used to demonstrate the approximate time required to complete a single full load test of the system. The equations and commercial equipment information necessary for the calculations are as follows:

- Voltage Rating:
  $V_{EVSE\ RATING}$ is 240 VAC (volts alternating current)
- MCD:
  $A_{EVSE\ MCD}$ is 30 A

In this example, it is determined that during the test, the MDA achieved is also 30 A.

Note that the MCD and MDA are both associated with the level of current flow through the system but can represent different values due to multiple factors affecting the EVSE. Each term is also defined in Section 4. Definitions of this EPO. In accordance with HB 44 3.40 paragraph N.3.1. (c) the full load test of an AC system in this example shall be performed at a point between 70 % up to 100 % of the MDA. Therefore, the MDA that must be achieved for the full load test of the AC system shall be at minimum 21 A up to but not exceeding 30 A. This is the permissible range for performing the full load test for this MDA.

- MMQ:
  MMQ_{EVSE} is 0.5 kWh

Equations can be used to determine information that can be used in preparation for testing prescribed in HB 44 3.40 paragraph N.3.1. Testing of an AC EVSE. This information includes use of basic electrical formulas related to Ohm's Law [I = V/R] as shown in the formulas below:

Ohm's Law I = V/R

Where: I is current expressed in Amps (A);

V is voltage expressed in Volts (V); and

R is resistance expressed in Ohms (R)

Power Formula P = V x I

Where: P is power expressed in Watts (W);

V is voltage expressed in Volts (V); and

I is current expressed in Amps (A)

The duration of the test is determined using the EVSE energy information communicated or signaled to the test standard where those values are necessary for use in calculations as shown below in the following equations. Should a test point at 100 % of the MDA not be achievable recall there is a range of current levels that are permissible for performing the full load test on an AC system. If it is determined the "full load" test will be performed at 85 % of the MDA, this would meet the criteria specified in Code Section 3.40 paragraph N.3.1.(c) for a test point between 70 % and 100 % of the EVSE MDA. A test at 85% of the 30 A MDA results in (0.85 x 30 A = 25.5 A), a full load test performed at a test point of 25.5 A.

Once the EVSE's current level for the test point (i.e., 25.5 A) is established that value is inserted into the Power Formula to determine the power (kilowatts) level during the performance of the test. To solve the Power Formula to determine the power value (P) make the following calculations using the current value (i.e., 25.5 A). Solve the equation for the unknown power value P, using the Power Formula, P = V x I, where V is the voltage rating and I is the current level for the "full load" test as determined above:

$$P = (240\ \text{V})(25.5\ \text{A}) = 6120\ W \qquad Equation\ 1$$

To convert the power value (P) from watts (W) to kilowatts (kW), the unit prescribed for measurement of electrical energy sold as vehicle fuel, multiply P by the conversion factor 1 kW/1000 W:

$$6120\ \text{W}\ x\ \left(\frac{1\ \text{kW}}{1000\ \text{W}}\right) = 6.12\ \text{kW} \qquad Equation\ 2$$

A delivery of a quantity of electrical energy equivalent to the EVSE's declared MMQ is required for the "full load" test. The test draft size must at minimum equal the MMQ or the draft size could be a larger delivery quantity which exceeds the MMQ. Using the information calculated above, the duration or length of time for the full load test is determined using the equation:

$$\text{Duration of the Test} = {}^{\text{Test Draft Size}_{\text{kWh}}}/_{\text{Power}} \qquad Equation\ 3$$

Solve the "Duration of the Test" equation by dividing the delivered quantity of electrical energy that is the test draft size (in this example the EVSE's MMQ) by the calculated Power (P) value as shown below:

$$Duration\ of\ the\ Test = {}^{0.5\ \text{kWh}}/_{6.12\ \text{kW}}$$

$$Duration\ of\ the\ Test = 0.0816993\ h$$

$$Duration\ of\ the\ Test = 0.0816993\ h\ x\ {}^{60.0\ \text{min}}/_{1.0\ \text{h}}$$

$$Duration\ of\ the\ Test = 4.901958\ \text{min}$$

The duration of the "full load" test for the AC system, in this example, will take approximately 4.901958 minutes or approximately 4 minutes and 54 seconds.

SAFETY REMINDER!!!

- **Wear appropriate personal protection equipment such, nonskid safety shoes (to prevent possible injury from spills or slipping on slick surfaces), protective clothing, and eye protection to prevent injury from projected objects.**
- **Do not leave an activated dispenser unattended!**
- **Ensure the test standard and associated equipment is properly grounded.**

7. Test Notes.

NOTE: Code references used throughout the document are drawn from NIST Handbook 44 (HB 44) General Code (Section 1.10), Electric Vehicle Fueling Systems Code (Section 3.40), and Timing Devices Code (Section 5.55). The relevant code section(s) is cited by its numerical designation and the applicable requirement(s) from that code section is identified by letter-number designation only. The code section and paragraph designation(s) are then shown immediately after the corresponding line item or task listed in the procedure. For example, NIST Handbook 44 (HB 44) General Code (Section 1.10) is designated as "1.10:" followed by the paragraph designation(s) relevant to the line item.

7.1. Totalizers.

Code Reference: 3.40: S.7.

To determine proper operation of totalizers, read and record the totalizer indications before and after all test drafts. The system shall include this design feature for the quantity delivered for each device and this information shall be readily available on site or through on-site internet access.

7.2. Steps in the Test of an EVSE.

This EPO does not preclude the use of test methods and test standard apparatus that have been approved by the Director as described in NIST HB 44, Appendix A, Section 3. Testing Apparatus. If other test standards, apparatus, or equipment is used, they must be suitable for commercial applications and corresponding adjustments to the test procedures described in this EPO may be needed to reflect the use of that test standard or other equipment. It is acknowledged that the steps prescribed in EPO 30 Test Sections 8.1.4. through 8.1.6. may be automated by the test apparatus; however, the standard's operation shall ensure that the official test remains suitable for use in evaluating an EVSE for compliance to NIST Handbook 44 performance requirements. Any mention of the operation of an apparatus within this NIST EPO does not imply these are the sole test procedures recommended or endorsed by NIST.

7.2.1. EVSE and Test Standard Connection Process.

a. Select the appropriate setup for the test standard; type of current and power transfer method and voltage based on the EVSE's fuel rating.

b. After connecting to the EVSE coupler, test procedures will be initiated using the test standard's user interface.

Code Reference: 3.40: N.2.

c. Utilize the authorization/activation method that has been identified to initiate the EV charging transaction session.

d. Determine the MDA from the digital communication message communicated from the EVSE to the test standard.

Code Reference: 3.40: N.3.1., N.3.3.

e. Automatic Timeout - Pay-At-EVSE.

Once the device has been authorized, it must de-authorize within 2 minutes if the device has not been activated. To verify this operation, first authorize the EVSE. Next, without dispensing electrical energy or, where applicable, time being assessed in association with the charging session, wait 2 minutes and then attempt to dispense product. The system must not dispense electricity nor assess time fees.

Code Reference: 3.40: S.2.8. (1/1/20)

f. Verify that the EVSE is displaying the correct quantity and total price for at least 15 seconds:

i. When the EVSE is activated and,

ii. At the start of the transaction

Code Reference: 3.40: S.1.2.

g. Determine proper operation of totalizers, read and record the totalizer indications before and after all test drafts.

Code Reference: 3.40: S.7.

7.2.2. After Each Test Draft Delivery:

a. Print a ticket if the device is so equipped and verify required information is provided on the receipt.

Verify that appropriate abbreviations are used for indicated and recorded representation of units.

Required recorded representations include itemized timing charges when time services are assessed separately from charges for electrical energy as specified in Section 3.40. Electric Vehicle Fueling Systems paragraph S.2.6. EVSE Recorded Representations.

Code Reference: 1.10: G-S.5.6., G-S.5.6.1., 3.40: S.2.6., UR.3.3., 5.55: S.1.4.1.

b. Verify that any options for obtaining a recorded representation are appropriate. The customer may be given the option of not receiving the recorded representation.

Code Reference: 1.10: G-S.5.6.

c. If the system is equipped with the capability, the customer may also be given the option of receiving the recorded representation electronically in lieu of or in addition to a hard copy.

Code Reference: 1.10: G-S.5.6., 3.40: S.2.6.

d. Verify that required information is printed on the receipt for each transaction.

Code Reference: 3.40: S.6., S.6.1.

e. For EVSE that assess fees for time services separate from fees for the sale of electrical energy (by the kWh), duplicate receipts are permissible, provided the word "duplicate" or "copy" is included on the receipt.

Code Reference: 5.55: S.1.4.1.1.

f. Check price computations on all indicators (including consoles) and on recorded representations for mathematical agreement with its associated quantity representation or indication to the nearest 1 cent of money value.

Code Reference: 1.10: G-S.5.5., 3.40: S.2.5., S.2.5.1.

g. Check for agreement of quantity, unit price, and total price values between indicated and recorded representations.

Code Reference: 1.10: G-S.5.2.2., 3.40: S.2.4.4., S.2.5.2.

h. Verify, after a delivery is completed, that the quantity and total price are displayed for at least 15 seconds.

Code Reference: 3.40: S.1.2.

7.3. Automatic Timeout, Pay-At-EVSE Retail Devices.

Code Reference: 3.40: S.2.8. (1/1/20)

For Pay-At-EVSE retail devices, once the EVSE has been authorized, it must de-authorize within two minutes if the EVSE has not been activated.
To verify this operation

- First authorize the dispenser.
- Next, without dispensing product, wait two minutes and then attempt to dispense product.
- The system must not dispense product.

If the time limit to deauthorize the device is programmable, it shall not accept an entry greater than two minutes.

7.4. Confirm Results.

Code Reference: 1.10: G-S.5.4., 3.40: N.3., N.4., T.3.

If the result of any test is at, near, or exceeds the applicable tolerance limit, repeat that test to confirm the results and to help ensure you did not inadvertently introduce error into the test process. If necessary, conduct a "Repeatability Test" as described under the "Test" section of this EPO.

7.5. Display of Quantity and Total Price After Delivery.

Code Reference: 3.40: S.1.2., S.1.2.1.

Verify that the EVSE is displaying the correct quantity and total price for at least 15 seconds:

1. After a delivery is completed

Electrical energy sold shall be clearly identified and separate from other time-based fees indicated by the EVSE.

A system with a single indicating element for two or more EVSEs shall provide a means to indicate clearly which EVSE is associated with the displayed information.

7.6. Use of Adjustments.

Code Reference: 1.10: G-UR.4.1., G-UR.4.2., G-UR.4.3.

Verify that adjustments are used only to correct for conditions that these elements are designed to control and that adjustments are made to bring performance errors as close to zero value as possible. Verify that equipment is properly maintained and that errors are not predominantly in favor of the device user.

SAFETY REMINDER!!!

- **Use proper lifting techniques when lifting any equipment associated with the test standard and the testing process.**
- **Be aware of and attempt to eliminate potential ignition sources in or near the inspection site.**
- **Be aware of vehicular and pedestrian traffic when moving between the EVSE and test standard.**
- **Do not conduct the test when particulates and other airborne debris are present in the environment that can be drawn into the air intake for the test standard or test load emulator.**
- **Caution should be exercised to avoid contact with the high temperatures of the exhaust elements of the test load emulator.**
- **Operate the test standard only when the ambient temperature is within the temperature range recommended by the test standard manufacturer.**
- **Maintenance of the test standard should be performed as necessary to ensure the equipment's proper operation while in service.**
- **There should be a clear perimeter and no site fixtures, other equipment, or landscaping that obstruct access to the test standard and the EV when used as the test load.**

8. Test.

NOTE: Code references used throughout the document are drawn from NIST HB 44 General Code (Section 1.10), Electric Vehicle Fueling Systems Code (Section 3.40), and Timing Devices Code (Section 5.55). The relevant code section(s) is cited by its numerical designation and the applicable requirement(s) from that code section is identified by letter-number designation only. The code section and paragraph designation(s) are then shown immediately after the corresponding line item or task listed in the procedure. For example, NIST HB 44 General Code (Section 1.10) is designated as "1.10:" followed by the paragraph designation(s) relevant to the line item.

Automation of the test steps in the operation of the test standard shall ensure that the official test remains suitable for use in evaluating an EVSE for compliance to NIST Handbook 44 performance requirements.

8.1. Accuracy Test.

Code Reference: 1.10: G-UR.3., 3.40: S.5.2., UR.2.

For this and subsequent tests, verify that other conditions of use do not exceed marked or manufacturer-specified limitations for operation of the EVSE.

The MDA available from the EVSE at the time of the test is determined via digital communication between the EVSE and EV to the test standard equipment.

8.1.1. At the beginning of the first delivery, start with an initial zero condition.

Code Reference: 3.40: S.1.3.2., S.1.3.3., S.2.1., S.2.7., UR.3.2.

All DC EVSEs placed into service prior to January 1, 2025 are exempt from the provisions of S.2.7. Indication of Delivery (3.40) until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

8.1.2. If the result of the first test is at or near the tolerance limit, repeat this test.

If necessary, conduct a Repeatability Test.

Code Reference: 1.10: G-S.5.4., 3.40: N.2., N.4., T.3.

8.1.3. General and Load Test Notes and Tolerances.

Code Reference: 1.10: G-A.3., 3.40: N.1., N.3., T.1., T.2. T.2.1. T.2.2.

All DC EVSEs placed into service prior to January 1, 2025 are exempt from T.2.2. EVSE Accuracy Test Tolerances for DC Systems until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

8.1.4. Light Load Test.[1]

(1) Connect the EVSE to the test standard.

(2) Verify the EVSE and test standard ae communicating properly.*

(3) Determine the MDA available from the EVSE.*

(4) For AC EVSEs set the test load to a value at a point between 4 A and 10 A.
For DC EVSEs set the test load to a point between 10 % and 20 % of the MDA, but not less than 30 A. All DC EVSEs placed into service prior to January 1, 2025 are exempt from the tests as specified in N.3.3. Performance Verification in the Field of a DC EVSE (3.40) until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

(5) Start energy measurement on the test standard.*

(6) Start a charging transaction on the EVSE.*

(7) The EVSE will cycle through various charging states to achieve an active charging status.*

(8) Continue the measurement for an accumulated energy of not less than the MMQ as declared by the manufacturer.

(9) The EVSE will cycle through various charging states to return an inactive charging status.*

(10) Verify that the transaction on the EVSE has completed.

(11) Record the energy delivered as displayed on the EVSE.

(12) Record the price per kWh.

(13) Record the total price of the transaction.

(14) Record the energy delivered as displayed on the test standard.

[1] The % Energy Error formula was changed in this EPO revision to align with the definition of measurement error in the 3rd edition (2012) of the International Vocabulary of Metrology (VIM). The VIM can be found at **www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf**

(15) *Verify Accuracy of Indications and Recorded Representations.* Verify the resulting energy indications and recorded representations are within applicable tolerances and meet requirements for agreement of indications.

Code Reference: 1.10: G-S.5.2.2., 3.40: S.2.4.4.

(16) Calculate the percent energy measurement error as follows:

$$\%\ \text{Energy Error} = \left(\frac{\text{EVSE Indicated Energy} - \text{Test Standard Indicated Energy}}{\text{Test Standard Indicated Energy}}\right) \times 100$$

(17) Based on the unit price(s) [fixed or variable] per kWh, calculate and record the itemized and total computed price for the transaction.

(18) Calculate the total sales price as follows:

$$(Quantity\ of\ Energy)\left(Energy\ Unit\ Price\ \left({}^{\$}/_{kWh}\right)\right) = Sales\ Price\ \pm {}^{1}/_{2\ cent}$$

(19) Agreement of Indications. Verify the energy sales price indications and recorded representations agree to within the nearest one cent of the mathematically computed money value and those money values agree with one another.

If the result of the first test is at or near the tolerance limit, repeat this test. If necessary, conduct a Repeatability Test.

Code Reference: 1.10: G-S.5.4., G-S.5.5., 3.40: S.2.5.1., N.4., T.3.

****This may require intervention by the official/serviceperson or it may be an automated process initiated by the test standard.***

8.1.5. Midrange Load Test (Only required on AC systems).[1]

(1) Connect the EVSE to the test standard.

(2) Verify the EVSE and test standard are communicating properly.*

(3) Determine the MDA available from the EVSE.*

(4) For AC EVSEs set the test load to a value at a point between 40 % and 60 % of the MDA.

(5) Start energy measurement on the test standard.*

(6) Start a charging transaction on the EVSE.*

(7) The EVSE will cycle through various charging states to achieve an active charging status.*

(8) Continue the measurement for an accumulated energy of not less than the MMQ as declared by the manufacturer.

(9) The EVSE will cycle through various charging states to return an inactive charging status.*

(10) Verify that the transaction on the EVSE has completed.

(11) Record the energy delivered as displayed on the EVSE.

(12) Record the price per kWh.

(13) Record the total price of the transaction.

(14) Record the energy delivered as displayed on the test standard.

(15) Verify *Accuracy of Indications and Recorded Representations.* Verify the resulting energy indications and recorded representations are within applicable tolerances and meet requirements for agreement of indications.

Code Reference: 1.10: G-S.5.2.2., 3.40: S.2.4.4.

(16) Calculate the percent energy measurement error as follows:

$$\%\ \text{Energy Error} = \left(\frac{\text{EVSE Indicated Energy} - \text{Test Standard Indicated Energy}}{\text{Test Standard Indicated Energy}}\right) \times 100$$

(17) Based on the unit price(s) [fixed or variable] per kWh, calculate and record the itemized and total computed price for the transaction.

(18) Calculate the total sales price as follows:

$$(Quantity\ of\ Energy)\left(Energy\ Unit\ Price\ \left({}^{\$}/_{kWh}\right)\right) = Sales\ Price\ \pm {}^{1}/_{2\ cent}$$

(19) Agreement of Indications. Verify the energy sales price indications and recorded representations agree to within the nearest one cent of the mathematically computed money value and those money values agree with one another.
If the result of the first test is at or near the tolerance limit, repeat this test. If necessary, conduct a Repeatability Test.

Code Reference: 1.10: G-S.5.4., G-S.5.5., 3.40: S.2.5.1., N.4., T.3.

****This may require intervention by the official/serviceperson or it may be an automated process initiated by the test standard.***

8.1.6. Full Load Test.[1]

(1) Connect the EVSE to the test standard.

(2) Verify the EVSE and test standard are communicating properly.*

(3) Determine the MDA available from the EVSE.*

(4) For AC EVSEs set the test set load to a value at a point between 70 % and 100 % of the MDA.

For DC EVSEs set the test set load to a value at a point between 25 % and 100 % of the MDA. As a minimum this is the second point where a test shall be conducted on a DC EVSE and these two test points shall not be the same value and there shall be sufficient separation between the values of the two test points. When an EV is used as the test load for a DC system the load presented by the vehicle shall be greater than 40 % of the MDA and no less than 30 A. All DC EVSEs placed into service prior to January 1, 2025 are exempt from the tests as specified in N.3.3. Performance Verification in the Field of a DC EVSE (3.40) until January 1, 2028. Requirements and provisions from the General Code and other device codes apply when equipment does not fall clearly in an established separate code.

(5) Start energy measurement on the test standard.*

(6) Start a charging transaction on the EVSE.*

(7) The EVSE will cycle through various charging states to achieve an active charging status.*

(8) Continue the measurement for an accumulated energy of not less than the MMQ as declared by the manufacturer.

(9) The EVSE will cycle through various charging states to return an inactive charging status.*

(10) Verify that the transaction on the EVSE has completed.

(11) Record the energy delivered as displayed on the EVSE.

(12) Record the price per kWh.

(13) Record the total price of the transaction.

(14) Record the energy delivered as displayed on the test standard.

(15) *Verify Accuracy of Indications and Recorded Representations.* Verify the resulting energy indications and recorded representations are within applicable tolerances and meet requirements for agreement of indications.

Code Reference: 1.10: G-S.5.2.2., 3.40: S.2.4.4.

(16) Calculate the energy measurement error as follows:

$$\%\ \text{Energy Error} = \left(\frac{\text{EVSE Indicated Energy} - \text{Test Standard Indicated Energy}}{\text{Test Standard Indicated Energy}}\right) \times 100$$

(17) Based on the unit price(s) [fixed or variable] per kWh, calculate and record the itemized and total computed price for the transaction.

(18) Calculate the total sales price as follows:

$$(Quantity\ of\ Energy)\left(Energy\ Unit\ Price\ \left(\$/_{kWh}\right)\right) = Sales\ Price\ \pm 1/_{2\ cent}$$

(19) *Agreement of Indications.* Verify the energy sales price indications and recorded representations agree to within the nearest one cent of the mathematically computed money value and those money values agree with one another.

If the result of the first test is at or near the tolerance limit, repeat this test. If necessary, conduct a Repeatability Test.

Code Reference: 1.10: G-S.5.4., G-S.5.5., 3.40: S.2.5.1., N.4., T.3.

****This may require intervention by the official/serviceperson or it may be an automated process initiated by the test standard.***

8.2. Time Test.

Code Reference: 5.55: N.1., N.2., T.1.3., Table T.1.3.

If the EVSE assesses fees for time-based services in addition to those for the sale of electrical energy (by the kWh), conduct a time test representative of a transaction where the EVSE is metering time.

- Establish the time interval for the test based on the rate structure applied by the EVSE.
- Initiate the EVSE in time mode and at the end of the time test interval record the time registration error.
- Determine if the rate calculations displayed and recorded representation (where applicable) are mathematically correct.

If the result of this test is at, near, or exceeds the tolerance limit, repeat the test.

8.3. Interference Test.

Code Reference: 5.55: N.3., T.1.3.

If an EVSE assesses fees for time-based services in addition to those for the sale of electrical energy (by the kWh), conduct an interference test representative of a transaction where both the assessment of fees for the delivery of electrical energy and the time associated with that charging session are both metered through the EVSE.

Indicating and recording elements must be clear, definite, and easily read. The design shall be such that indications are clear and there is no interference between time measurements (when applicable) and electrical energy measurement during the simultaneous or separate registration (due to variable application of these services) of each service over the course of a transaction.

Code Reference: 3.40: S.1.1.(b), S.2.6.(e), UR.3.3.(e), 5.55: S.1.4.1., S.1.4.1.1., S.1.4.2.

For an EVSE with an integral design feature where the device also has the capability to assess fees associated with the delivery of electrical energy to an EV which represent the registration of time that has elapsed simultaneously during the electrical energy charging session and/or immediately after that charging session, there shall be no interference in the registration or continuous indication between the electrical energy and time portion of the transaction.

Code Reference: 5.55: S.3.

Verify the recorded values for both electrical energy and time are properly itemized and appropriately identified.

8.4. Repeatability Test.

Code Reference: 3.40: N.4., T.3.

If necessary, conduct a repeatability test. A repeatability test must include at least three consecutive test loads. Test loads must be conducted under approximately the same conditions (e.g., energy rate and temperature) and be of approximately the same draft size and duration.

8.5. Money-Value Computations and Recorded Representations.

Code Reference: 1.10: G-S.5.5., 3.40: S.2.5.1.

8.5.1. Check money-value computations for a fixed price sales transaction and, when offered, for a selectable variable pricing sales transaction. Check that the computed price is mathematically correct.

Code Reference: 1.10: G-S.5.2.2.

8.5.2. Print a ticket, if the device is so equipped, and check price computations for agreement with the indication display.

Code Reference: 3.40: S.4.4.

8.6. RFI Test.

Code Reference: 1.10: G-N.2., G-UR.1.2., G-UR.3.2., G-UR.4.2.

A system shall meet performance requirements when associated and nonassociated equipment is operated in a customary manner and location. This testing is typically done during the inspection of a new installation. It is conducted subsequently only if a problem is suspected. This would include potential sources of interference such as, but not limited to:

- Radio Frequency Interference (RFI)

8.7. Zero-Set-Back Interlock.

Code Reference: 3.40: S.2.1.

8.7.1. Check the effectiveness of the zero-setback interlock.

Code Reference: 3.40: S.2.2., 5.55: S.5.

8.7.2. On equipment activated with a single remote controller, activate one EVSE and check all others operated by the same controller to make certain they will not operate without activating the individual EVSE starting mechanism.

8.8. Power Loss Test.

Code Reference: 3.40: S.2.3., S.2.3.1, S.2.3.2., S.2.6.

8.8.1. At the time of the power loss, the transaction shall either:

(1) terminate; or

(2) continue without additional authorization after restoration of power if the EVSE is able to determine it is connected to the same vehicle before and after the power outage. In this case, the information needed to complete the transaction in progress at the time of the power loss shall be available at the EVSE, console, internet, or toll-free phone access. There must also be a clear indication on the receipt provided to the customer of the interruption, including:

- the date and time of the interruption;
- other information required by S.2.6. EVSE Recorded Representations.

Code Reference: 3.40: S.2.3.3.

8.8.2. The EVSE memory, or equipment on the network supporting the EVSE, shall retain information on the quantity of fuel dispensed and the sales price totals during power loss.

It is not typically necessary nor is it recommended to repeat this test for every inspection; however, this does not preclude the test from being conducted when deemed necessary by the regulatory authority or serviceperson to ensure continued compliance with this requirement. As a minimum, this test should be conducted on the examination of a system or device that is put into service for the first time to verify proper installation and set-up. It may also be warranted in response to specific complaints where the test would be relevant. NIST recommends that, prior to conducting a test to verify compliance with these requirements, you check with your supervisor to verify your jurisdiction's or organization's policy regarding this test.

Code Reference: 3.40: S.3.4.

9. Post-Test Tasks.

NOTE: Code references used throughout the document are drawn from NIST Handbook 44 (HB 44) General Code (Section 1.10), Electric Vehicle Fueling Systems Code (Section 3.40), and Timing Devices Code (Section 5.55). The relevant code section(s) is cited by its numerical designation and the applicable requirement(s) from that code section is identified by letter-number designation only. The code section and paragraph designation(s) are then shown immediately after the corresponding line item or task listed in the procedure. For example, NIST Handbook 44 (HB 44) General Code (Section 1.10) is designated as "1.10:" followed by the paragraph designation(s) relevant to the line item.

9.1. Security Means.

Code Reference: 1.10: G-S.8. (1/1/90), G S.8.1. (1/1/10), 3.40: S.3.3. Table S.3.3., 5.55: S.4.

9.1.1. Adequate provision shall be made for applying a physical security seal and/ or providing other approved means of security such as a data change audit trail.

Code Reference: 1.10: G-S.8. (1/1/90), 3.40: S.3.3., 5.55: S.4.

9.1.2. For devices and systems in which the configuration or calibration parameters can be changed by use of a removable digital storage device, security shall be provided for those parameters as specified in G-S.8.2. Devices and Systems Adjusted Using Removable Digital Storage Devices.

Code Reference: 1.10: G-S.8.2.

9.1.3. For multiple measuring elements with a single provision for sealing, a change to the adjustment of any measuring element must be individually identified.

Code Reference: 1.10: G-S.8.1. (1/1/10).

9.1.4. A metrologically-significant software change is a sealable event.

Code Reference: 1.10: G-S.9.

9.1.4.1. Audit Trail Information.

Code Reference: 1.10: G-S.8. (1/1/90), 3.40: S.3.3, Table S.3.3., S.3.4.

If the system is equipped with an audit trail, note the event counter settings on the test report form for future reference. If equipped with an event logger, print a copy of the event log and attach it to the report form for future reference. Note that some systems may be equipped to provide an electronic copy of the event counter or the event log in place of or in addition to providing a hard copy of the security information at the time of the inspection. This data shall not be affected or alterable. Examine these records for any signs of misuse of adjustments.

9.1.4.2. Security Seals.

Code Reference: 1.10: G-UR.4.5.

Check for the presence of security seals on the device. A security seal shall be affixed to any adjustment mechanism designed to be sealed. Document missing seals on the official report and apply new ones as needed.

9.2. Record Total Quantity.

Code Reference: 1.10: G-UR.4.1., G-UR.4.2., 3.40: S.7.

Note the final totalizer reading and record the total quantity of electricity dispensed and (where time-based fees are assessed in association with the electrical energy charging session service) the total time during the test on the official test report. Verify totalizers are working correctly.

9.3. Review/Analyze Results.

Code Reference: 1.10: G-UR.4.1., G-UR.4.3.

After all equipment at a location has been tested, review the results to determine compliance with requirements for equipment maintenance and use of adjustments.

9.4. Record Compliance Action and Explain Results.

Record the compliance action and disposition of the device on the report and explain the results to the device owner.

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