IEEE 1547-2018
and IEEE 1547a-2020

Opportunities, Adoption Methods & Stakeholder Coordination

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Jens Boemer

Virtual Training on Bulk Power System Issues for State Energy Officials

June 22, 2021
Steps to Unlock Benefits of Advanced DER

**Grid Planning & Technical Interconnection Requirements**
(e.g., IEEE 1547-2018)

- Specify DER Performance and Functional Capabilities
  - e.g., adopt IEEE Std 1547-2018
- Update interconnection agreements
  - e.g., allow for utilization of DER capabilities

**Research, Development, Standardization**
(e.g., DERMS, IEEE 2030.11)

- Design architecture and deploy DER communication infrastructure
  - e.g., start with utility-scale DER before integrating retail-scale DER

**Markets & Operations**
(e.g., FERC Order 2222)

- Specify DER Management System and select DER Aggregations/Group Management Functions
  - e.g., codify messages to be exchanged across the T&D interface

**FERC ORDER 2222**

- Design market and integrate DER into grid operations
  - e.g., energy products, capacity products, re-dispatch, regulating reserves

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Potential Impacts of Aggregate DER on Bulk Power System Reliability

DER Frequency Ride-Through versus Tripping

- System frequency is defined by balance between load and generation
- Frequency is similar across entire interconnection
  - any DER exposed to large frequency deviations may trip simultaneously;
  - special concerns for system-split conditions
- Impact the same whether or not DER is on a high-penetration feeder
- NERC Reliability Coordinators
  - Colored entities in the map to the right

Source: NERC

DER Voltage Ride-Through versus Tripping

- Transmission faults can depress distribution voltage over very large areas
- Sensitive voltage tripping (i.e., 1547-2003) can cause massive loss of DER generation
- Resulting BPS event may be greatly aggravated

Source: SCE
Role of IEEE Std 1547-2018

- **DERs**
  - Defines and Standardizes “smart DERs” across the industry
  - All DER not just inverter based!

- **TECHNICAL**
  - Technical basis for regulatory proceedings
  - Can be flexibly adjusted to regional differences
  - Widely-accepted by industry

- **VALUE**
  - Avoid lengthy discussions with stakeholders
  - Avoid specifying technical requirements
  - Account for regional differences (flexibility)
  - Accelerate regulatory proceedings
  - Mitigate technical risks

IEEE Std 1547-2018
How IEEE 1547 Relates to Other Requirements

- **Product & Installation Requirements**
  - UL 1741 (Listing / Certification Test)

- **Grid Interconnection & Functional Requirements**
  - IEEE Std 1547.1
  - IEEE Std 1547

- **Communication Certification Requirements**
  - NERC¹ / FERC²
  - IEC 61850
  - IEEE P2030.5
  - DNP3
  - IEEE P1815
  - SunSpec

**Standards**
- National Electric Code (voluntary)
- State Codes/Laws (selective adoption of NEC)
- Local Municipal Codes

**Tests**
- UL 1741 (Listing / Certification Test)

**State**
- State/PUC Utility Laws (e.g. CA Rule 21)

**Individual Utility Generator Connection Agreements**

¹ e.g., NERC PRC-024-02,
² e.g., FERC Order No. 828
Capability versus Utilization

(Performance) Capability
- Functions
- Ranges of available settings

Examples
- Frequency Response
  - Frequency Droop Response
  - Ramp rate limitations
- Ride-Through
  - Voltage ride-through
  - Frequency ride-through
  - ROCOF ride-through
  - Phase angle jump ride-through
  - Consecutive voltage ride-through

Utilization of Capability
- Enable/disable functions
- Functional settings / configured parameters

Examples
- Deadband
- Droop
- Response Time
IEEE 1547-2018 Adoption Methods

**General Reference**
- Full adoption of standard by general reference
- Specification of
  - performance categories
    - normal category
    - abnormal category
  - functional settings (utility-required profiles)
  - standardized comms. protocols

**Detailed Reference**
- Full or partial adoption of std
- Clause-by-clause references
- Any additional requirements

**Full Specification**
- All on the left
- Clause-by-clause own language
- Any additional requirements

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**EPRI’s Generic TIIR Template**

**Benefit:** Consistency to standard

**Risk:** Fragmentation of requirements, certification challenges, additional costs

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**Benefit:** No need to buy standard

**Risk:** Inconsistencies to standard and fragmentation of requirements, certification challenges, additional costs
EPRI Recommended Steps for IEEE 1547-2018 Adoption

Near Term (M1-6)
- Determine adoption timeline
- Determine interconnection & interoperability capability
- Initiate collection, management, and maintenance of DER deployment, performance capability, and functional settings data
- IF needed, THEN determine regional settings
- IF needed, THEN specify utility/site-specific settings
- Assign normal performance categories
- Assign abnormal performance categories
- Specify single DER communication protocol
- Consider adopting the new IEEE 1547-2018 framework for DER facility design and as-built evaluations

Medium Term (M7-24)
- Update TIIRs and IA templates
- IF non-regional, utility/site-specific trip or active power related settings are needed, THEN coordinate with regional reliability coordinator
- Initiate process development to share non-default settings
- Establish protocols/procedures for T&D aggregated data exchange
- Initiate stakeholder processes to determine interconnection & interoperability capability, and IF needed, regional functional settings; include Regional Reliability Coordinator
- Alert regulatory agencies of lead times

Long Term (M25-36)
- Develop protocols/procedures for T&D aggregated data exchange
- Initiate stakeholder processes to determine interconnection & interoperability capability, and IF needed, regional functional settings; include Regional Reliability Coordinator
- Alert regulatory agencies of lead times

Distribution, Transmission, and Stakeholder Coordination
- DER Data Mgt & Functional Settings Determination
- Training & Education

Interconnection & Interoperability Capability
- Interoperability & Interconnection
- DER Data Mgt & Functional Settings Determination
- Distribution, Transmission, and Stakeholder Coordination

Training & Education
- Consider adopting the new IEEE 1547-2018 framework for DER facility design and as-built evaluations
- Initiate stakeholder processes to determine interconnection & interoperability capability, and IF needed, regional functional settings; include Regional Reliability Coordinator
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Balancing Bulk & Distribution Grid Needs

Distribution Grid Side
- Short trip times
- Ride-through \textit{with momentary cessation}
- Voltage rise concerns
- Islanding concerns
- Protection coordination
- Safety of line workers

Bulk System Side
- Long trip times
- Ride-through \textit{without momentary cessation}
- Reactive power support
- Dynamic voltage support during abnormal voltage
- Frequency support

\textbf{Increasing need for T&D Coordination}
Adoption guidelines from Reliability Coordinators for IEEE Std 1547-2018

- April 1, 2022

hyperlinks to ISO/RTO guidelines are printed in bold underline font

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EPRI Recommended Steps for IEEE 1547-2018 Adoption

Interconnection & Interoperability Capability

- Determine adoption timeline
- Assign abnormal performance categories
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DER Data Mgt & Functional Settings Determination

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Training & Education

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Distribution, Transmission, and Stakeholder Coordination

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Near Term (M1-6)

- Initiate stakeholder processes to determine interconnection & interoperability capability, and IF needed, regional functional settings; include Regional Reliability Coordinator
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- Alert regulatory agencies of lead times

Long Term (M25-36)
EPRI Recommended Steps for IEEE 1547-2018 Adoption

Interconnection & Interoperability Capability
- Near Term (M1-6)
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- Medium Term (M7-24)
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DER Data Mgt & Functional Settings Determination
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Training & Education
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- Long Term (M25-36)
  - Consider adopting the new IEEE 1547-2018 framework for DER facility design and as-built evaluations
Layers of Smart Inverter Settings with IEEE 1547-2018 Adoption

- A file format specification was developed by a broad set of industry stakeholders and is publicly available at https://www.epri.com/research/products/000000003002020201

- **Utility-Required Profile (URP) for Specific Site**
  - Included in site-specific interconnection agreement (IA)
  - May result from site-specific interconnection screenings

- **Utility-Required Profile for Distribution Service Area**
  - Included in interconnection agreement template
  - Specific to Distribution Utility’s practices, e.g., automatic re-closing, distribution circuit characteristics, operating practices

- **Utility-Required Profile for Region and/or ISO/RTO Reliability Region**
  - Consideration of distribution and bulk system impacts.
  - May include some settings other than the SRD’s default values

- **Adopted SRD1 with Default Values**
  - (state-wide or similar)

1 Based on decision by Authority Governing Interconnection Requirements (AGIR), may be a public utilities commission or similar

Source Requirements Document
- Preferably IEEE Std 1547-2018
- Otherwise: CAR21, HR14H, etc.

https://dersettings.epri.com/

Database Scope
Timeline for Rollout of IEEE Std 1547™-2018 Compliant DER

- **Stopgap solution for adoption of parts of IEEE Std 1547-2018 by inverter certification per UL 1741 SA.**

- **Full adoption of IEEE Std 1547™-2018 by inverter certification per UL 1741 SB.**

**Notes**
1. The new UL 1741 Supplement SB will directly refer to IEEE 1547.1-2020 and will be the only test procedure to certify IEEE 1547-2018 compliance. The existing Supplement SA will remain for the time being for those codes that continue to reference UL 1741 SA.
2. UL 1741 SB is currently under a revision to provide guidance on consistent application of IEEE 1547-2018.
3. Products to market not generally available until 18 months after release of IEEE 1547.1-2020 and UL 1741 SB.

**Example Enforcement Dates**
- MN, MD: at “Commission Notice”
- CA: April 1, 2022

**See also:** [https://site.ieee.org/sagroups-scc21/standards/1547rev/](https://site.ieee.org/sagroups-scc21/standards/1547rev/)

The time to prepare for integration of IEEE 1547-2018 compliant inverters is now.
States adopting IEEE Std 1547-2018

MN – “Commission Notice”

CA – “Commission Notice”

HI - April 1, 2022

MN – “Commission Notice”

NY - July 1, 2022

MD – “Com Notice”

D.C. - Jan 1, 2022

hyperlinks to state dockets are printed in bold underline font

1 Reference to “latest” IEEE 1547
2 Likely adoption dates

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Together...Shaping the Future of Electricity

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RTOs/ISOs Guidelines for IEEE Std 1547™-2018 Adoption

ISO New England – UL 1741 SA
- Coordination between ISO-NE and the MA’s utilities in the Massachusetts Technical Standards Review Group
- Reference to UL 1741 SA as a stopgap to verify DER ride-through capability in the interim
- Harmonization of voltage & frequency trip settings with IEEE Std 1547-2018 ranges of allowable settings (Link)

PJM Interconnection – UL 1741 SA/SB
- Initiation of formal stakeholder proceedings in 2019
- Published PJM Guideline for Ride Through Performance of Distribution-Connected Generators for voluntary DER ride-through in Oct 2019 (PJM Website)
- Established minimum ride-through requirements and trip time settings

Midcontinent Independent System Operator (MISO) – UL 1741 SB
- MN PUC requested stakeholder process, see MISO’s IEEE 1547 website
- Published the MISO Guideline for IEEE Std 1547-2018 Implementation (Link)
- Established the regional ride-through capabilities and trip time settings

See also NERC’s Reliability Guideline
Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018 (March 2020)
# Publicly Available EPRI Resources on IEEE Std 1547-2018

## EPRI Training Modules (EPRI-U)

<table>
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## EPRI White Papers

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<td>Fact Sheet, May 2017</td>
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<td>Minimum Requirements for DERs Ride-Through, May 2015</td>
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<td>Communications Interface and Interoperability, Jul. 2017</td>
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<td>Power Quality Considerations for DERs, Dec. 2017</td>
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### Comparison of P2800 Initial Ballot Draft with IEEE 1547-2018

#### Legend:
- X Prohibited, √ Allowed by Mutual Agreement, ‡ Capability Required,
- (‡) Procedural Step Required as specified, ∆ Test and Verification Defined

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IEEE Standards Classification and Consensus Building

Standards
documents specifying mandatory requirements (shall)

Recommended Practices
documents in which procedures and positions preferred by the IEEE are presented (should)

Guides
documents that furnish information – e.g., provide alternative approaches for good practice, suggestions stated but no clear-cut recommendations are made (may)

IEEE 1547
IEEE P2800
IEEE P2800.1
IEEE P2800.2
IEEE P1547.2
IEEE P1547.3
IEEE P1547.9
IEEE 1547.1