ENERGY STAR®
Electric Vehicle Supply Equipment

June 25, 2019

Meeting Details

- Slides and related materials will be available on the EVSE Product Development Web page:
  - www.energystar.gov/RevisedSpecs
  - *Follow link to "Version 1.1 is in Development" under "Electric Vehicle Supply Equipment"*

- Audio provided via teleconference:

  Call in: +1 (877) 423-6338 (U.S.)
  +1 (571) 281-2578 (International)
  Code: **773-366 #**

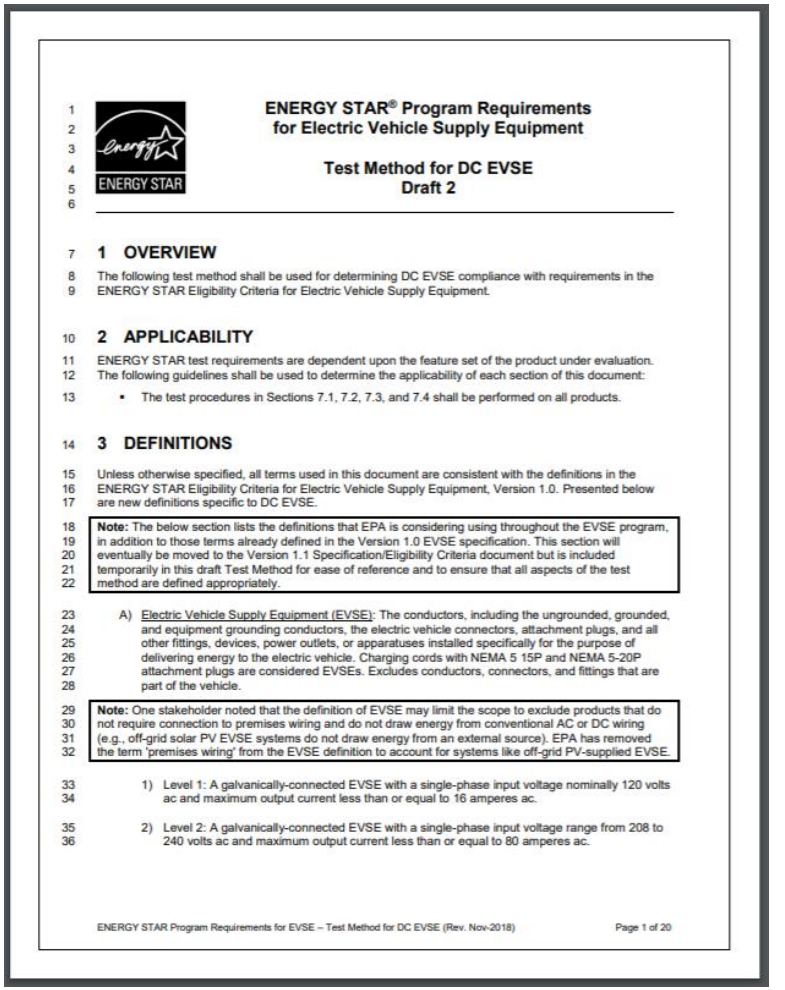
  - Phone lines will remain open during discussion
  - Please mute line unless speaking
  - Press *6 to mute and *6 to un-mute your line

Introductions

Time	Topic
2:00–2:10	**Introductions and Overview of Specification Development Process**
2:10–2:30	Definitions/Scope
2:30–3:00	Test Setup
3:00–3:30	Test Conduct
3:30–3:45	Test Procedures
3:45–4:00	Timeline

Agenda

- Introductions and activities to-date
- Draft 2 Test Method Key Topics
  - Definitions and Scope
  - Test Setup
    - DC-Input Power
    - Temperature Conditions
  - Test Conduct
    - Network Configuration
    - Illuminance Conditions
  - Test Procedures
    - Integral Battery Banks
    - Operation Mode Testing
- Timeline



ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment

Test Method for DC EVSE
Draft 2

1 OVERVIEW

The following test method shall be used for determining DC EVSE compliance with requirements in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

- The test procedures in Sections 7.1, 7.2, 7.3, and 7.4 shall be performed on all products.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment, Version 1.0. Presented below are new definitions specific to DC EVSE.

Note: The below section lists the definitions that EPA is considering using throughout the EVSE program, in addition to those terms already defined in the Version 1.0 EVSE specification. This section will eventually be moved to the Version 1.1 Specification/Eligibility Criteria document but is included temporarily in this draft Test Method for ease of reference and to ensure that all aspects of the test method are defined appropriately.

A) Electric Vehicle Supply Equipment (EVSE): The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy to the electric vehicle. Charging cords with NEMA 5 15P and NEMA 5-20P attachment plugs are considered EVSEs. Excludes conductors, connectors, and fittings that are part of the vehicle.

Note: One stakeholder noted that the definition of EVSE may limit the scope to exclude products that do not require connection to premises wiring and do not draw energy from conventional AC or DC wiring (e.g., off-grid solar PV EVSE systems do not draw energy from an external source). EPA has removed the term 'premises wiring' from the EVSE definition to account for systems like off-grid PV-supplied EVSE.

1) Level 1: A galvanically-connected EVSE with a single-phase input voltage nominally 120 volts ac and maximum output current less than or equal to 16 amperes ac.

2) Level 2: A galvanically-connected EVSE with a single-phase input voltage range from 208 to 240 volts ac and maximum output current less than or equal to 80 amperes ac.

ENERGY STAR Program Requirements for EVSE – Test Method for DC EVSE (Rev. Nov-2018) Page 1 of 20

Introductions

James Kwon
U.S. Environmental Protection Agency

Peter Banwell
U.S. Environmental Protection Agency

Emmy Feldman
ICF

Stacy Noblet
ICF

ENERGY STAR Version 1.0 Specification Today

Scope:

- ✓ AC Level 1
- ✓ AC Level 2
- ✓ AC Dual Input L1/L2

Key Features:

1. Energy Savings, 40% in Standby Modes
2. Safety
3. Open Communications

Communications Details:

- Grid Communications
- Open Access
- Consumer Override


Photo by Dennis Schroeder, NREL 39251

ENERGY STAR Version 1.0 Charging Partners

solaredge

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chargepoint™

eMotorWerks

EVBOX

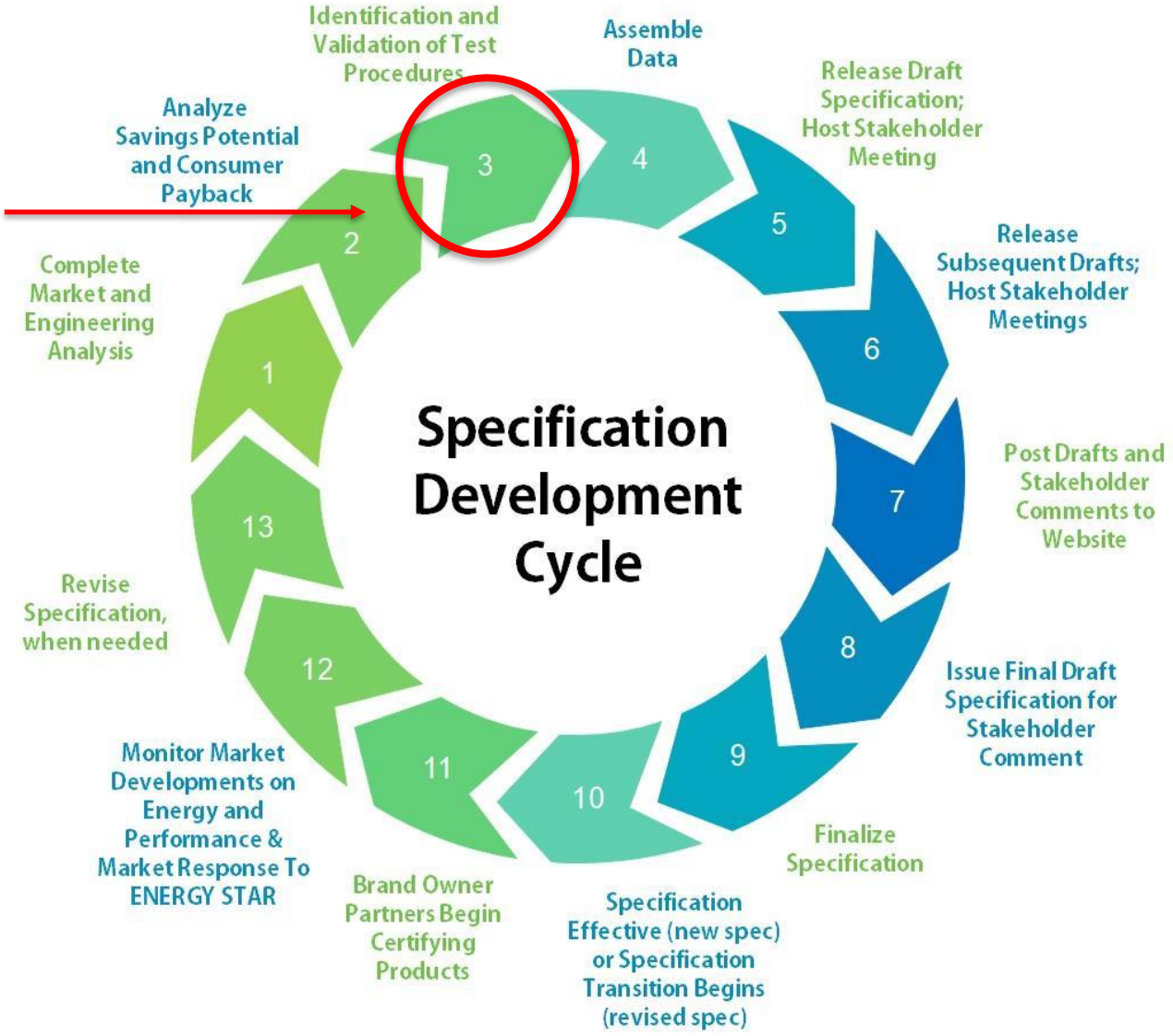
LiquidSky Technologies

SemaConnect

Webasto

ENERGY STAR Version 1.1

We are here



Version 1.1 DC EVSE Test Method Activities To-Date

- **Goal of Version 1.1 is to include DC EVSE in scope**
  - Develop test method to measure energy efficiency
  - Collect data based on test method
  - Draft specification criteria to recognize most efficient products
- **Activities from launch until today:**
  - Released a Discussion Guide in May 2018
  - Released a Draft 1 Test Method in November 2018
  - Held 4 stakeholder webinars to discuss proposals between May and December 2018
  - Released a Draft 2 Test Method June 6, 2019

Photo by Kendall Septon, NREL 45635

ENERGY STAR Version 1.1 Forthcoming Specification

- EPA will begin development of efficiency criteria for DC EVSE in a Version 1.1 Specification after the test method is close to finalization.
- Key topics that will be addressed in the specification:
  - **Criteria to recognize energy efficiency in DC chargers:**
    - ✓ Active charging % efficiency
    - ✓ Standby losses

Topics to be Addressed in Forthcoming Specification

- **Allowances for features**
  - Lighting
  - Networking
  - More?
- **Modular products**: The test method does not specify how to test modular EVSE, the output power of which can be adjusted by adding/removing modules.

  How to select more limited combinations of modules for test that can represent all the combinations can be specified later in the ENERGY STAR eligibility criteria

EPA welcomes stakeholder input on DC EVSE features that require power allowances, and data to demonstrate what those allowances should be. Stakeholder feedback on any additional considerations for testing modular products is also appreciated.

Definitions/Scope

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Definitions

- A stakeholder noted that the previous definition which included the phrase "connected to premises wiring" may exclude products like off-grid solar PV EVSE.

> Electric Vehicle Supply Equipment (EVSE): The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy to the electric vehicle. Charging cords with NEMA 5 15P and NEMA 5-20P attachment plugs are considered EVSEs. Excludes conductors, connectors, and fittings that are part of the vehicle.

EPA edited the definition accordingly.

Scope

EPA is proposing the following scope of what DC EVSE would be included in the Version 1.1.

DC EVSE Output Power	≤ 50 kW	50 kW < Output Power ≤ 350 kW	> 350 kW
Standby Mode Criteria	✓	✓	Out of scope, no criteria
Operation Mode Criteria	✓	Report efficiency, but no criteria	
Network Connection Required	✓	✓	

- The relevant criteria will be determined in the specification development process based on data available and data produced.

Scope

- EPA is proposing new requirements to allow for the testing of DC-input EVSE, such as those intended to be used with solar photovoltaic (PV) systems.
- EPA also proposes to exclude pantograph EVSE from the scope of the Version 1.1 since standard operating parameters for these products are under development.

Source: Charged EVs

Test Setup

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DC-Input EVSE

- A stakeholder noted that off-grid EVSE need to be tested with a DC source and consideration will need to be made on how to simulate the output of a PV panel array.

- EPA received feedback that a predefined DC-input voltage may not represent the overall efficiency because DC-input power can come from a variety of sources.

Source: Wired

DC-Input EVSE

- EPA is proposing new requirements to allow for the testing of DC-input EVSE, such as those intended to be used with solar photovoltaic systems.
- In addition, EPA has provided for the possibility of DC-output EVSE that take both DC and AC-input voltage

DC-input Power: The UUT shall be tested at the nameplate rated voltage.

1) The voltage and frequency used for the test shall be reported.
2) The voltage tolerance shall be as specified in Table 3.
3) Products that require both DC and AC-input power shall be connected to both applicable input power sources, and both types of input power shall be measured and summed.
4) Products that can accommodate either DC or AC-input power shall be tested with AC-input power and again with DC-input power.

Table 3: DC-input Power Tolerances

Voltage Tolerance
+/- 4.0 %

Temperature Conditions

- Based on discussions with manufacturers, EPA does not expect much variation in energy use for standby modes due to ambient temperature.

- One stakeholder noted that if an EVSE is passively cooled, then the impact of ambient temperature will be small, so they recommended testing these products at one temperature.

Source: Sun Prairie Utilities

Temperature Conditions

- EPA is proposing to require testing only in the **temperate** climate condition for:
  - Standby modes for all products
  - EVSE without active cooling/heating

Table 3: Ambient Test Temperature for DC EVSE without Active Cooling or Heating

Type of Climate	Representative Temperature	Applicable Test
Temperate	68° F or 20° C (± 5° F, ± 2.5° C)	No Vehicle Mode, Partial On Mode, Idle Mode, and Operation Mode

Table 4: Ambient Test Temperatures for DC EVSE with Active Cooling or Heating

Type of Climate	Representative Temperature	Applicable Test
Cold	20° F or –7° C (± 5° F, ± 2.5° C)	Operation Mode
Temperate	68° F or 20° C (± 5° F, ± 2.5° C)	No Vehicle Mode, Partial On Mode, Idle Mode, and Operation Mode
Hot	104° F or 40° C (± 5° F, ± 2.5° C)	Operation Mode

EPA would appreciate stakeholder feedback on this proposal.

Communicating Test Load

- A stakeholder noted that communication between the EV and EVSE for CCS will take place on the SAE J1772 control pilot but should include both the J1772 PWM signaling protocol and the IEC/ISO 15118 or DIN 70121 digital communications protocol.

EPA agrees that different protocols may be used for communication between the EV and EVSE. The Draft 2 clarifies that the reference to the SAE J1772 control pilot is just one example of how communication can take place for a CCS connection.

G) Test Load: A DC Test Load shall be used for testing DC-output EVSE. The DC load shall be combined with a Vehicle Emulator Module (VEM) that can communicate via the protocol defined for the connector type intended to ship with the product (e.g., for Combined Charging System, or CCS, the VEM may communicate via SAE J1772 Appendix F and G along with other protocols).

AC-input versus DC-input Measurements

- A stakeholder noted that the following would not be relevant for testing DC-input EVSE:
  - Crest Factor,
  - Frequency Response,
  - Power Factor,
  - Apparent Power, and
  - RMS Measurements

2) Crest Factor (applicable to AC-input only):
   a) An available current crest factor of 3 or more at its rated range value; and
   b) Lower bound on the current range of 10 mA or less.
3) Minimum Frequency Response (applicable to AC-input only): 3.0 kHz

6) Measurements and Calculations:
   a) Cable Length (ft.);
   b) Cable Gauge (AWG);
   c) Average Power (W); and
   d) AC-input EVSE only:
      i. Power Factor (PF) ;
      ii. Apparent Power (S);
      iii. Voltage (RMS);
      iv. Current (RMS);
      v. Frequency (Hz).

EPA has clarified that these requirements apply to AC-input EVSE testing only.

Measurement Accuracy

- A stakeholder suggested that EPA add explanations with the measurement accuracy for all products requirements in Section 5.1 H)1) to describe how inaccuracy would be measured.

EPA has included a reference to ISO/IEC 98-3:2008 Guide to Expression of Uncertainty in Measurement, so laboratories will be able to better estimate sources of uncertainty.

5) Accuracy: +/- 0.1% of reading PLUS +/- 0.1% of full scale

Note: This requirement pertains to the accuracy of the power meter only. For the accuracy of the entire measurement system, see Section 6.1.H). For more information, see ISO/IEC 98-3:2008 Guide to Expression of Uncertainty in Measurement.

Test Conduct

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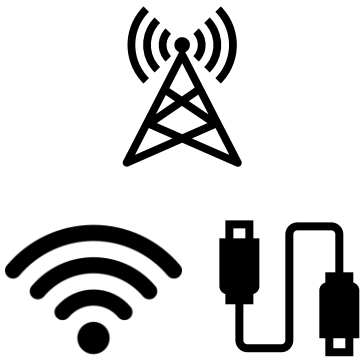
Network Connection Order of Preference

- A stakeholder recommended prioritizing a cellular network connection over Wi-Fi or Ethernet for DC EVSE because they are typically installed in outdoor public locations.



c. If the UUT is equipped with multiple network capabilities, only one connection shall be made in the following order of preference:

i. Cellular modem;

ii. Wi-Fi (Institution of Electrical and Electronics Engineers - IEEE 802.11- 2007[3]);

iii. Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet Defined in Clause 78 of IEEE 802.3 (originally specified in IEEE 802.3az)[4], then it shall be connected to a device that also supports IEEE 802.3az; or

iv. Other.

EPA has edited the list of network connections to prioritize a cellular network connection, as it appears to be the most likely connection for DC EVSE.

As-Shipped Configuration

- A stakeholder suggested a few changes to the requirement that the EVSE be configured as-shipped because they are typically configured in the field.

The Draft 2 requires that manufacturer recommendations be used to configure any DC EVSE that offers customizable settings rather than a default configuration.

A) As-shipped Condition: Unless specified otherwise, the model unit shall be tested in its default configuration as-shipped.

1) If no default settings are available and unless specified otherwise, the tester shall follow manufacturer recommendations regarding UUT set-up, or if no manufacturer recommendations are available, the first available setting.

Illuminance Conditions

Applicable only for products with lighting/display with Automatic Brightness Control (ABC)

EPA has included more specific instructions on how to measure screen luminance for products that can display the three-bar pattern and those that cannot, in order to ensure repeatable results.

1) If the UUT cannot display the three-bar pattern specified in IEC 62087:2011, Section 11.5.5, through an external port or network connection, the UUT shall be tested using the default image that appears as-shipped.
   a) If the UUT can display the three-bar pattern: Measure the luminance in the center white bar of the three-bar pattern. Ensure that the luminance meter measurement area does not overlap any black bar area.
   b) If the UUT cannot display the three-bar pattern and the default as-shipped image is used: Measure luminance in the brightest area of the screen where the measurement area is between 0.4 square inches and 0.6 square inches.

Illuminance Conditions

EPA indicated that testing at the **light and dark** illuminance conditions should only be conducted during standby mode testing.

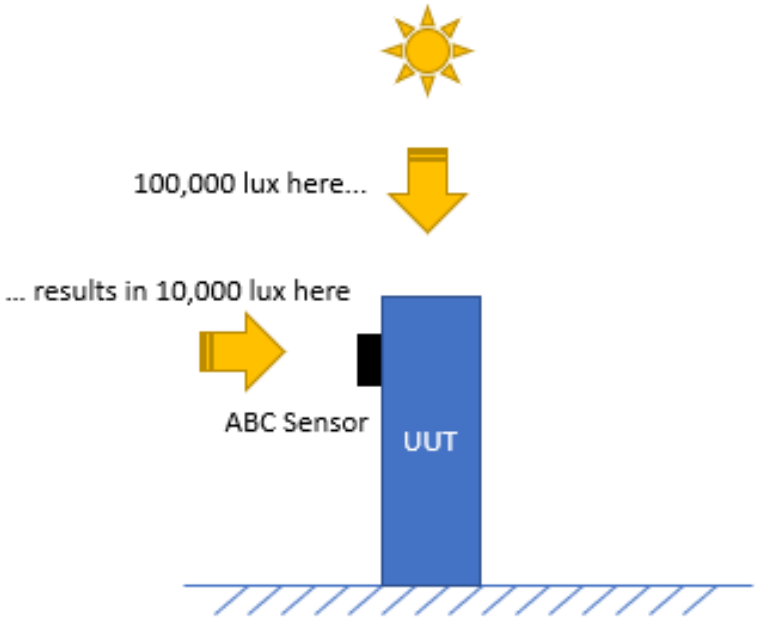
Source: PlugShare

- EPA does not believe that product luminance will have a large impact on power consumption during Operation Mode testing and proposes that products be tested with the ABC sensor disabled in Operation Mode.
- EPA hopes this proposal will reduce testing burden while still encouraging an appropriate implementation of ABC.

EPA would appreciate feedback from stakeholders on the implementation of ABC in the three different standby modes (No Vehicle Mode, Partial On Mode, and Idle Mode).

Illuminance Conditions

- A stakeholder suggested that EPA change the illuminance testing conditions to be brighter since DC EVSE are typically installed outdoors.
- Typical outdoor illuminance conditions in North America are typically 1,000–100,000 lux on a horizontal surface (conditions ranging from overcast to direct sunlight).
- 100,000 lux horizontally, would result in approximately 10,000 lux on a vertical surface, which is how ABC sensors are expected to be mounted.

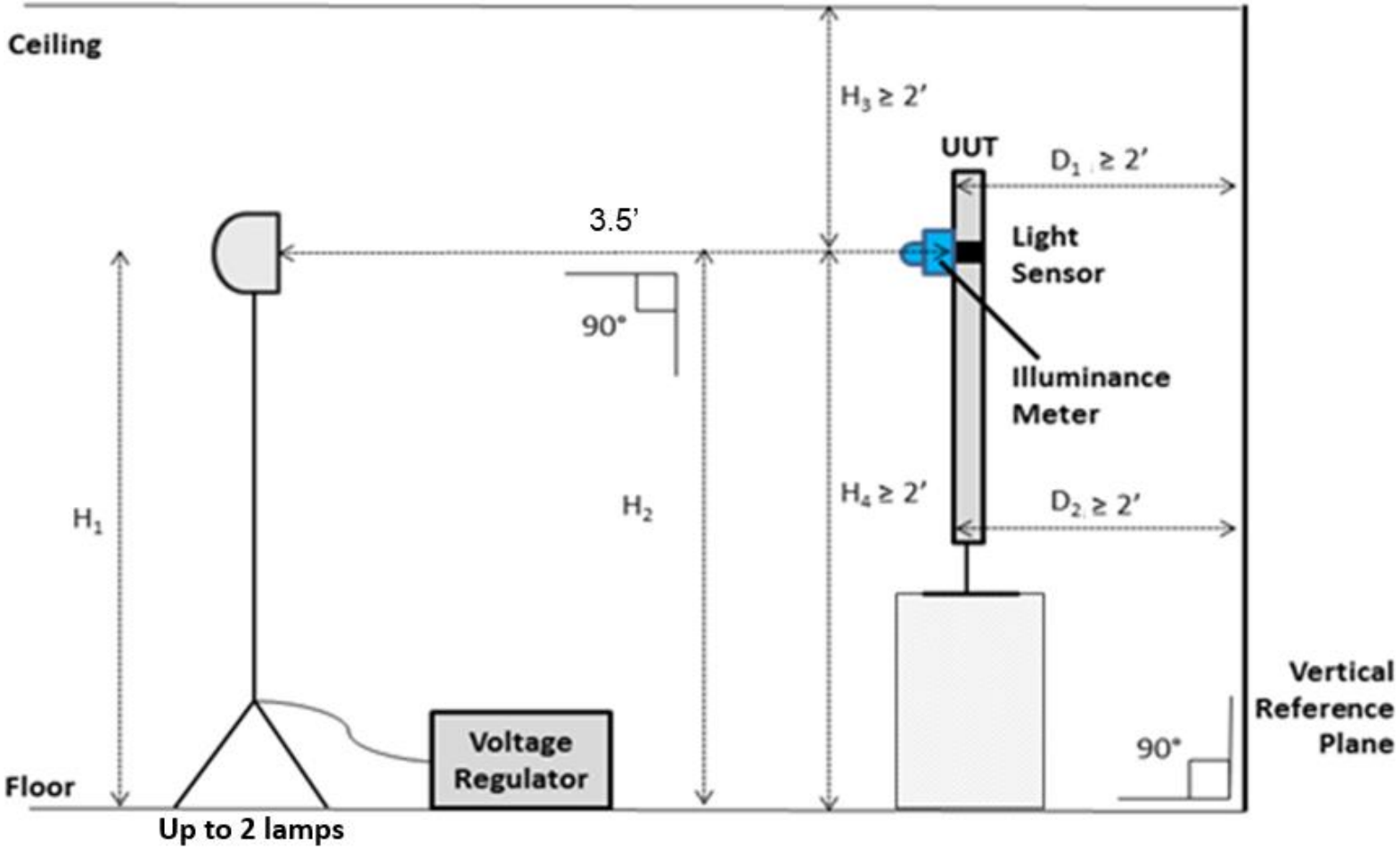


Illuminance Conditions

- EPA is proposing to allow for lamps with varying rated brightness to increase the lamp options available to test labs, as long as up to two aligned next to one another can achieve a brightness of **10,000 lux** ± 400 lux.
  - EPA is permitting the use of up to two lamps to achieve the desired illuminance condition.
  - EPA has found several narrow spot (9-10° beam angle) lamps that are readily available.
- EPA has also proposed to decrease the distance of the UUT (3.5 feet) to increase the illuminance on the ABC sensor.

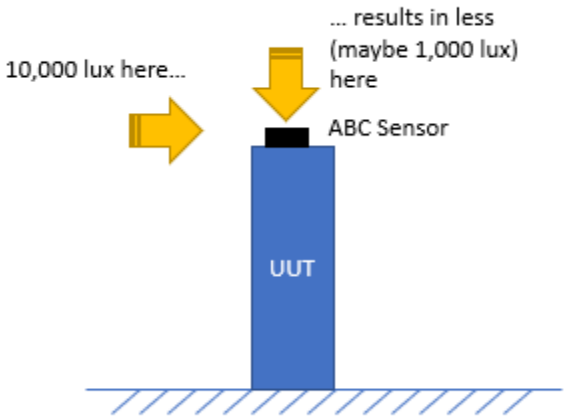
1) Lamp Type:
   a) Standard spectrum halogen reflector lamp. The lamp shall not meet the definition of "Modified spectrum" as defined in 10 CFR 430.2 - Definitions[5].
   b) Up to two lamps may be used as long as the lamps are aligned such that each bulb is pointing at the light sensor and the bulbs are as close together as possible.
   c) Bulbs with varying rated brightness may be used but they should be able to achieve 10,000 lux at 3.5 feet.

Illuminance Conditions Test Setup – Side View



Illuminance Conditions

EPA would appreciate feedback on this proposal, especially the expected location and orientation of ABC sensors, such that the test is representative.



- EPA wants to ensure that ABC sensors are not likely to be mounted facing up or down, where they would be expected to receive much greater or less illuminance, respectively, than the 10,000 lux proposed in the test method.

Test Procedures

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Test Procedure Warm-up

- EPA received stakeholder feedback that a 1% drift in input current during the warm-up period could lead to significant variation in resulting efficiency measurements and they suggested to decrease this to 0.2%.

D) Measurement

1) After the 5-minute warm-up period, the technician shall monitor input current for a period of 5 minutes to assess the stability of the unit under test.

a) If the input current level does not drift by more than 0.2 percent from the maximum value observed over the 5-minute period, the unit under test can be considered stable and measurements can be recorded at the end of the 5-minute period.

EPA has decreased the allowable input current drift during the warm-up period to 0.2% in response to stakeholder suggestions.

Required Measurements

- A stakeholder requested that EPA include measurements specific for DC power sources.

EPA has clarified that these measurements are only applicable to AC-input EVSE and specified measurement of DC power.

- In addition, EPA has included total harmonic distortion as an additional measurement to record because power factor and THD are measures of power quality.

2) The following measurements and calculated values shall be recorded after the 5-minute stabilization period:

a) RMS input current or DC-input current;

b) RMS input voltage or DC-input voltage;

c) Power Factor (PF) (not applicable for DC-input)

d) Total Harmonic Distortion (THD) (not applicable for DC-input)

e) DC-output current for each output;

f) EVSE input power: $P_{INPUT} = \frac{1}{T}\int_0^T i_{in}(t) \times v_{in}(t)dt$

g) EVSE output power: $P_{OUTPUT} = \frac{1}{T}\int_0^T i_{out}(t) \times v_{out}(t)dt$

Integral Battery

- One stakeholder stated that off-grid DC EVSE must have an internal battery to power internal electronics since there is no utility presence to do so.
- Another manufacturer recommended that EPA specify that:
  - The battery should be fully discharged to ensure that batteries do not provide stored energy to the EVSE during the test, or
  - EPA could require the test to start and end with batteries fully charged to capture any potential energy consumption that occurs when the batteries are discharged during the test and then recharged.

Integral Battery

- For DC EVSE that contain a battery that cannot be disabled, EPA will continue to require that the battery be fully charged prior to testing.

However, the power draw will continue to be monitored after each modal test until there is no more power draw.

5) At the conclusion of Operation Mode testing, return to Idle State (zero output current) and record the power until the measured power draw returns to that measured in Section 7.3.

Operation Mode Loading Conditions

- Per the proposed limitation of scope, EPA has removed the 350 kW test condition from Table 5.
- For the maximum power, EPA is proposing a voltage that is calculated from the maximum power by dividing by 0.7 A and adding 300 V, to provide a voltage proportional to power.

	Test Condition Current (A)	Example for 150 kW capable UUT	Example for 50 kW capable UUT
Loading Condition 1	10 kW ± 0.2 kW and 350 V ± 7 V	10 kW	10 kW
Loading Condition 2	30 kW ± 0.6 kW and 350 V ± 7 V	30 kW	30 kW
Loading Condition 3	50 kW ± 1 kW and 350 V ± 7 V	50 kW	50 kW
Loading Condition 4	150 kW ± 3 kW and 400 V ± 8 V	150 kW	N/A
Loading Condition 5	Max Available Power Output (determined in Section 7.4.B), above) ± 2% and Voltage= Pout / 0.7 A + 300 V ± 2%.	N/A	N/A

EPA would appreciate stakeholder feedback on the equation to calculate the appropriate voltage at the maximum output power loading condition.

DC-Input EVSE Operation Mode Loading Conditions

- A stakeholder noted that off-grid solar-powered DC EVSE are not capable of delivering precise loading conditions, instead they deliver the current available from the sun which varies between ~ 0 W - 20 kW.

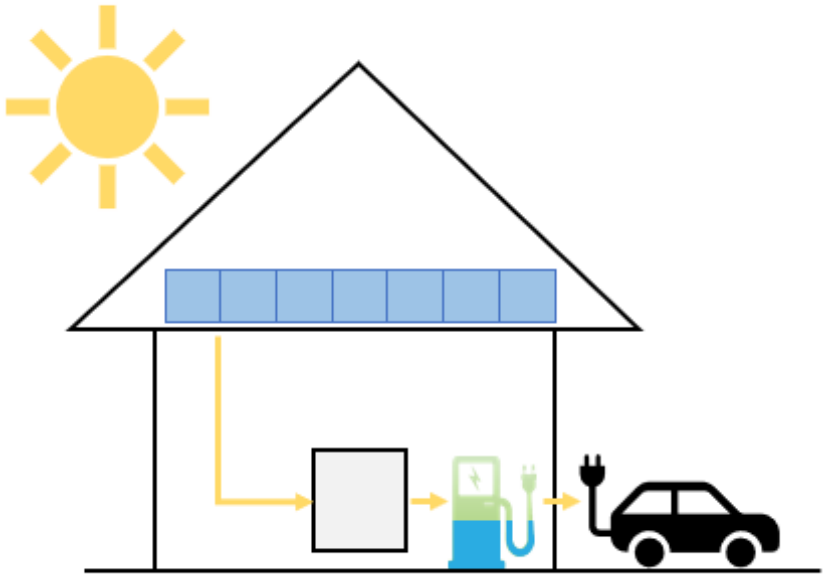
EPA is proposing to reuse the AC-output EVSE test method to specify loading conditions during Operation Mode testing.

Table 6: Loading Conditions for DC-input UUT

	Test Condition Current (A)
Test Condition 1	Maximum Input Current ± 2%.
Test Condition 2	30.0 A ± 0.6 A
Test Condition 3	15.0 A ± 0.3 A
Test Condition 4	4.00 A ± 0.1 A

Battery Storage

EPA is aware that EVSE are increasingly being installed in conjunction with battery storage. EPA would like to continue discussions with stakeholders on how to appropriately account for battery storage input in this test method



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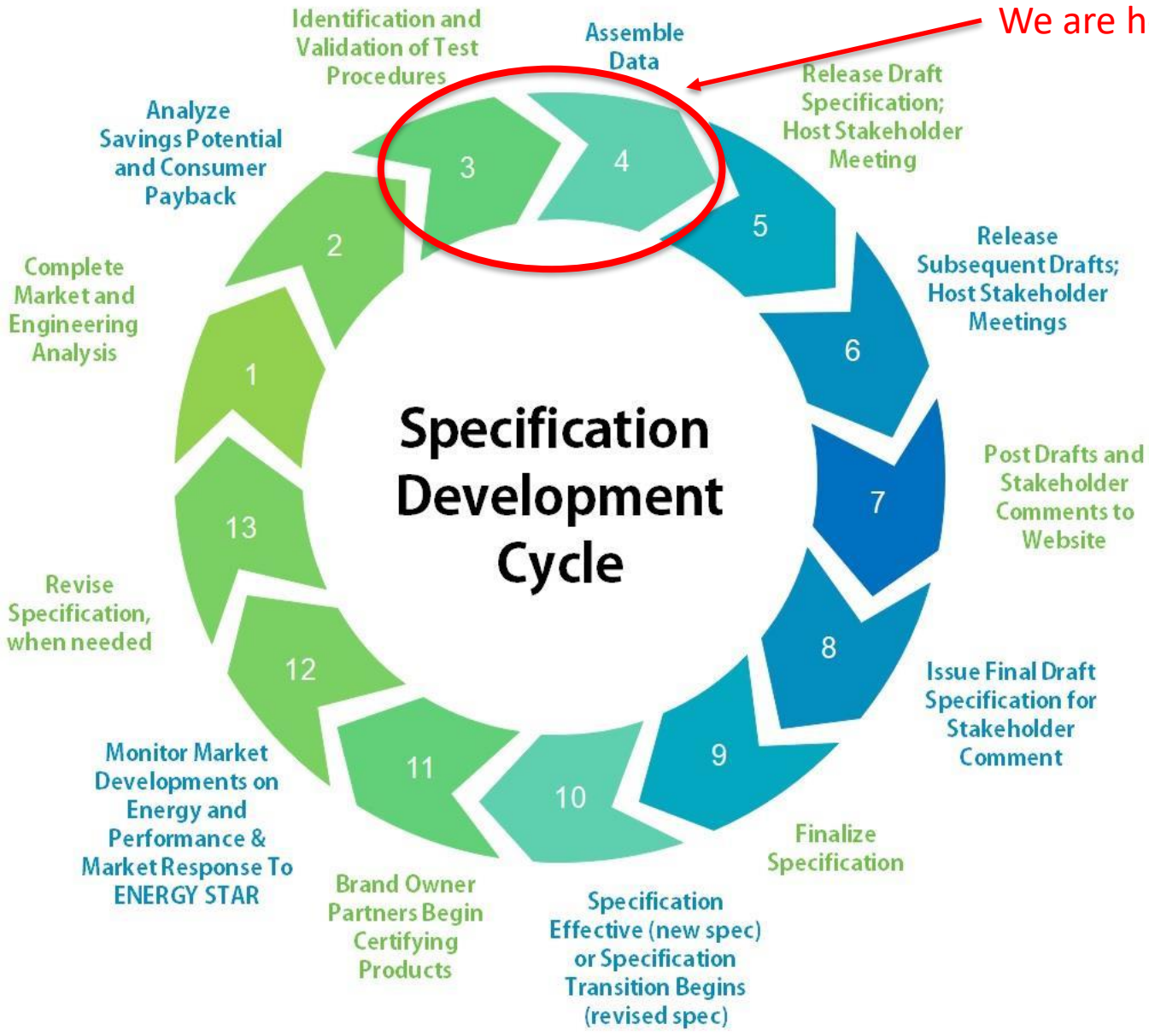
Version 1.1 Next Steps

Event	Date
Discussion Guide Published and Webinar	*May/June 2018*
Test Method Working Session #1 and #2	*August and September 2018*
Draft 1 Test Method Published and Webinar	*November 2018*
Draft 2 Test Method Published	*June 6, 2019*
Draft 2 Test Method Webinar	**June 25, 2019**
Draft 2 Test Method Written Comments Due	**July 8, 2019**
Final Draft Test Method	September 2019
Release Version 1.1 Draft 1 Specification, Final Test Method, and Call for Data	November 2019
Version 1.1 Effective Date	Spring/Summer 2020


We are headed here
Specification Development Cycle
1 Complete Market and Engineering Analysis
2 Analyze Savings Potential and Consumer Payback
3 Identification and Validation of Test Procedures
4 Assemble Data
5 Release Draft Specification; Host Stakeholder Meeting
6 Release Subsequent Drafts; Host Stakeholder Meetings
7 Post Drafts and Stakeholder Comments to Website
8 Issue Final Draft Specification for Stakeholder Comment
9 Finalize Specification
10 Specification Effective (new spec) or Specification Transition Begins (revised spec)
11 Brand Owner Partners Begin Certifying Products
12 Monitor Market Developments on Energy and Performance & Market Response To ENERGY STAR
13 Revise Specification, when needed

Next Steps

- EPA expects that the Final Draft Test Method will be released in September.

- Data Assembly
  - EPA will release a call for data when the Final Draft Test Method is published and will collect data within 4 weeks.
  - A data assembly form will be released to provide stakeholders with information on what data would be most useful.

- The Draft 1 Specification and Final Test Method will be released together following an analysis of the data received.

How to Participate

- If you wish to be added to EPA's stakeholder distribution list to receive test method/specification development updates, please email us at:
  - Emmy.Feldman@icf.com, or
  - EVSE@energystar.gov
- All information related to the Version 1.1 DC EVSE Test Method and Specification development process can be found at:

https://www.energystar.gov/products/spec/electric_vehicle_supply_equipment_version_1_1_pd

Thank you!

James Kwon
Product Manager, ENERGY STAR
(202) 564-8538
Kwon.James@epa.gov

Emmy Feldman
ICF
(202) 862-1145
Emmy.Feldman@icf.com

www.energystar.gov/productdevelopment