IEEE 1547-2018

and IEEE 1547a-2020

Opportunities, Adoption Methods &

Stakeholder Coordination

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Virtual Training on Bulk Power System Issues for State Energy Officials

June 22, 2021

Steps to Unlock Benefits of Advanced DER

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

Grid Planning & Technical Interconnection Requirements
(e.g., IEEE 1547-2018)
Research, Development, Standardization *(e.g., DERMS, IEEE 2030.11)*

Design **market** and integrate DER into **grid operations**

- e.g., energy products, capacity products, re

Specify DER Management System and select

Specify **DER**

Performance

Functional

• e.g., adopt IEEE Std 1547- 2018

and

Capabilities

Update interconnection agreements

of DER capabilities

scale DER before

• e.g., allow for **utilization**

Design architecture and deploy DER **communication infrastructure**

• e.g., start with utility

T&D interface

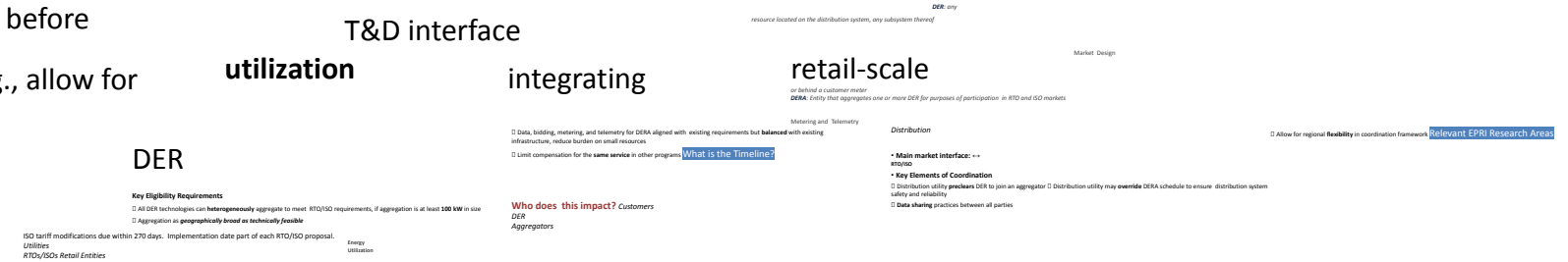
DER

integrating

DER Aggregations/ Group Management Functions

• e.g., codify messages to be exchanged across the dispatch, regulating reserves

retail-scale



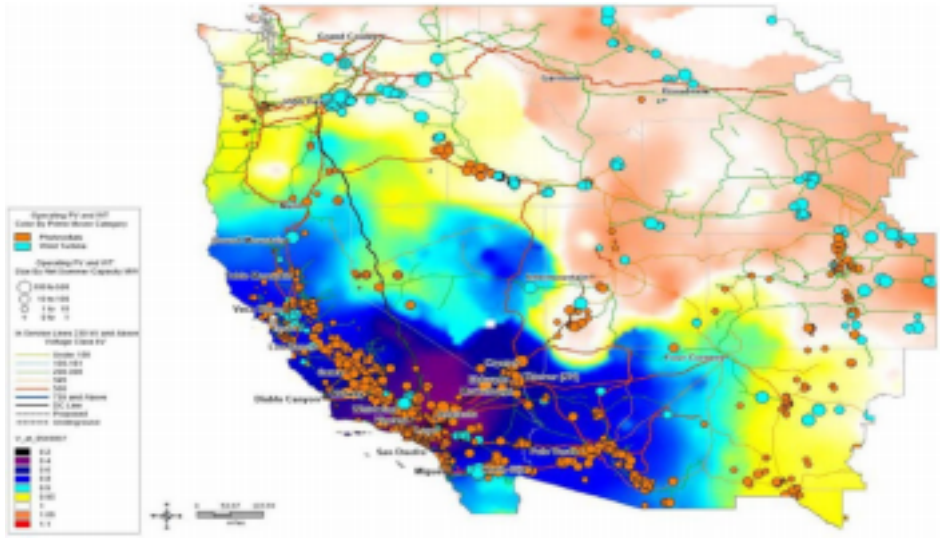
*FERC Order 2222 Phase 1: Collaborative Forum, Gap Assessment, and Implementation Roadmap, https://www.epri.com/research/products/000000003002020167

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

DER Voltage Ride-Through versus Tripping



Source: SCE

• Colored entities in the map to the right

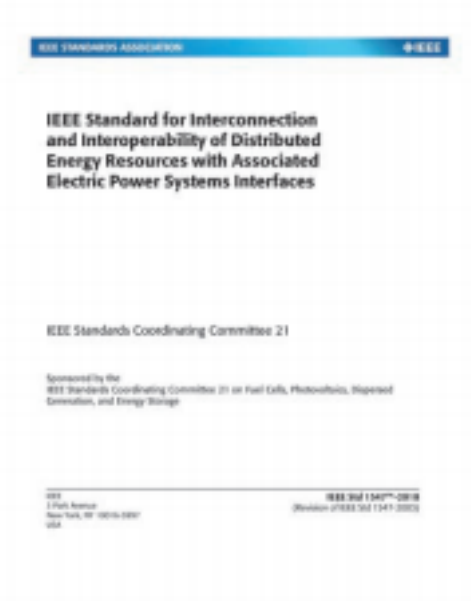
Source: NERC

- 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

• NERC Reliability Coordinators

Role of IEEE Std 1547-2018

• Defines and Standardizes "smart DERs" across the industry
• All DER not just inverter based!
• Technical basis for regulatory proceedings



• Can be flexibly adjusted to regional differences • Widely-accepted by industry

IEEE Std 1547-2018

• Avoid specifying technical requirements • Account for regional differences (flexibility) • Accelerate regulatory proceedings
• Mitigate technical risks

• Avoid lengthy discussions with stakeholders

How IEEE 1547 Relates to Other Requirements

Product & Installation Requirements

Grid Interconnection & Functional Requirements

Communication Certification Requirements

(Standards have no inherent authority)

UL 1741

(Listing / Certification Test)

National Electric Code

(voluntary)

State Codes/Laws

(selective adoption of NEC)

Local Municipal Codes

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

Individual Utility Generator Connection Agreements

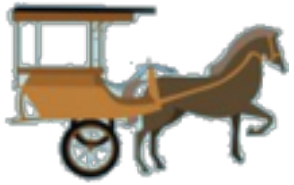
NERC[1] / FERC[2]

[1] e.g., NERC PRC-024-02,
[2] e.g., FERC Order No. 828

Capability versus Utilization

(Performance) Capability Utilization of Capability

- Functions
- Ranges of available settings



Examples

- Frequency Response

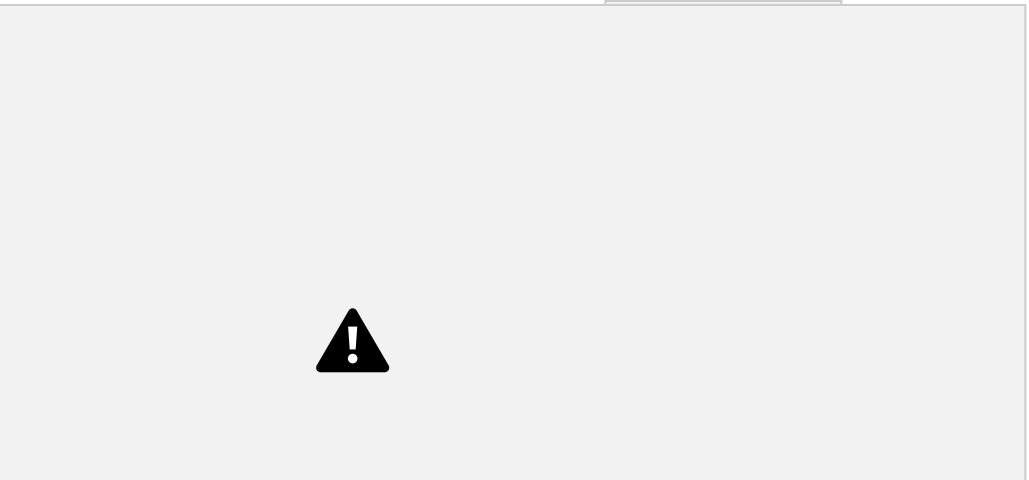
- Frequency Droop Response
- Ramp rate limitations

- Ride-Through
  - Voltage ride-through
  - Frequency ride-through
  - ROCOF ride-through
  - Phase angle jump ride-through
  - Consecutive voltage ride-through

- Droop
- Response Time

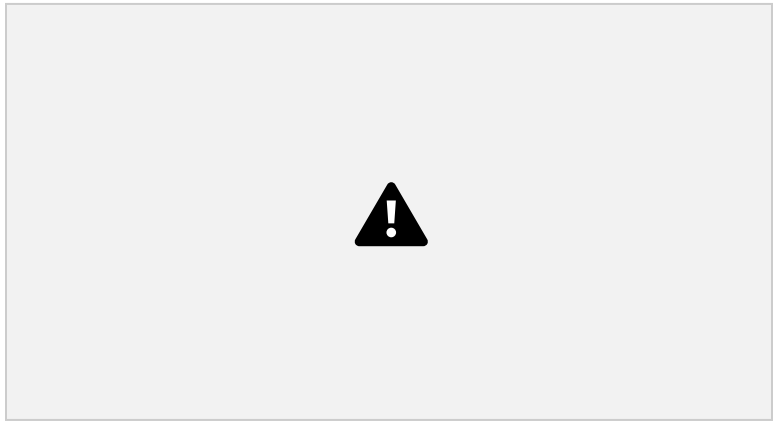
- Enable/disable functions
- Functional settings / configured parameters

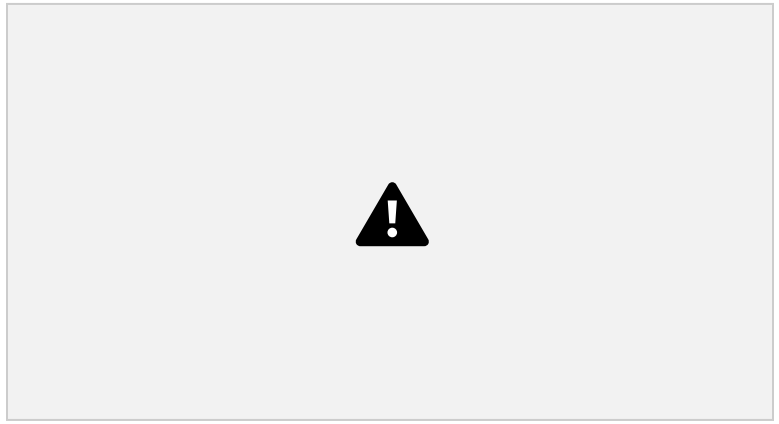
Examples

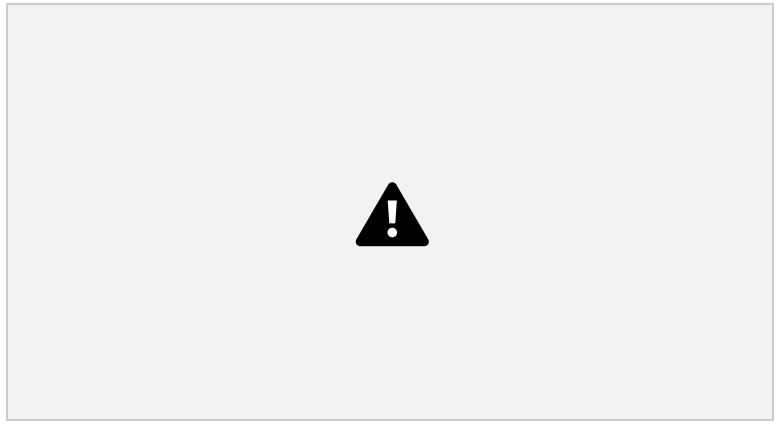


- Deadband

IEEE 1547-2018 Adoption Methods







- Full adoption of standard by general reference
- Specification of
  - performance categories
    - normal category
    - abnormal category
  - functional settings (utility-required profiles)
  - standardized comms. protocols
- Full or partial adoption of std
- Clause-by-clause references
- Any additional requirements

Benefit: *Consistency to standard* ***Risk:*** *Fragmentation of requirements, certification challenges, additional costs*

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

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

Interconnection & Interoperability Capability

Determine adoption timeline

Assign abnormal performance categories

Assign normal performance categories

Specify single DER communication protocol

Consider adopting the new IEEE 1547-2018 framework

DER Data Mgt & Functional Settings Determination

Initiate collection, management, and maintenance of DER deployment, performance capability, and functional settings data for DER facility design and as-built evaluations

IF needed, THEN determine regional settings

IF needed, THEN specify utility/site specific settings

Training & Education

(M25-36) Update TIIRs and IA templates

Distribution, Transmission, and Stakeholder Coordination

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

Near Term (M1-6) Medium Term (M7-24) Long Term

agencies of lead times

Balancing Bulk & Distribution

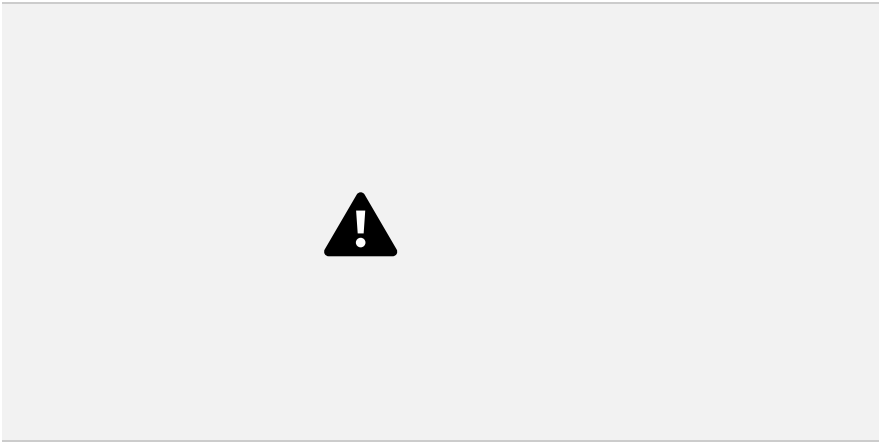
Public EPRI-U Webinars
3002014545
3002014546
3002014547

Grid Needs Distribution Grid Side

- Short trip times
- Ride-through *with momentary cessation*
- Voltage rise concerns
- Islanding concerns
- Protection

Bulk System Side

Safety of



Increasing need for T&D

Coordination

- Long trip times
- Ride-through *without* momentary cessation
- Reactive power support
- Dynamic voltage support during abnormal voltage
- Frequency support

Adoption guidelines from Reliability Coordinators for IEEE Std 1547-2018

No activity

Some ISO/RTOs activity

ISO/RTO Guideline published (general reference)

ISO/RTO Guideline published (detailed reference)

In force date

OR
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MISO

HI

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

EPRI, April 2021

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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

- Included in site-specific interconnection agreement (IA)
- May result from site-specific interconnection screenings

IA-URP

(site specific)

Database

Utility-Required Profile (URP) for Specific Site

Utility-Required Profile for Distribution Service Area

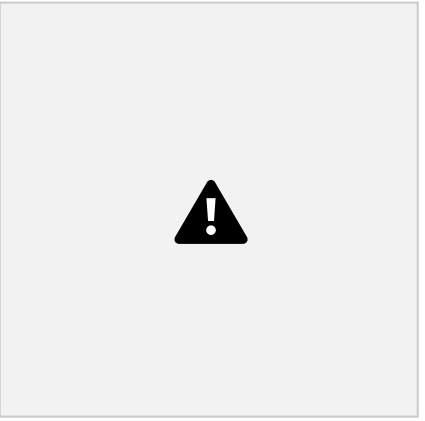
DU-URP
(distribution utility specific)

template • Specific to Distribution Utility's practices, e.g., automatic re-closing, distribution circuit characteristics, operating practices

Regional-URP[1]
(state-wide or similar)
• Included in interconnection agreement

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

Scope



Adopted SRD[1] with Default Values (state-wide or similar)

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

https://dersettings. epri.com/

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

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

1547.1 (Test Specification)

Published

Published

Published

Released

Pre Ballot Comment

Ballot Ballot

Comments Resolved

Product Certification[3]

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

Notes

[1] The new UL 1741 Supplement SB

the time being for those codes that continue to reference UL 1741 SA.

[2] UL 1741 SB is currently under a

UL 1741 SB[1,2] Released Revision Published 1547- 2018

revision to provide guidance on consistent application of IEEE

of IEEE 1547.1-2020 and UL 1741 SB.

Phase 1 Required

CA Rule 21 Revision

Phase 2 Required

1547 Enforcement Anticipated

NARUC Resolution on IEEE 1547-2018

[3] Products to market not generally available until 18 months after release

Example Enforcement Dates • MN, MD: at "Commission Notice"

1/2017 7/2017 1/2018 7/2018 1/2019 1/2021

7/2019 1/2020 1/2022

1/2015 1/2016 7/2016

See also: rds/1547rev/

https://site.ieee.org/sagroups-scc21/standa • CA: April 1, 2022

Adoption of CA Rule 21 and Hawai'ian Rule 14H by inverter certification per UL 1741 SA.

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

Question from **distribution** perspective: *Need to increase DER Integration?*

Question from **transmission** perspective: *Need to address bulk system reliability?*

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

States adopting IEEE Std 1547-2018

NY

No activity

Completed order, not yet

SD

Inquiry or open docket

WA[1]

OR

ID

MT

ND

NH

Completed order, not yet enforced (general reference)

MN

VT

date

WI

ME

NY[1]
enforced
(detailed reference) In force

WY

NV

NE

MI

IA

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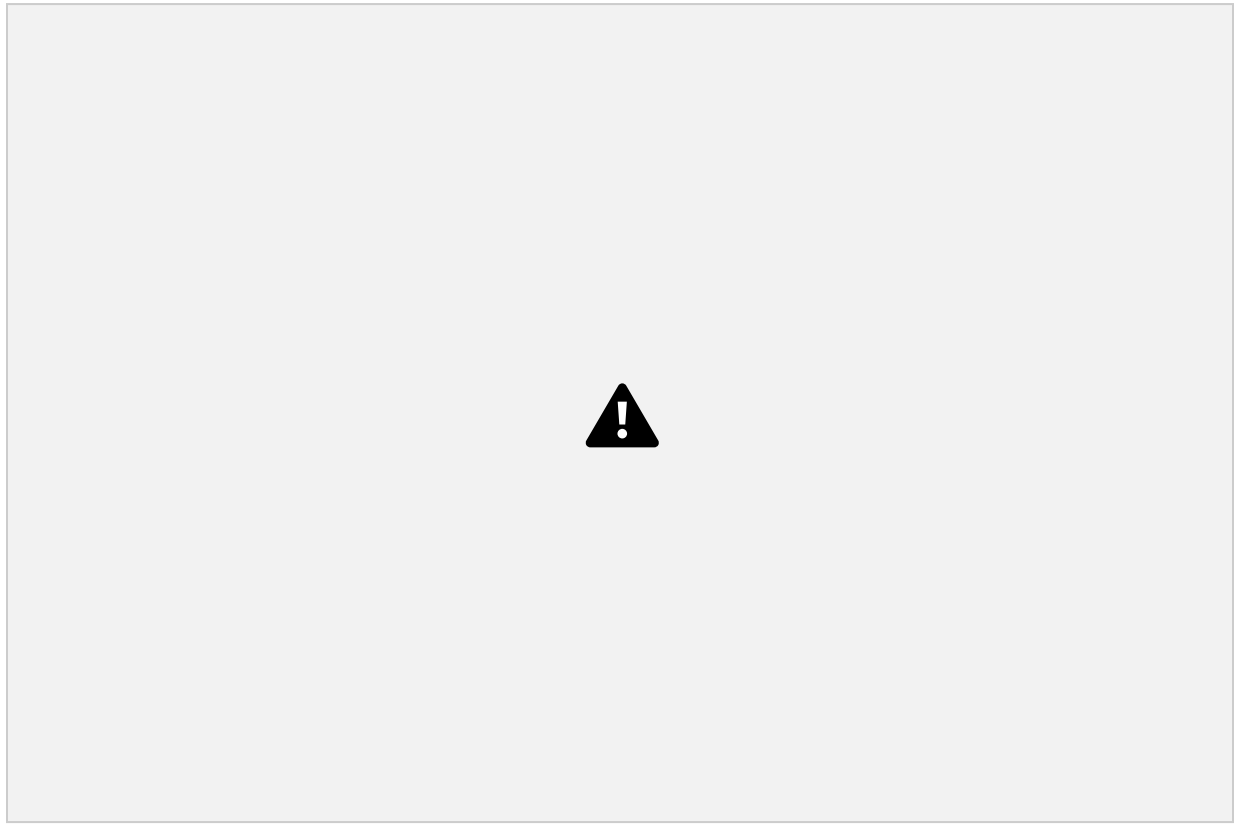
[1] Reference to “latest” IEEE 1547 [2] Likely adoption dates

 EPRI, April 2021

Q&A



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

June 1, 2018

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)

Initiation of formal stakeholder proceedings in 2019

PJM Interconnection – UL 1741 SA/SB •

Jan 1, 2022

- 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	date not specified

Publicly Available EPRI Resources on IEEE Std 1547-2018

1. *Overview on IEEE Std 1547-2018,* Dec. 2018	Public (*3002014545)*	Quiz 1
2. *DER Ride-through Performance Categories and Trip Settings,* Dec. 2018	Public (3002014546)	Quiz 2
3. *T+D Coordination for DER Ride-Through and Trip Requirements*, Dec. 2018	Public (3002014547)	

https://www.epri.com/#/epri-u?lang=en-US

5. *Fact Sheet*, May 2017 Public (3002011346) 6. *Minimum Requirements for DERs Ride-Through*, May 2015 Public (3002006203) 7. *Communications Interface and Interoperability*, Jul. 2017 Public (3002011591) 8. *Power Quality Considerations for DERs*, Dec. 2017 Public (3002010282) https://www.epri.com/#/?lang=en-US

Comparison of P2800 Initial Ballot Draft with IEEE 1547-2018

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

Function Set Advanced Functions Capability	**IEEE 1547- 2018**			
	Ra	Fas		Limit
				C

Function Set Advanced Functions Capability
IEEE 1547- 2018

Adjustability in Ranges o
Priorit
Comr

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(Remote Shut-Off, Remote Dis
M
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Scheduling Powe

IEEE
P2800 ‡

Co
Voltage-React
Autonomously Adjustabl
Capability at zero active pov
Active Power-Reacti
Cons

Voltage-Active Power (Vo
Dynamic Voltage Support dur

IEEE
P2800
Bulk System
‡ ‡ ‡

General **‡ ‡**

‡

Monitoring,

Reliability &
Frequency Support

‡ ‡ ‡ ‡ ‡ √

‡

Control, and Scheduling **‡**

‡

√

‡

‡

Reactive
Power
&
(Dynamic) Voltage
Support **‡**

‡

‡

‡

Unbalanced Dynamic Voltage Support during VRT **‡**

Protection & Power Quality

‡
‡
√
‡
(‡)
(‡)
(‡)

(‡)

Test,
Verification, Modeling & Measurements **(‡)**
(‡)
(‡)
√ **(‡)**
√ **(‡)**
√ Periodic Verification **(‡) (‡)**

IEEE Standards Classification and Consensus Building

IEEE 1547

IEEE
IEEE

1547.1 IEEE

Standards

documents
specifying mandatory
requirements (***shall***)

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

Guides

IEEE
P2800

IEEE
P2800.2

IEEE
P1547.9
P1547.3
documents that furnish information – e.g., provide alternative approaches for good practice, suggestions stated but no clear-cut recommendations are made (***may***)

IEEE
P2800.1

P1547.2

