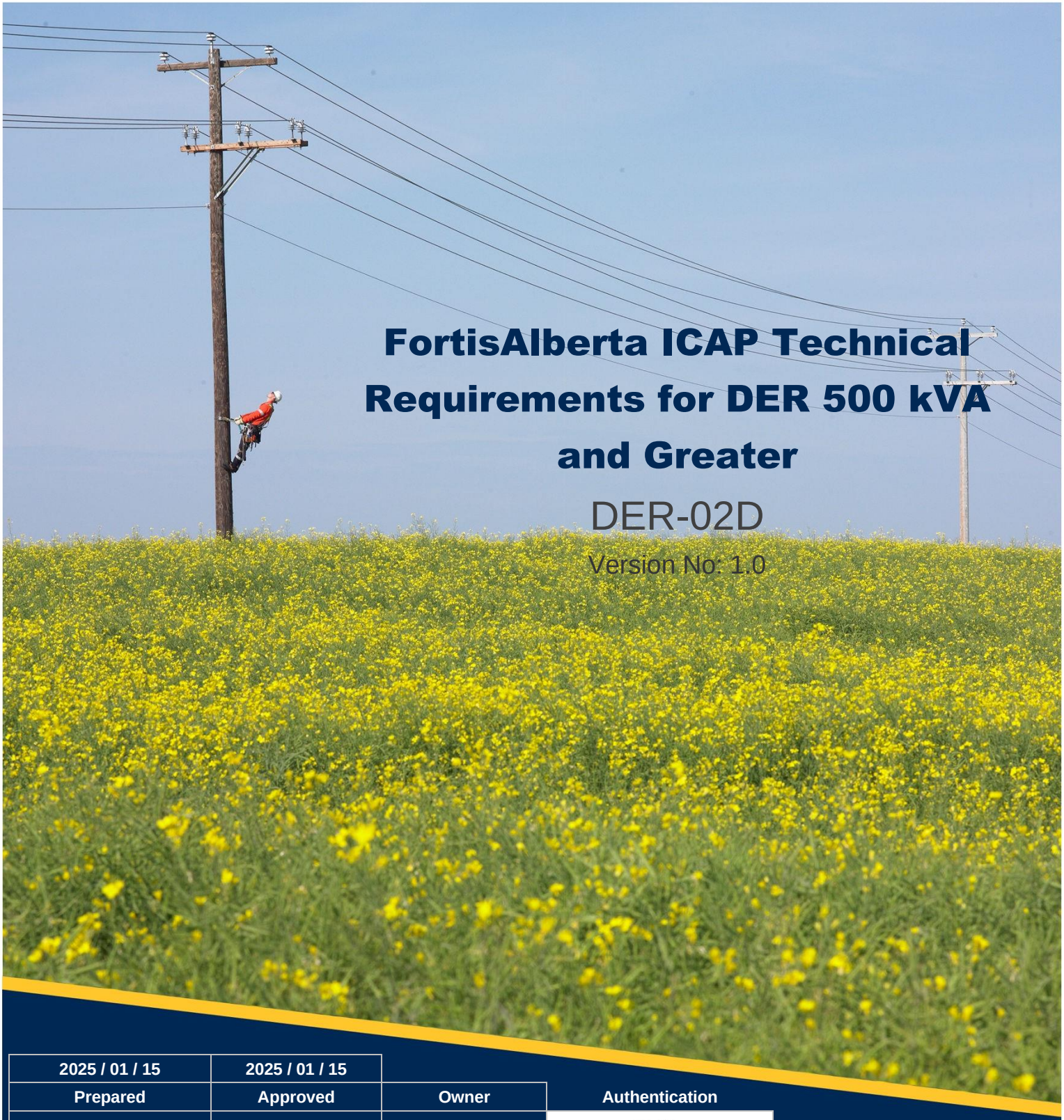

FortisAlberta ICAP Technical Requirements for DER 500 kVA and Greater

DER-02D

Version No: 1.0

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Prepared	**Approved**	**Owner**		
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This document is not a replacement for electrical codes or other applicable standards.

This document is not intended or provided as a design specification or as an instruction manual.

The DER owner, employees or agents recognize that they are, at all times, solely responsible for the generator plant design, construction and operation.

FortisAlberta Inc. (FAI), and any person employed on its behalf, makes no warranties or representations of any kind with respect to the DER requirements contained in this document, including, without limitation, its quality, accuracy, completeness or fitness for any particular purpose, and FAI will not be liable for any loss or damage arising from the use of this document, any conclusions a user derives from the information in this document or any reliance by the user on the information it contains. FAI reserves the right to amend any of the requirements at any time. Any person wishing to make a decision based on the content of this document should consult with FAI prior to making any such decision.

Revision History

Version	Date	Revision Details
1.0	January 2025	Initial Release

Table of Contents

1. Scope and Overview

This document provides a description of the technical requirements for evaluation of a distributed energy resource (DER) in conformity with FortisAlberta DER-02 and its companion standards together with normative adopted standards from the Institute of Electrical and Electronics Engineers (IEEE), including IEEE 1547, IEEE 1547a, and IEEE 1547.1. Together with its companion process document, this document addresses adoption of the IEEE Conformity Assessment Program's (ICAP) Commissioning Conformity Evaluation process for evaluation of large DERs interconnecting with the FortisAlberta distribution system by certified Commissioning Conformity Evaluators (CCEs).

The companion document, DER-02E FortisAlberta ICAP Process Requirements for DER 500 kVA and Greater, provides an overview of the ICAP process undertaken by generators interconnecting with FortisAlberta's system, including FortisAlberta specific requirements and variations. The requirements of this document and DER-02E supplement and do not replace the requirements set forth by IEEE for the ICAP process.

This document describes technical requirements and limitations of the ICAP process, provides an overview of how ICAP fits into the overall Canadian and FortisAlberta requirements framework, highlights the technical data submission requirements, and provides specific technical evidence requirements for the conformity evaluation. This document is not intended to supersede any technical requirements expressed in FortisAlberta DER-02, DER-02A, DER-02B, or DER-02C, nor does it supersede any contents of IEEE 1547, 1547a, or 1547.1 or the Alberta amendments to IEEE 1547.

Some informative annexes provide further information to support generator owners and IEEE ICAP CCEs.

2. Normative References

All normative references must be fully understood and are applicable to this DER and application of this practice standard. It is expected that the DER owner's representatives and ICAP CCE are fully familiar with these documents in detail.

FortisAlberta:

- FortisAlberta Terms and Conditions
- DER-02
- DER-02A
- DER-02B
- DER-02C
- PQ-SPEC-01

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE 1547-2018
- IEEE 1547a-2020
- IEEE 1547.1-2020

Note that where "the IEEE 1547 series" is referred to in this standard, it means IEEE 1547 and IEEE 1547.1, together with any applicable amendments (e.g. IEEE 1547a).

Alberta Municipal Affairs

- Electrical STANDATA

CSA Group

- CSA C22.1
- CSA SPE-1000

APEGA

- APEGA Professional Practice Standard: "Authenticating Professional Work Products"
- APEGA Professional Practice Standard: "Relying on the Work of Others and Outsourcing"

3. Informative References

Informative references are included to support DER owners and ICAP CCEs. It is strongly recommended that the DER owner's representative and ICAP CCE are familiar with these documents.

Institute of Electrical and Electronics Engineers

- IEEE 1547.2-2023
- IEEE 1547.3-2023
- IEEE 1547.9-2022

4. Glossary and Acronyms

This section describes the definitions and acronyms used within this document.

The ICAP CCE is responsible to have read and fully understood the reference standards.

4.1. Definitions

All definitions adopted in FortisAlberta DER-02 apply in this document.

In addition, the following definitions are applicable:

- **electrically remote:** an impedance greater than 0.5% on the service power base[1] between the points under consideration.
- **technical interconnection requirements:** the complete set of applicable DER requirements, including DER-02 and normative references required by DER-02, such as the IEEE 1547 series.

[1] Any transformer between a DER unit's terminals and the PCC is likely to cause the DER unit to be electrically remote from the PCC. In addition, voltage drop along cabling can cause DER unit measurements to be electrically remote from the PCC.

4.2. Acronyms

The following definitions apply in this document:

AESO	Alberta Electric System Operator
AIES	Alberta Interconnected Electric System
APEGA	Association of Professional Engineers and Geoscientists Alberta
CCE	commissioning conformity evaluator
CHIL	control hardware-in-the-loop
CSA	CSA Group (formerly Canadian Standards Association)
CT	current transformer
DER	distributed energy resource
DLS	detailed level study
EGP Act	Engineering and Geoscience Professions Act
EMI	electromagnetic immunity
EMT	electromagnetic transient
EUA	Electric Utilities Act
FAI	FortisAlberta Inc.
FCC	FortisAlberta Control Centre
GFOV	ground fault overvoltage
ICAP	IEEE Conformity Assessment Program
IEEE	Institute of Electrical and Electronics Engineers
LROV	load rejection overvoltage
NDA	non-disclosure agreement
PCC	point of common coupling
RPA	reference point of applicability
RVC	rapid voltage change
SCADA	supervisory control and data acquisition
TIRs	technical interconnection requirements

5. Overview of the FortisAlberta ICAP Process and Technical Reporting

The standard IEEE ICAP DER conformity evaluation process follows a two-phase protocol:

- a pre-site evaluation, and
- an on-site evaluation.

DERs of significant size connect to FortisAlberta's distribution system. To ensure large DERs[2] cannot cause damage to FortisAlberta's distribution system, the transmission system, or FortisAlberta's other customers, FortisAlberta mandates an additional step: on-site protection evaluation. The resulting minimum process is:

- Stage 1: Pre-site evaluation,
- Stage 2: On-site protection evaluation, and
- Stage 3: On-site performance evaluation.

At each stage, FortisAlberta requires a report from an ICAP CCE meeting the minimum technical requirements of this section. For more information on the process and its application in the overall DER connection process, see DER-02E.

5.1. General Technical Requirements for ICAP Reports

The ICAP report is a technical report that involves application of engineering judgement in determining whether requirements of the technical standards are addressed by the DER system. As a result, the requirements of the EGP Act and APEGA / ASET apply to the conformity evaluation. For more information, see DER-02E.

The following general requirements are applicable to the ICAP reports submitted for each stage of the ICAP process in FortisAlberta service territory.

5.1.1. Professional Licensees (Engineering) and Professional Technologists shall submit additional evidence demonstrating their scope of practice includes generator interconnection to IEEE 1547, and that they have training and experience in the application of the applicable edition of the IEEE 1547 series of standards outlined in FortisAlberta requirements.

5.1.2. ICAP reports shall be authenticated by a qualified professional and validated by a Permit Holder as per DER-02E, fully complying with the requirements of APEGA/ASET and the EGP Act. Authentication / validation of the ICAP report(s) are necessary for FortisAlberta to comply with APEGA's requirements on "Relying on the Work of Others and Outsourcing". No exceptions will be given.

5.1.3. Supporting evidence documents demonstrating conformity of the DER system consist of:

- authenticated / validated original design documents,
- test reports, or
- other applicable documents

5.1.4. Supporting evidence documents demonstrating conformity of the DER system shall be attached to each ICAP report.

[2] i.e. DERs ≥ 500 kVA.

5.1.5. Documentation shall be provided to support evidence of conformity to each requirement.

5.1.6. It is recommended that the DER owner and the ICAP CCE obtain copyright and disclosure approval from any party as required prior to submitting the supporting evidence documents to FortisAlberta. FortisAlberta is bound by the Code of Conduct Regulation and will not sign any NDAs either with the DER owner, the ICAP CCE, or any equipment manufacturer or consultant; doing so could put FortisAlberta in violation of the Code of Conduct Regulation.

5.1.7. The ICAP report and supporting evidence documents shall be structured to transparently provide all details of the evaluation undertaken by the ICAP CCE, for independent assessment and evaluation by FortisAlberta's engineers during or after the ICAP process.

5.1.8. Each ICAP report may be a revision of the previous ICAP report or may be a completely independent report at the discretion of the ICAP CCE. If separate reports are utilized, a summary with each report attached shall be submitted to FortisAlberta for record at the conclusion of the ICAP process.

5.2. Technical Requirements for the Pre-Site Evaluation Report

The pre-site evaluation report provides indication that all the requirements will be met by means of evaluating the design documents for the DER system.

5.2.1. The pre-site evaluation report shall include a copy of the Design Evaluation (see section 10).

5.2.2. Evaluation shall include a detailed checklist of all requirements in the applicable standards and how each requirement is met by the design of the DER system.

5.2.2.1. The ICAP report(s) addressing the pre-site evaluation shall contain an appropriate ICAP CCE checklist for the DER under consideration (e.g. “P4 PCC Composite Pre-Site Checklist”).

5.2.2.2. The ICAP report(s) shall include a checklist addressing DER-02 requirements (e.g. a checklist such as annex D).

The pre-site evaluation report submission may identify areas where the DER can never conform to the requirements of the standards. Areas where the DER can never conform to the requirements may prevent the DER from ever being connected; it is strongly recommended to obtain a review of the pre-site evaluation report before undertaking procurement or construction.

FortisAlberta recommends that the DER owner determine what testing and evaluation evidence will be submitted to demonstrate conformity to each requirement, and the pre-site evaluation report be completed and submitted as early as possible.

FortisAlberta will not permit connection, even for testing, without the pre-site evaluation report being accepted by FortisAlberta.

5.3. Technical Requirements for the On-Site Protection Evaluation Report

The on-site protection evaluation report consists of witnessing by the ICAP CCE of the testing of all applicable protective system elements implemented on the DER system. The on-site protection may be demonstrated by tests such as secondary injection tests for protection system relays or by

certification documents where DER unit protections are permitted to be used[3].

FortisAlberta personnel may attend this test, but witness by FortisAlberta personnel is independent of the assessment of the ICAP CCE. The FortisAlberta witness may only address a subset of the interconnection requirements, while the ICAP CCE is responsible for full conformity assessment.

5.3.1. The ICAP report(s) addressing the on-site protection evaluation shall contain evidence of conformity with all protection requirements in FortisAlberta DER-02 and the IEEE 1547 series[4].

5.3.2. The ICAP report(s) addressing the on-site protection evaluation shall contain a clear statement of attendance and witness by the ICAP CCE.

5.4. Technical Requirements for the On-Site Performance Evaluation Report

The ICAP report(s) addressing on-site performance evaluation requires witnessing by the ICAP CCE of the testing of all DER system control and power quality performance. The on-site performance evaluation is typically performed with the generator online and operating under controlled / monitored conditions.

5.4.1. The ICAP report(s) addressing on-site performance evaluation shall contain evidence of conformity with all control and power quality requirements in FortisAlberta DER-02 and the IEEE 1547 series, including diagrams similar to those of Annex H of IEEE 1547 relating the requirements to the performance.

5.4.2. The ICAP report(s) addressing on-site performance evaluation shall contain a clear statement of attendance and witness by the ICAP CCE.

5.4.3. The ICAP report(s) addressing on-site performance evaluation shall contain an appropriate ICAP CCE checklist for the DER under consideration (e.g. “S4 PCC Composite Onsite Checklist”).

6. Technical Limitations of the ICAP Process

The ICAP process is intended to support evaluation of conformity of a complete and installed DER system to the requirements of the IEEE 1547 series. However, the ICAP process is not a substitute for equipment certification that is inclusive of equipment type testing to the IEEE 1547 series.

While FortisAlberta permits connecting DER systems that utilize DER units which are not certified to the IEEE 1547 series in line with requirements in DER-02, detailed evaluations and testing must be performed by licensed professionals to show that:

- the DER system will meet the performance requirements defined in the interconnection standards (i.e. DER-02 and IEEE 1547), and

[3] DER unit protections are unlikely to be permissible for DER systems for which this standard is applicable. IEEE 1547 indicates requirements where DER unit protections may be applicable to larger systems (e.g. where demonstrable low impedance exists between the DER unit terminals and the POC). FortisAlberta reserves the right to reject any given protection system that does not adequately protect the FortisAlberta distribution system, the transmission system, or other FortisAlberta customers.

[4] Generally, this includes all requirements of IEEE 1547 Clause 6 "Response to Area EPS Abnormal Conditions" and IEEE 1547 Clause 8 "Islanding". Evidence of appropriate protective trips for faults both within the DER and outside the DER are necessary. Evidence that protective action (e.g. tripping) does not impede ride-through performance is also necessary.

- the DER system will not cause harm to the FortisAlberta distribution system, the transmission system, and other FortisAlberta customers.

7. Supporting Evidence Documents

This section addresses supporting evidence documents to be included with each ICAP report.

7.1. At a minimum, the ICAP report(s) shall contain:

1. checklist(s) and any other document summarizing evaluation of conformity with the requirements (e.g. ICAP checklists P4 and S4);
2. a DER System AC single line, showing all applicable protections and equipment between the DER unit terminals and the PCC, including any supplemental DER devices;
3. a protection and control system design description, indicating how all requirements of FortisAlberta and IEEE requirements are met[5];
4. permits / inspection reports by a qualified Safety Codes Officer;
5. applicable certification documents for DER units and any supplemental DER devices;
6. applicable special inspection / field evaluation reports for DER units and any supplemental DER devices;
7. authenticated engineering studies, where studies are utilized to demonstrate conformity with the requirements in lieu of testing.

7.2. The DER owner and ICAP CCE shall have the written approval of FortisAlberta to accept evidence of conformity to the requirements other than by testing at FortisAlberta's sole discretion. Certification documents are considered evidence of testing (by the certification body) for this purpose; this requirement typically applies where studies are to be utilized in lieu of actual field testing.

8. Witness Requirements

8.1. The ICAP CCE shall witness all commissioning testing providing evidence of conformity to the requirements.

8.2. The ICAP CCE is not required to witness type testing or production testing as defined in the IEEE 1547 series but must review the evidence of conformity (e.g. certifications or special inspection reports). Where commissioning testing is utilized due to a lack of type testing or production testing evidence, the ICAP CCE shall witness the testing.

8.3. The ICAP CCE may be supported by other personnel. See DER-02E for more information.

9. Variances

This section provides an overview of variances and their application to the ICAP process.

9.1. Overview of Variances

9.1.1. FortisAlberta may or may not permit variances to certain technical requirements if it can be shown

[5] This description may be incorporated in a protection study provided by the DER owner's professional of record.

that the distribution system will not be negatively impacted for the foreseeable life of the DER system[6]. FortisAlberta will assess the suitability of a variance based on the impact to the distribution system both now and in the future.

9.1.2. Variances shall be documented by the ICAP CCE as a non-conformity with the requirements; however, the non-conformity may be marked closed based on the variance.

9.1.3. Evidence of the variance in writing from FortisAlberta shall be included with the ICAP report(s).

Some common variances granted on a per-project basis by FortisAlberta are provided below. The DER owner is not entitled to the variances noted in this section; they are for reference only as typical examples of variances.

- AESO-Permitted Ride Through Variances
  - The AESO has responsibility on the AIES for management of frequency. Where AESO provides permission in writing to a DER owner, FortisAlberta may permit DER owners to connect DER that do not meet ride through requirements or meet other ride through requirements specified by AESO for the system under consideration.
  - Notwithstanding the AESO's permission for alternative ride through requirements, DER system protective and control functions must continue to operate until the DER has ceased to energize and tripped.
- Interoperability Variances
  - Section 17 of this standard describes some typical variances to IEEE 1547 series interoperability requirements that may be permitted for DERs.

10. Design Evaluation

This section describes the requirements for the design evaluation conducted as part of DER connection.

10.1. General Requirements for the Design Evaluation

10.1.1. The design evaluation for the DER system shall assess and determine whether existing type testing and production testing of the DER system demonstrates conformity with the requirements at the RPA. Generally, unless a DER system has been designed and undergone certification testing as a whole, complete with remote measurement systems (e.g. at the PCC), type testing of individual components cannot demonstrate conformity of the system as a whole.

10.1.2. The design evaluation shall assume that all tests are required unless it can be demonstrated that existing type or production testing already demonstrates conformity with the requirements. The licensed professional performing the design evaluation must justify in writing why testing is not required, with appropriate evidence, to FortisAlberta.

10.1.3. For uncertified DER units, the design evaluation shall be performed together with the uncertified DER unit evaluation. Refer to 10.3 and annex E.

[6] A typical generator lifetime for DER is 20-30 years; this is also often the term of an interconnection agreement. Upon renewal, interconnection agreements for DERs may require bringing the DER up the standard of the time.

10.2. Specific Topics for Design Evaluation

10.2.1. The design evaluation shall directly evaluate the following specific topics:

- RPA location and measurement system;
- application of external protections (e.g. power system relaying) for the RPA;
- zero-sequence continuity between the DER units and the FortisAlberta primary distribution system (e.g. 25 kV), and the effects on the above items;
- LROV / GFOV mitigation, including DER settings and supplemental DER devices necessary to mitigate;
- RVC, including energization of customer-owned transformers associated with the DER system;
- whether all components fulfilling IEEE 1547 requirements were type-tested and certified together as a single system;
- whether certified DER units were utilized (see annex E).

10.2.2. In addition, the design evaluation shall address all topics described below as required for inclusion in the ICAP report(s).

10.3. Design Evaluation for DER Systems including Uncertified DER Units

10.3.1. Where DER units that are not certified to the IEEE 1547 series are utilized, the design evaluation shall identify type tests and production tests required by IEEE 1547.1 for which evidence of certification testing is not available.

10.3.2. The DER owner shall propose a testing program as per annex E.

10.3.3. Where tests cannot be performed adequately, the design evaluation shall identify the mitigations put in place to ensure untested capabilities do not create a hazard to the distribution system.[7]

11. Generator Profile

DER systems are assigned a normal operating performance category and an abnormal operating performance category, which further define the detailed performance requirements for the DER system.

11.1. The ICAP report(s) shall incorporate clear statements regarding the performance categories assigned to the DER system by FortisAlberta as per DER-02 or the FortisAlberta DLS.

11.2. If clarification or variance is required, it shall be obtained in writing from FortisAlberta, and the clarification or variance shall be included as an exhibit to the ICAP report(s).

[7] Testing and evidence of performance is one means of mitigating technical risk of DERs. Other means may be available. It is left to the DER owner to propose technical solutions to mitigate the risks to the distribution system associated with lack of demonstrated, certified conformity to the standards. Each requirement must be demonstrated as being conformant or the hazard of non-conformity must be mitigated. The ICAP report must ultimately identify all non-conformities, and the DER owner must propose mitigations. See DER-02E.

12. Reference Point of Applicability (RPA) and Measurements

DER systems to which this standard is applicable generally have the RPA at the PCC. As a result, the RPA is often electrically remote from the DER unit terminals, and thus the DER unit measurements do not accurately reflect the conditions at the RPA.

12.1. The ICAP report shall include an assessment as to whether measurement is being conducted at the RPA for each requirement. For large systems, relaying protection is often required for conformity with IEEE 1547 clause 6, while a power plant controller having measurement at the PCC is often required for conformity with IEEE 1547 clause 5.

12.2. The ICAP report shall include evidence of conformity with the measurement accuracy requirements. To demonstrate conformity, it may be necessary to provide the datasheets for any instrument transformers, and a calculation of the total accuracy as provided to the protection and control elements of the DER; the DER owner shall provide this calculation.

12.3. The ICAP report shall include evidence that measurements for protection systems will not be impacted by CT saturation.

13. Active / Reactive / Apparent Power Capability

FortisAlberta requires that DER systems contribute reactive power to support grid stability and maintain active / apparent power ratings in compliance with their interconnection agreements. The IEEE 1547 series lays out reactive power capability requirements.

13.1. The ICAP report shall include evidence of evaluation of the reactive power capability of the DER at the RPA, inclusive of any reactive consumption due to cables, transformers, or other devices. The reactive power requirements must be demonstrated across the range of voltages specified in the IEEE 1547 series for the given normal operating performance category.

Because of the typical operating condition of FortisAlberta's rural distribution system, it is often not possible to directly demonstrate the reactive capability of a DER system by testing. Evidence including a load flow study, complete with a DER system reactive power capability curve, may be acceptable[8].

14. Protection Requirements

FortisAlberta requires that DER systems detect and respond to faults on the FortisAlberta distribution system and system conditions on the transmission system, and either ride through the fault or cease to energize and trip according to the requirements of the IEEE 1547 series.

14.1. The ICAP report shall include evidence of evaluation of the protection system. Note: because testing of protection systems under applied fault conditions is not possible without affecting the distribution system and other customers, a combination of a protection study, instrument transformer testing, and relay testing by secondary injection is often used together to demonstrate the suitability of the overall protection system.

[8] For example, see “Generation Capability Curves for Wind Farms”, E. Enrique, 2014 and IEEE Std 3002.2.

14.2. Where direct transfer trip is used for anti-islanding, the ICAP report shall include the evidence of direct transfer trip testing, and the ICAP CCE shall have witnessed the testing. Where other active anti-islanding methodologies are being utilized, evidence of suitability of the anti-islanding scheme may include certification documents and/or EMT studies.

15. System Grounding

FortisAlberta's primary distribution system is operated as an effectively grounded system.

15.1. The ICAP report shall identify whether the requirements of DER-02 and DER-02B have been met. Specifically, the ICAP report should clearly identify the analyses performed (e.g. DER-02B EMT study), the mitigations recommended, and whether the mitigations were implemented and tested in the field for both key topics: relay desensitization and ground fault overvoltage.

16. Ride Through Requirements

The IEEE 1547 series specifies requirements for ride through, to ensure that generation does not unnecessarily leave the transmission system during bulk system contingencies; FortisAlberta requires conformity to these requirements to ensure the reliability of the AIES.

16.1. Review of Non-DER Protection Affecting Ride Through

IEEE 1547 does not permit DER systems to exit service during ride-through for self-protection as a direct or indirect result of a voltage disturbance within the ride-through region; DER systems must be capable of riding through.

16.1.1. As a result, the ICAP report(s) shall evaluate whether any equipment connected between the terminals of a DER unit or supplemental DER device and the PCC will cause the DER to fail to comply with ride-through. This may be due to equipment such as voltage elements protecting motors, or overcurrent elements with extremely aggressive settings for arc flash mitigation.

16.2. Application of Batteries, Capacitors, or Other Equipment to Support Ride-Through

DER system equipment must remain online and functional as required in the ride through requirements of the IEEE 1547 series. Batteries, capacitors, or other equipment are used in some DER system designs to ensure protection and control equipment remains in service during fault conditions on the power system.

16.2.1. The ICAP report(s) shall evaluate whether any applied batteries, capacitors, or other equipment conforms with the ride through requirements.[9]

[9] As an example: protective relaying equipment is often supplied by battery systems sized in conformity with IEEE 485. IEEE 485 calculations may support analysis of conformity to the requirements.

17. Interoperability Requirements

This section addresses requirements regarding interoperability and SCADA.

17.1. Overview

To permit the coordinated operation of the grid as a whole, the IEEE 1547 series specifies requirements for interoperability interfaces. The DER system must offer the full interface; however, FortisAlberta testing at this time is limited to only basic interoperability testing. Note that the DER system must provide a single interface as per the IEEE 1547 series, and not one interface per DER unit.

17.1.1. Interoperability points required by IEEE 1547 shall be based on aggregate values for the DER system at the RPA.

17.1.2. The DER owner shall be responsible for implementing the fully conformant interface.

17.1.3. The ICAP report(s) shall describe the complete conformity of the DER system interoperability interface to the requirements of both DER-02 and the IEEE 1547 series.

17.2. Basic Interoperability Testing

FortisAlberta conducts basic testing of key features currently implemented in FortisAlberta's distribution system.

17.2.1. The ICAP report(s) shall provide evidence of the completed basic interoperability testing; the evidence may be an e-mail from the FortisAlberta SCADA representative.

17.3. Detailed Interoperability Testing

17.3.1. The DER owner shall undertake detailed interoperability testing of DER systems to confirm that they correctly implement all the required monitoring, control, and information exchange capabilities. Annex C provides information on potential means to achieve this testing. Qualified licensed professionals should be consulted for this testing.

17.3.2. The ICAP report(s) shall provide evidence of the completed detailed interoperability testing following the on-site performance evaluation, prior to entering commercial operation.

Some common variances granted on a per-project basis by FortisAlberta are provided below for interoperability. The DER owner is not entitled to the variances noted in this section; they are for reference only as typical examples of variances.

- Typical Variance: Permit Service
    - IEEE 1547 describes "permit service" as a setting that:
        - When enabled, allows the DER to connect to the grid and export power.
        - When disabled, causes the DER to immediately cease to energize and trip, and not return to service until re-enabled.
    - Where PCC protection is utilized, FortisAlberta requires the ability to trip the protection via SCADA and block it from reclosing. By tripping the DER and then preventing it from reclosing, these two settings perform a similar function to permit service; however, the FortisAlberta method is more permissive, as it allows FortisAlberta to block close should

a DER trip, but continue generating until it does, whereas permit service inhibits generation when blocking closure.

- FortisAlberta may permit a DER system that implements both remote trip and block close via SCADA (as required in DER-02) to omit the permit service parameter.

- Typical Variance: Relay Settings
  - IEEE 1547 clause 10 specifies requirements regarding the ability to remotely set frequency and voltage trips for DER systems. It is not good protection relay operating and maintenance practice to operate a relay with revised settings unless it has been tested to operate correctly with those settings[10]. Indeed, many protection relays do not offer a way to remotely set relay settings.
  - FortisAlberta may permit a DER system relying on protection relaying to prevent remote changing of relay settings. FortisAlberta may require DER owners to change settings and re-test within a given timeframe as part of the Interconnection Agreement.

18. Other DER System Elements

This section describes DER system elements other than protection or active / reactive power control.

18.1. Isolation Device

FortisAlberta may require a visible break isolation device for some DER systems, as per DER-02.

18.1.1. The ICAP report(s) shall provide evidence of the visible break isolation device that has been provided in conformity with DER-02 requirements. This evidence must be provided during the on-site protection evaluation stage.

18.2. Interconnection Integrity

The IEEE 1547 series makes requirements for generators to survive certain power system surges or electromagnetic interference.

18.2.1. The ICAP report(s) shall evaluate whether all DER system equipment, including DER units and supplemental DER devices, meet the interconnection integrity requirements of the IEEE 1547 series, including surge and electromagnetic interference withstand capabilities.

18.2.2. DER unit type testing / certification may provide evidence of conformity with the interconnection integrity requirements.

18.2.3. Where type testing / certification evidence to the performance level required by the IEEE 1547 series cannot be demonstrated, the ICAP report shall disclose the standard (if any) to which each element of DER system equipment has been type tested / certified; if no evidence is available, the ICAP report must explicitly state this to be the case.

18.3. Paralleling device and synchronization

Equipment capable of independently generating voltage must have a suitably rated device for managing the paralleling of the generation with the distribution system.

[10] e.g. via secondary injection testing.

18.3.1. The ICAP report(s) shall evaluate the suitability of the DER paralleling device (e.g. circuit breakers or contactors) to withstand 220% of the rated voltage[11]. Evidence may include type testing of the paralleling device, or field testing of dielectric withstand across the contacts. This evidence must be provided during the on-site protection evaluation stage.

18.3.2. The ICAP report(s) shall evaluate the method of controlling synchronization (e.g. sync. check relaying), and whether the settings are in compliance with the standards.

18.4. Enter service / return to service

The IEEE 1547 series makes requirements on the conditions under which equipment may enter and exit service. In addition, DER-02 mandates a communication capability to modify the enter service delay (conforming with IEEE 1547 enter service settings requirements).

18.4.1. The ICAP report(s) shall evaluate how the enter service criteria are met and which devices manage enter service behavior (i.e. a relay / breaker or the DER units themselves).

18.4.2. The ICAP report(s) shall evaluate how the enter service delay is implemented.

19. DER System Performance and Testing Requirements

DER systems are required to control active and reactive power and voltage in accordance with the system conditions and interoperability interface settings as per the requirements of the standard.

19.1. Requirements for Online Testing, Limitations of Online Testing, and Support by Study

Some DER systems utilize custom protection and control devices which are not certified as a system with the DER units they supervise and control. Online testing is typically required for such systems to ensure the control behaviors and protection behaviors meet the interconnection requirements.

19.1.1. Where type testing as per IEEE 1547.1 of the full DER system has not been conducted, field testing shall be performed; however, full online field testing conformant with IEEE 1547.1 may not be possible[12].

19.1.2. If online testing is performed, the DER owner shall submit a testing plan for all DER system performance testing to FortisAlberta for approval. The testing plan must describe:

- which behaviors will be tested, and how they will be tested,
- steps taken to ensure FortisAlberta's distribution system remains within its required operating conditions (e.g. power quality and voltage levels) while the DER is under testing, and,
- how conformity with the requirements will be evaluated.

19.1.3. Where testing cannot reasonably be performed within certain operating regions (e.g. exporting VARs or ride through), engineering analysis undertaken by licensed professionals such as EMT simulation (e.g. for ride through), load flow simulation (e.g. for reactive power capability), or other analysis may supplement the testing to demonstrate conformity.

[11] Withstand testing may conform to the requirements of standards such as IEEE C37.09 or IEC/IEEE 62271-37-013.

[12] For example: FortisAlberta will not permit the DER owner to connect a fault to the FortisAlberta distribution system to test ride-through.

19.1.4. Engineering analyses used as evidence of conformity shall conform to Annex B.

19.1.5. FortisAlberta must approve the use of engineering analysis to meet requirements, and FortisAlberta reserves the right to reject any analysis at its sole discretion.

19.1.6. The ICAP report(s) shall clearly indicate which performance requirements have compliance demonstrated using engineering analysis.

19.1.7. The ICAP report(s) shall clearly indicate which performance requirements have compliance demonstrated via field testing in lieu of type testing or production testing.

19.1.8. All field test reports, and engineering analyses used as evidence of conformity shall be included as exhibits in the ICAP report(s).

19.2. Voltage / Power Control Testing

19.2.1. Where the DER system is comprised of components which have not been tested and certified as a system, the DER system control functions shall be tested during commissioning.

20. Power Quality Testing

FortisAlberta makes requirements on the power quality delivered to customers on its distribution system. FortisAlberta places limitations on the effects DERs may have on the power quality of the distribution system, to ensure other customers are not affected.

20.1. Power Quality Testing During Commissioning

20.1.1. The DER owner is responsible to ensure that testing is conducted in a manner that ensures conformity with the FortisAlberta power quality requirements.

20.1.2. The DER owner's testing plans shall indicate how power quality will be monitored and managed during testing, to ensure integrity of the FortisAlberta distribution system.

20.1.3. If, during testing, the DER system does not meet the power quality requirements, the DER owner shall shut down the DER system and make any necessary modifications to ensure compliance.

20.1.3.1. The DER owner shall submit an event report, complete with details of the power quality issue leading to the shutdown.

20.1.4. The ICAP report(s) shall include any power quality event reports prepared by the DER owner, complete with evidence of mitigation.

20.2. Power Quality Pre-/Post-Testing

20.2.1. FortisAlberta requires testing of power quality for one week prior to interconnection of the DER system and for one week following its completion.

20.2.2. In addition, IEEE 1547.1 makes requirements on power quality monitoring during testing. The IEEE 1547.1 power quality tests need not be conducted separately if power quality monitoring conforming to FortisAlberta DER-02 requirements is being conducted (e.g. pre-/post-testing).

20.3. Right to Disconnect

20.3.1. FortisAlberta is responsible to maintain power quality for its customers. If the DER system is discovered to be causing power quality issues, FortisAlberta may direct the DER owner to disconnect the DER system or otherwise cause the DER system to disconnect (e.g. remote trip).

20.3.2. The DER system shall not reconnect until the power quality issue is remedied and permission is given in writing from FortisAlberta engineering and FCC.

20.4. DC Injection and Transformers

20.4.1. DC injection does not require testing if the PCC is isolated from all DER units by one or more isolation transformers providing galvanic separation between windings[13].

20.4.2. The ICAP report(s) shall clearly identify where DC injection evaluation has been omitted due to the presence of interfacing transformers.

20.5. GFOV / LROV

Over-voltages may arise from ground faults or due to load rejection[14]. The IEEE 1547 series makes requirements on GFOV and LROV.

20.5.1. The ICAP report(s) shall include evidence of verification of GFOV and LROV. DER-02B may require analysis of GFOV and LROV using EMT simulation.

20.5.2. Where testing of LROV must be conducted, it shall meet the requirements of IEEE 1547.1 for measurement equipment.

20.5.2.1. In addition, the DER owner must have a licensed professional conduct an assessment of the safety of performing LROV testing[15].

20.6. RVC

Rapid voltage change may occur due to control behaviors of DER systems[16] or due to switching of equipment (e.g. transformer inrush).

20.6.1. The ICAP report(s) shall include evidence of verification of transformer inrush for DER systems that include transformers.

20.6.1.1. Note: DER-02A requires a transient analysis of transformer inrush for the worst-case transformer flux and system conditions.

20.6.1.2. Power quality testing included with the ICAP report(s) shall contain evidence of an inrush event being captured.

20.6.2. The ICAP report(s) shall include evidence of management of ramp rates for DER systems and shall evaluate whether power quality testing showed any evidence of RVC during DER system operation.

20.6.2.1. The ICAP report(s) shall confirm that ramp rate limits are set on each DER unit, and also on any plant controller(s).

20.6.2.2. Testing for ramp rate management shall include sudden loss and restoration of generation, including due to loss and restoration of communications.

[13] Transformer configurations where the windings are not galvanically isolated require evaluation of DC injection.

[14] I.e. load suddenly being removed from the system, or the DER system being disconnected from the grid.

[15] E.g. due to conditions such as ferroresonance.

[16] E.g. changing the power export of DER systems without respecting ramp rate constraints.

Annex A (Informative)

Applicable Standards and the Canadian Context

This informative annex provides some guidance on applicable codes and standards for DER interconnections within FortisAlberta territory to support ICAP CCEs in addressing the specific requirements. It addresses the relationship between CSA C22.1, the Canadian Electrical Code Part I, and FortisAlberta distribution standards. It further addresses the relationships between safety certifications and interconnection certifications. Finally, for larger DERs, it provides a reminder of compliance requirements with AESO's ISO Rules and the Alberta Reliability Standards.

A1. Canadian Electrical Code and FortisAlberta Standards

CSA C22.1 provides the requirements for interconnection of electrical systems owned by non-utilities, and it is adopted in Alberta via the Electrical Code Regulation. Rule 84-002 requires "electrical power production equipment" to conform with the requirements of the "supply authority". The supply authority in FortisAlberta distribution territory is FortisAlberta Inc.; as a result, compliance with FortisAlberta standards is not only a requirement of interconnection under FortisAlberta's terms and conditions, but are mandated by the Canadian Electrical Code.

FortisAlberta specifies technical standards, including DER-02 and PQ-SPEC-01. These standards incorporate by normative reference other standards such as IEEE 1547, IEEE 1547a, and IEEE 1547.1. These requirements are intended to provide suitable DER system capabilities for distribution and transmission system stability and equipment protection.

CSA C22.1 84-014 requires that "electrical power production equipment" provide any additional devices as necessary for system stability and equipment protection. It is the intent of FortisAlberta's distribution standards, including the applicable normative references, to define the requirements for system stability and equipment protection.

A2. Equipment Certification and DER System Conformity

FortisAlberta DER-02 and the IEEE 1547 series place requirements on the interconnection of a full DER system, including any supplemental DER devices (e.g. protection relays, switchgear, and plant controllers) and all DER units that form part of the DER system.

The requirements for performance of a DER system are at the RPA[17], typically the PCC. DER units are typically certified to meet the performance requirements at their terminals. As a result, equipment installed between the DER unit terminals and the RPA may impact the ability of the DER unit to meet its requirements in conformity with the interconnection standards.

Typical examples of issues arising in DER systems are:

- breaking zero sequence continuity with a transformer having an ungrounded delta or wye winding, and

[17] For all DER systems covered by this standard, the RPA will be the PCC, which is typically remote from the DER unit terminals.

- significant cable or transformer impedance.

These issues can inhibit the protection systems offered in fully certified DER units, preventing them from seeing and responding to system conditions on the FortisAlberta distribution system and/or the transmission system, as required in the standards.

The ICAP DER process is required to evaluate even DER systems that include fully certified DER units, because of the risks associated with these issues. For more information, IEEE 1547.2 provides reference on many system-level issues that may inhibit unit-level performance at an RPA that is remote from the DER unit terminals (e.g. the PCC). Engineering judgement is generally required for evaluation of the impacts of specific equipment on the performance requirements under FortisAlberta standards.

A3. Special Inspection and DER System Conformity

CSA C22.1 requires approval of all electrical equipment in rule 2-024. In Alberta, the Electrical Code Regulation lays out the requirements for approval, requiring that equipment be certified or inspected by a body accredited with the Standards Council of Canada to be "approved".

Certification generally follows applicable CSA C22.2 standards or other standards, as listed in CSA C22.1 Annex A. Certification testing is conducted thoroughly by testing labs under controlled conditions within a laboratory or factory environment. It is generally rigorous, and it is always recommended that certified equipment be purchased.

For equipment that has not received certification testing, inspection may be possible. CSA SPE-1000 provides the framework for performing inspections (also called field evaluations) of modified or uncertified electrical equipment in Alberta. Use of this standard is permitted under Alberta's Electrical Code Regulation as a means of demonstrating conformity with applicable standards.

Generally, CSA SPE-1000 is intended to provide safety evaluation requirements to ensure safety of persons and property in respect of electrical equipment. However, generally the SPE-1000 process is limited only to basic electrical testing. SPE-1000 does not provide evidence of conformity to grid safety requirements such as those specified in FortisAlberta DER-02 and the IEEE 1547 series of standards. For this reason, FortisAlberta mandates the ICAP process and requires a deeper evaluation of unit-level capabilities where applicable.

A certification to the requirements of IEEE 1547, such as provided via UL 1741 SB evaluation, provides the most expedient evidence of DER unit conformity. It is always recommended that DER owners pursue DER unit certification where feasible. Uncertified DER units carry significant risks of being unable to meet the requirements, and therefore carry significant risks of being prohibited from connecting to FortisAlberta's distribution system.

A4. ISO Rule and Alberta Reliability Standard Compliance

The Alberta Electric Utilities Act requires that electricity market participants comply with the ISO rules and reliability standards[18]. The ISO rules and reliability standards are specific rules of conduct for the Alberta Interconnected Electric System for the conduct of all parties to keep the grid in a stable operating condition that serves the public interest.

DER owners are electricity market participants[19], and are obligated to comply with the ISO rules and reliability standards in respect of DER systems they install. This requirement can be seen as an extension of CSA C22.1 84-002 and 84-014.

FortisAlberta does not enforce compliance to the reliability standards, except to the extent required by the ISO rules and reliability standards. The DER owner is responsible for conformity with the ISO rules and reliability standards. In addition, the DER owner may be required to support FortisAlberta in meeting FortisAlberta's requirements under the ISO rules and reliability standards, to the extent that the DER system affects compliance. The DER owner is required to work together with the AESO and FortisAlberta to ensure conformity with the requirements of the ISO rules and the reliability standards.

[18] See 20.8 of the Alberta Electric Utilities Act.

[19] i.e. "… any person that supplies, generates, … stores, discharges, … electricity, electric energy, electricity services or ancillary services" as per the EUA.

Annex B (Normative)

Study Evidence and Equipment-Level Validation

Where studies are utilized as evidence of compliance with the requirements, the following requirements are provided to ensure studies meet appropriate engineering standards.

B1. Professional Involvement

B1.1. All studies used as evidence of conformity with the technical interconnection requirements shall be undertaken by a licensed professional.

B1.2. The licensed professional shall hold one of the following qualifications:

- APEGA licensed professional engineering (P.Eng.),
- APEGA professional licensee, engineering (P.L.(Eng.)), or,
- ASET professional technologist (P.Tech.)

B1.3. For licensed professionals holding P.L.(Eng.) and P.Tech. qualifications, the study report submitted by the licensed professional must include evidence of the limited Scope of Practice approved by the appropriate professional regulator.

B2. Equipment-Level Validation

B2.1. Where studies are utilized to confirm conformity with the requirements, the equipment models shall be validated against the actual as-installed, as-configured equipment. The validation may consist of component-level testing, such as:

- time-domain reflectometry and impedance testing to confirm cable length and properties as per NETA ATS;
- transformer testing as per NETA ATS;
- CHIL testing of plant controllers; or,
- secondary injection testing of protection relays.

B2.2. Studies based only on design data are considered preliminary (indicative) and may not be used to confirm ultimate conformity with the requirements. Updated studies based on field-tested data must be completed by the licensed professional and submitted with the final Stage 3 ICAP report(s).

B3. System-Level Validation

B3.1. Where studies are utilized to confirm conformity with the requirements in regions that could not be tested, the system model shall be validated against the testing in regions that could be tested to the extent possible. This validation is comparable to system-level model validation testing in transmission.

Annex C (Informative)

Interoperability Testing Tools

Interoperability testing is generally conducted at two levels in accordance with this standard: basic level testing and detailed level testing. This annex describes some tools available to DER owners to perform interoperability / SCADA testing. The information contained in this annex is intended for use by a professional engineer, professional licensee (engineering), or professional technologist who is qualified in design, implementation, and testing of SCADA systems.

The information provided here is not an endorsement of these tools by FortisAlberta; these tools shall not be used on FortisAlberta systems or equipment without prior written approval from FortisAlberta. The user is responsible to evaluate the safety of any tools mentioned in this section for use on their DER system.

Basic level testing is an online test conducted with FortisAlberta personnel to demonstrate the functionality of the minimum SCADA system requirements currently imposed by FortisAlberta. Detailed level testing is conducted by the DER owner on the system to demonstrate full conformity to the FortisAlberta and IEEE 1547 series requirements. It should include validating that the applicable DER system interoperability interface is available and reporting the correct data in respect of the DER system.

Some no-cost / open-source testing tools available to aid in testing include:

- **nmap** (https://nmap.org) - This tool is used for network evaluation, and may be used to evaluate the interoperability interface for cybersecurity purposes.
- **Wireshark** (https://www.wireshark.org/) - This tool is used for evaluation of communications during troubleshooting. It can be used with various tools for capture of network traffic or serial traffic, to evaluate whether communications are successfully being transmitted across the wire.
- **FreyrSCADA DNP3 Master Simulator** (https://sourceforge.net/projects/dnp3-client-master-simulator/) - This tool is utilized to simulate a DNP3 master / client (e.g. FortisAlberta's SCADA system) using serial or TCP/IP or UDP/IP.

Reports from these tools or other tools may provide evidence of testing, but should be accompanied by a written report from a qualified testing engineer.

Annex D (Informative)

IEEE ICAP Report Checklist

The following checklist is provided as a guide to support ICAP CCEs in meeting the requirements outlined in this standard. It is informative only, and the ICAP CCE remains responsible for the evaluation of the DER system as required in the normative sections of this standard.

This supplements the standard IEEE ICAP process, and some items may overlap.

Pre-Site Evaluation Report Checklist

- □ ICAP CCE qualifications
- □ Pre-site checklist included (e.g. P4)
- □ Onsite checklist included (e.g. S4)
- □ Written approvals where evidence other than testing is used
- □ Written variances to interconnection requirements, where applicable
- □ DER design evaluation report
- □ Uncertified DER unit evaluation summary and ITP (if applicable)
- □ Statement of operating performance categories (normal / abnormal)
- □ Measurement assessment / conformity
- □ CT saturation checks
- □ Reactive power capability assessment
- □ Effective grounding report, GFOV, and relay desensitization check
- □ Battery, capacitor, or other equipment ride through check
- □ Description of DER system interoperability interface
- □ Interconnection integrity evidence
- □ Description of enter service / synchronization controls

On-Site Protection Evaluation Report Checklist

- □ Isolation device evidence
- □ Protection test evidence
- □ Paralleling device withstand evidence
- □ DTT test evidence
- □ Enter service delay implementation (if managed by protective equipment)

On-Site Performance Evaluation Report Checklist

- □ Onsite checklist included (e.g. S4)
- □ Evidence of detailed interoperability testing
- □ Enter service delay implementation (if managed by DER units)
- □ Statements defining fully tested versus study-supported conformity
- □ Power quality event reports
- □ Evidence of GFOV / LROV mitigation
- □ Evidence of ramp rate controls
- □ Evidence of RVC transformer inrush event (if applicable)
- □ Evidence of conformity for uncertified DER units

Annex E (Normative)

Evaluation of Certified versus Uncertified Units

Notwithstanding the Canadian Electrical Code requirements of 2-024[20], FortisAlberta may permit DER units that lack specific, comprehensive certification to the IEEE 1547 series to connect to the FortisAlberta distribution system. Additional steps must be undertaken to ensure the DER system as a whole performs in accordance with the interconnection requirements.

The requirements of the standards are placed upon the DER system as a whole. As a result, DER units provide some requirements, and other supplemental DER devices (e.g. relays, surge arrestors, breakers, power plant controllers) may meet the interconnection requirements. This annex is used where the DER units do not possess certification, and thus cannot be directly relied upon at the unit level.

E1. Overview of Application of Uncertified DER Units

E1.1. Certification (i.e. type testing) typically provides testing for all items included in IEEE 1547.1, including tests for:

- temperature stability of the DER unit,
- response to voltage disturbances (including tripping and ride-through),
- response to frequency disturbances (including tripping and ride-through),
- enter service behavior,
- interconnection integrity (including surge withstand and electromagnetic interference),
- synchronization behavior,
- DC injection into the AC system output,
- unintentional islanding,
- open phase detection and tripping,
- current distortion (e.g. harmonics),
- active power limitation control capability,
- voltage regulation and reactive power control capability,
- frequency support capability,
- overvoltage contribution (including ground fault overvoltage),
- fault current output,
- persistence of DER settings following loss of power, and
- correct priority of the above-mentioned protection and control behaviors.

In addition, communication capabilities for dynamic DER management by FortisAlberta are tested by certification (i.e. interoperability tests).

[20] FortisAlberta permits these connections if, and only if, the Safety Codes Officer inspecting the DER installation provides a written variance approving the use of alternative means of conforming with CSA C22.1 84-014. The Safety Codes O

In the absence of certification, it is necessary to evaluate the DER units for conformity with the requirements, to ensure safety of the distribution system, the transmission system, and other customers.

E1.2. For the purpose of this normative annex, an uncertified DER unit is any DER unit that does not possess a third-party certification to the IEEE 1547 series.

E1.3. Certifications to standards other than the IEEE 1547 series are still uncertified DER units for the purposes of this annex, as they cannot demonstrate conformity to the IEEE 1547 series in accordance with the certification requirements of CSA C22.1 2-024 and Alberta's Electrical Code Regulation.

E1.4. The typical process where uncertified DER units are to be utilized is:

1. Evaluate the DER system design, to determine which requirements of the interconnection standards (DER-02 and the IEEE 1547 series) are met by the DER unit(s) and which requirements are met by supplemental DER devices.
2. Evaluate the DER unit(s) to ensure they can meet the requirements.
3. Evaluate the complete DER system to ensure it can meet the requirements.

E1.5. This normative annex deals with steps 1 and 2 listed in E1.4; step 3 is addressed by the remainder of this standard using the same practices as applicable to large DER systems incorporating certified DER units.

E2. Right of Rejection and Right of Witness

E2.1. Notwithstanding any requirement listed in this annex, FortisAlberta reserves the right to reject an evaluation of an uncertified DER unit for any reason.

E2.2. FortisAlberta may require attendance of FortisAlberta personnel for tests conducted on DER systems including uncertified DER units.

E3. Evaluating Professional and the Uncertified DER Unit Evaluation Report

E3.1. Professionals evaluating uncertified DER units shall be licensed professionals, meeting the licensure requirements identified in DER-02E (e.g. P.Eng.); this professional is referred to as the evaluating professional through the remainder of this annex.

E3.2. The evaluating professional shall accept responsibility for the evaluation and its results, including any studies or tests performed.[21]

E3.3. The evaluating professional may rely on testing performed by others, provided the APEGA professional practice standard "Relying on the Work of Others and Outsourcing" is complied with.

E3.4. The evaluating professional must deliver an authenticated "uncertified DER unit evaluation report" to FortisAlberta and the ICAP CCE that:

[21] This is comparable to the "certification by a professional engineer" contemplated under the Alberta Occupational Health and Safety Code (OHS Code). FortisAlberta workers and the public rely on the safety of the DER protection and controls.

- evaluates which requirements on the complete DER system (i.e. DER-02 or IEEE 1547 series requirements) are addressed by or applicable to the uncertified DER unit(s),
- evaluates conformity to all requirements addressed in the type testing and production testing portions of IEEE 1547.1 for the requirements addressed by or applicable to the uncertified DER unit(s)[22], and,
- is provided with appendices attaching all relevant test data for inspection by the ICAP CCE and FortisAlberta.

E3.5. Test reports, studies, and other attachments provided in support of uncertified DER unit evaluation shall be authenticated; where data is provided which is not authenticated, the evaluating professional must review and accept responsibility in the authenticated DER evaluation report.

E3.6. The ICAP report(s) shall incorporate the uncertified DER unit evaluation report.

E4. Evaluation Summary and Inspection and Test Plan (ITP)

E4.1. Prior to undertaking connection of an uncertified DER unit, the evaluating professional shall submit an evaluation summary which requirements are addressed by or applicable to the uncertified DER unit(s).

E4.2. Based on the summary of requirements, the evaluating professional shall submit an inspection and test plan to demonstrate conformity for the requirements addressed by or applicable to the uncertified DER units.

E4.3. The inspection and test plan shall clearly indicate:

- the requirement of IEEE 1547 that is being addressed by the test,
- the procedure being applied,
- the acceptance criteria being used to evaluate conformity, and,
- the evidence documents that will be submitted as evidence of conformity.

E4.4. The inspection and test plan shall clearly indicate which tests can be safely performed while the DER system is connected to the distribution system, and any alternative test methods (e.g. testing supported by study, lab testing, use of manufacturer type testing) will be used where it is not safe to test while connected.

E4.5. FortisAlberta and the ICAP CCE will indicate which tests must be witnessed by each party in response to the provided ITP.

E5. Evidence of Calibration

E5.1. All tests performed in support of evaluations under this annex shall be performed with test equipment calibrated and traceable to a national measurement standard.

E5.2. Evidence of calibration shall be included with the evaluation report.

[22] This requirement is intended to address equivalency between a certified unit and an uncertified unit, when applied in a DER system as a whole. Evaluation of the DER system for overall conformity is addressed in the main body of this standard.

E6. Evaluation by Manufacturer Type Testing

E6.1. DER unit type testing requirements are specified in IEEE 1547.1 clause 5 “Type tests”, and clause 6 “Interoperability tests”.

E6.2. Where manufacturers have performed type-testing, the manufacturer’s type-testing may be used as evidence of conformity, subject to the following requirements.

E6.3. Type-testing performed by the DER unit manufacturer shall comply with the requirements of IEEE 1547.1, or the evaluating professional shall confirm that the test conditions result in a demonstration of equal or greater performance than required by the IEEE 1547 series.

E6.4. The evaluating professional shall assess and accept responsibility for the procedure and results of the type testing in the evaluation report.[23]

E7. Evaluation by Manufacturer Production Testing

E7.1. DER unit production testing requirements are specified in IEEE 1547.1 clause 7 “Production tests”.

E7.2. Manufacturer production testing per IEEE 1547.1 is intended to be completed by the manufacturer without witness; as a result, manufacturer-provided test documentation is acceptable. No witness is required, unless otherwise specified on the ITP by FortisAlberta or the ICAP CCE.

E7.3. Manufacturer production testing shall conform to IEEE 1547.1 requirements.

E7.4. The evaluating professional shall assess and report on the conformity of the production testing in the evaluation report.

E8. Alternative Evaluations – General Requirements

E8.1. Where type testing or production testing have not or cannot be performed in a laboratory, the evaluating professional shall propose alternative methods of evaluation.

E8.2. All testing shall conform with the general requirements of IEEE 1547.1 clause 4 “General requirements”, including:

- requirements for test result accuracy,
- requirements for test reports, and,
- requirements for test equipment.

E8.3. All documentation required to be submitted under IEEE 1547.1, including installation instructions, user instructions, application notes, and other documents, shall be submitted as part of the evaluation report.

E8.4. Procedures shall be submitted for all alternative evaluations at least 30 days in advance of the proposed test.

[23] The evaluating professional may specify test witness requirements or other requirements to satisfy their professional practice requirements.

E8.5. Alternative evaluation procedures featuring online testing while connected to the distribution system shall contain statements indicating how the distribution system will be protected from:

- faults caused by or internal to the DER, and
- unacceptable power quality / electrical safety conditions, including:
  - overvoltage,
  - overcurrent,
  - ferroresonance,
  - harmonics,
  - flicker, and
  - rapid voltage changes.

E8.6. No online testing involving uncertified DER units shall be conducted, except where the DER owner has obtained:

- written approval of the alternative evaluation procedures by FortisAlberta engineering 30 days in advance of the test, and,
- approval via telephone or in writing from the Fortis Control Centre (FCC) 1 hour prior to the test.[24]

E9. Alternative Evaluation by Online Testing

E9.1. Testing may be performed on the DER system as-installed on the distribution system, provided it can be demonstrated safe to do so by the evaluating professional[25].

E9.2. Testing shall be performed conformant with IEEE 1547.1, if possible.

E9.3. The test procedure and test results shall be included in the evaluation report.

E10. Alternative Evaluation by Partial System Testing Supported by Study

E10.1. Testing may be performed on the DER system as-installed on the distribution system at operating points achievable without harm to the distribution system, and supported by engineering studies that identify performance at all operating points[26].

E10.2. The evaluation report must indicate clearly how field test results are correlated to the predictions made by the studies.

E10.3. Studies shall conform to the requirements of annex B.

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[24] AESO may require further approvals as per the ISO Rules. The DER Owner remains responsible to comply with the ISO Rules as per the Electric Utilities Act.

[25] Full online testing is often preferable from a cost standpoint, since it uses equipment that was intended to be installed anyways; however, it is typically difficult to plan and execute a test while connected to the distribution system. Online testing should follow industry be practices for the types of operational tests. NERC / WECC / AESO have a body of knowledge describing this sort of testing for transmission-connected generators.

[26] Because the typical operating point of a rural distribution system is at or near the high end of the acceptable CSA C235 voltage range, many DER projects cannot export reactive power without risk to the distribution system or risk of tripping. In such cases, this sort of testing becomes necessary to demonstrate reactive power capability and control.

E11.Evaluation by Component Testing Only and Supported by Study

E11.1. Testing may be performed on the DER components in a lab or other offline conditions to confirm the validity of component models, and studies may be performed based on the validated component models to confirm behavior of the DER system[27].

E11.2. The evaluation report shall provide evidence of component-level testing in addition to the studies.

E11.3. Field testing must still be performed to the extent possible, and correlated to study results.

E11.4. Studies shall conform to the requirements of annex B.

E12.Evaluation by Study Only

E12.1. FortisAlberta will not accept evaluation by study only; studies in the absence of testing (component-level or system-level) to confirm the results is not sufficiently reliable to address the risk to the distribution system.

E12.2. FortisAlberta will not accept component models based on generic models, such as simple voltage / current sources or WECC models, unless supported by testing.

E13.Relationship between DER Unit Evaluation and the Design Evaluation

E13.1. The evaluation report and process described in this normative annex is intended to provide to address limitations in DER unit certification.

E13.2. The design evaluation is a summary of the overall performance of the DER system, determining which requirements are met by which components, and therefore what testing must be performed.

E13.3. The evaluation summary and ITP (section E4) shall form part of the design evaluation report. The evaluation summary and ITP may be a separate document or may form part of the design evaluation report.

E14.Relationship between DER Unit Evaluation and the ICAP Process

E14.1. The evaluation report and process described in this normative annex is intended to provide evidence of conformity with the interconnection requirements in lieu of DER unit certification.

E14.2. The ICAP CCE is prohibited from undertaking studies or executing testing associated with evaluation of uncertified DER units.

E14.3. The ICAP CCE shall:

- review the evaluation report and all supporting evidence for conformity to the requirements,
- witness any online testing of the DER system.

E14.4. The ICAP CCE may:

[27] This sort of testing is most common for ride-through behavior (i.e. using vendor model data), and for protection (i.e. using secondary injection on relays, together with instrument transformer testing). Practical testing of abnormal conditions such as those expressed in IEEE 1547 clause 6 would create system events that are unsafe for the distribution system and other customers.

- require attendance for any off-line testing of the DER system or any components, including the DER units.

E15. Acceptance of Non-Conforming DER and Variances

E15.1. Application of uncertified DER units is a non-conformance with the requirements, and should be identified as such in the ICAP report.

E15.2. FortisAlberta may provide a variance, subject to receipt of sufficient evidence to confirm the risk to the distribution system has been identified and mitigated.

E15.2.1 The evidence may include a completed system-level ICAP report backed by the uncertified DER evaluation report to show system-level conformity.

E15.2.2 The evidence may include application of other supplemental DER devices to mitigate the risk associated with the uncertified DER unit(s).

E15.3. See DER-02E for more information on addressing, documenting, and resolving variances.