

**INDUSTRY CONNECTIONS REPORT**

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**INDUSTRY CONNECTIONS REPORT**



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## ABSTRACT

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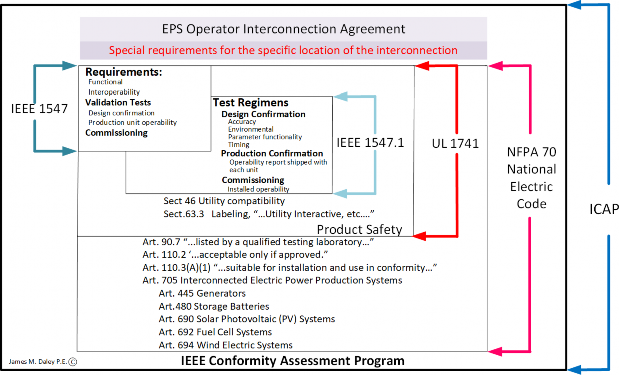
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FIGURE 1: Figure title to go here



Components, subsystems, and systems installed in the interconnection system are required to be evaluated for their intended service. IEEE Std 1547 establishes the required functional performance for interconnection service. Component, subsystem, and system conformance testing uses the IEEE 1547 tabulated functional parameters and their ranges as the criteria for evaluation. IEEE Std 1574.1 establishes the regimens for conformity evaluation.

A type test will subject the equipment under test (EUT) to an evaluation that operates the unit over the full range of specified operability. It will also evaluate the EUT for environmental exposure such as transient withstand, radiated, and conducted emissions immunity (harmonics, etc.). As an example, where the standard requires response to an abnormal parameter condition, for example a voltage out of range, the test regimen will evaluate the EUT at the minimum, mid-range, and maximum operating temperature; at the minimum, mid-range, and maximum parameter setting; and at the minimum, mid-range, and maximum time settings. This test sequence is conducted five times at each setting for each parameter, to achieve statistical significance. The criteria for success is expected operation at each setting within a specified accuracy. IEEE Std 1547.1 provides the test protocol and procedure. These evaluations are conducted and recorded by a NRTL at a facility that has the requisite equipment and infrastructure.4 A type test is required to be repeated when design revisions are made to the product.

Once the product type test has been conducted, the EUT as tested is defined in a technical construction file held by the NRTL. The file provides the basis for evaluation of production units in the follow-up service that the NRTL conducts on unannounced visits to the production facility. During these visits, the NRTL personnel compare a production unit to the technical construction file for compliance. When a discrepancy is found, the manufacturer must correct the discrepancy before the listing label can be applied to the product. Units shipped with the discrepancy must have their labels removed until the discrepancy is resolved and rectified.

The IEEE interconnection standards (IEEE Std 1547 and IEEE Std 1547.1) and UL 1741 require that each unit produced be subjected to a production test that confirms designated operation for each parameter as set at the production facility. The settings are recorded for each unit. A production report is required to be shipped with each unit. This report is required to document all settings as the unit was shipped from from the production facility.

4A Nationally Recognized Testing Laboratory (NRTL) is a United States Occupational Safety and Health Administration (OSHA) designation given to testing facilities that provide product safety testing and certification services to manufacturers. The testing and certification are done to U.S. consensus-based product safety test standards. Note that not all NRTLs are recognized as having the capability to conduct and/or oversee testing associated with all test standards. For additional information, please refer to: http[s://w](http://www.osha.gov/dts/otpca/nrtl/nrtllist.html)ww[.osha.](http://www.osha.gov/dts/otpca/nrtl/nrtllist.html)go[v/dts/otpca/nrtl/nrtllist.html.](http://www.osha.gov/dts/otpca/nrtl/nrtllist.html)

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Each EPS operator has an interconnection application form. Generally, the form will require the following:

* Interconnection customer identification information
* Generator facility location information
* Generator facility information

» Type

» Rating

» Energy source

» Operating parameters, voltage, current, power, power factor, etc.

» List of equipment, manufacturer, listing label, standards of evaluation (UL 1741, UL 489, UL 1008, ANSI C37. series, etc.)

» Installing contractor

» Electrical contractor

» Electrical diagram of the interconnection

From this information, the EPS operator will determine the steps to take in reviewing the application. Where the interconnection is rated at or below a threshold (usually 10 kW to 20 kW) and the interconnection uses an approved and listed inverter, little further evaluation would be necessary.

5

CITATIONS

[1] C2-2017, 2017 National Electrical Safety Code® (NESC®).6

[2] Energy Policy Act of 2005, United State Congress (July 29, 2005) Approved August 8, 2005.

[3] IEC 60364, Electrical Installations for Buildings.

[4] IEEE Std 1547™-2003, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.7, 8

[5] IEEE Std 1547™-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.

[6] IEEE Std 1547.1™-2005 (Reaff 2012), IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.

[7] NFPA 70:2017, National Electrical Code®, (NEC®).9

[8] UL 1741, Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.10

6 The NESC is available from the Institute of Electrical and Electronics Engineers ([http://standards.ieee.org/).](http://standards.ieee.org/))

7 The 2003 version of IEEE Std 1547 has been updated by the 2018 version; however, the 2003 version is relevant to this paper.

8 IEEE publications are available from the Institute of Electrical and Electronics Engineers ([http://standards.ieee.org/).](http://standards.ieee.org/))

9 The NEC is published by the National Fire Protection Association [(http://w](http://www.nfpa.org/))w[w.nfpa.org/).](http://www.nfpa.org/)) Copies are also available from the Institute of Electrical and Electronics Engineers ([http://standards.ieee.org/).](http://standards.ieee.org/))

10 UL publications are available from Underwriters Laboratories ([http://www.ul.com/).](http://www.ul.com/))

# APPENDIX A

### COMMISSIONING CHECKLIST

1. Area EPS Requirements—fully executed EPS interconnection agreement including all required information and documentation.
2. Description of operation—Given the interoperability requirements of the revised IEEE Std 1547, it will be necessary to specify which operating modes are applicable to this particular interconnection.
   1. Where applicable, specify Operating Category I, II, and/or III. Include a table of all settings for the operation.
   2. Where applicable, specify Operating Category A or B and operational performance for reactive power capability and voltage/power control. Include a table of all settings for the operation.
   3. Specify and tabulate all settings for response to abnormal voltage and frequency conditions.
   4. Explain operational coordination with EPS reclosers where applicable.
   5. Explain after-trip-return-to-service operation.
   6. Explain unintended islanding detection operation and state interval time setting from initiation of the island to cease-to-energize.
3. Where applicable, include a description of each interoperable function and packet of data to be communicated. Each description should include all particulars to confirm compliance with the EPS Interconnection Application/Agreement.
4. Verification of inspections
   1. Record the NRTL Label, File # and listed intended use of each component, subsystem and/or system in the interconnection system. Confirm that the application is in compliance with the listing.
   2. Confirm and record all settings. Compare settings with the manufacturer’s production report.
   3. Confirm system installation is in accordance with the electrical design as submitted with the application for interconnection.
   4. Confirm system grounding is in compliance with the governing interconnection agreement.
   5. Visually inspect and verify operability of the isolation device, as specified in the governing interconnection agreement.
   6. Verify that polarities, burdens, and ratios of field wired CTs and VTs are correct and in accordance with the design documents.
   7. Through visual inspection, continuity test and/or insulation resistance test, verify that field- installed power and control wiring is in compliance with design drawings, manufacturer’s requirements, and applicable codes.
   8. Where the interconnection system responds to or initiates a protection/control function with an external entity, identify, confirm and record operability response. Confirm compliance with the interconnection agreement.
      1. Input functions: describe the source, type of input and expected response. Observe and record the response.
      2. Output functions: Describe type and record both expected and observed operation.
   9. On three-phase systems, check the phase rotation of both the Area EPS and DER to verify that they are compatible as installed. Record phase rotation.
   10. Verify and record performance of each monitored entity. Confirm compliance with the interconnection agreement.
5. For a total of five readings spaced at 15-minute intervals, record interconnection operation voltage, current, and power on each phase. Record frequency and average power factor. This section of the commissioning process should be conducted when the DER is likely to produce maximum output power. Record energy source status during this regimen (good wind velocity and volume, maximum solar radiation, etc.)
6. Unintentional islanding—Document the method of unintentional islanding verification. Initiate, observe, and record the operation. Record the time taken to detect and then cease to energize the power output of the DER.
7. Cease to energize—Describe the method used to evaluate the cease to energize function of the interconnection system. Initiate, observe, and record system response. Record the time taken to detect and then cease to energize the power output of the DER.
8. Record any settings that were revised during the commissioning process with explanation of the reason for revision.
9. Commissioning report—A written report, tabulated as items 1 through 8 above, of the results obtained during the commissioning process is to be prepared and signed by the commissioning agent. A copy should be submitted to the EPS operator for the record and to confirm compliance with the interconnection agreement.

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