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Distributed Energy Resource Technical Requirements

REVISION SHEET

Revision	Description	Date	Initial
0	Original Document	2002-11-09	fk/df
1	Schematic Revision (All figures) Addition of Introduction section Addition of Group III Connection Process Document format standardization Integrate with Distribution System Code (OEB) (revised September 9th, 2004)	2005-02-02	fk/csm
2	Removed business processes	2010-02-01	dr/be
3	General revision; Harmonize with updates to CSA C22.3 No. 9, IEEE 1547 and DSC, removed connection processes	2022-08-26	rh/ead

1. Introduction

This technical guideline is intended to assist the Customer in understanding the technical requirements for connecting a Customer's Distributed Energy Resource (DER) to Hydro Ottawa Limited's (HOL) Distribution System. This guideline does not provide the details of costs or responsibilities that the Customer may assume; such details will be evaluated for each specific request.

Connection to the Distribution System is categorized according to size of the DER, and is set by the Ontario Energy Board's Distribution System Code according to the following table:

Table 1-1: OEB DSC Generation Categories

Category	Description	Category Criteria
1	Micro generation	All generation less than or equal to 10 kW
2	Small Generation	1.) All generation less than or equal to 500 kW for connections at voltages less than 15 kV. 2.) All generation less than or equal to 1 MW for connections at voltages greater than 15 kV
3	Mid-Sized Generation	1.) All generation greater than 500 kW but less than or equal to 10 MW for connections at voltages less than 15 kV. 2.) All generation greater than 1 MW but less than or equal to 10 MW for connections at voltages greater than 15 kV.
4	Large Generation	All generation greater than 10 MW

HOL's general requirements of a Customer connecting a DER are listed in Section 3.4 of HOL's Conditions of Service (ECS0012).

Any Customer that is considering installing a DER must contact HOL and ESA to collect all pertinent requirements. Requests can be sent by emailing DER@hydroottawa.com, or by initiating contact through HOL's website (www.hydroottawa.com).

To clarify the technical requirements for connection, each section specifies the basic requirements for Micro generation and expands on those requirements to include any additional requirements for larger categories of generation. For an outline of the connection process please refer to the OEB DER connection process.

2. Reference

The following documents are referred to in this guideline:

CSA C22.2 No. 107.1 – *Power conversion equipment*
CSA C22.3 No. 9 – *Interconnection of Distributed Resources and Electricity Supply Systems*.
CSA C235 – *Preferred voltage levels for AC systems up to 50 000 V*
Government of Canada – *Electricity and Gas Inspection Act* (R.S.C., 1985, c E-4)
Hydro Ottawa – ECG0008 – *Distribution System Voltage and Power Quality*
Hydro Ottawa – ECS0012 – Hydro Ottawa Limited *Conditions of Service*
Hydro Ottawa – GCS0043 – *HOL Monitoring and Control Box (MCB) Installation*
Hydro Ottawa – GCS0048 – *HOL Monitoring and Control Box Installation for < 500 kW ERF*
IEEE 1547 – *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*
IESO Market Rules
NRC – *MicroPower Connect: Connecting MicroPower to the Grid*
Ontario Energy Board – *Distribution System Code* (DSC)
Electrical Safety Authority – *Ontario Electrical Safety Code* (OESC)
UL 1741 – *Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*

3. Scope

This technical standard is intended to aid the Customer to understand all the requirements necessary to successfully connect a non-standby, non-emergency-use-only DER project from concept to energization. Content relates requirements to each DER type for each size category. This standard shall be used in conjunction with the OEB Distributed Energy Resources Connection Process (DERCP).

4. Definitions

Connection Impact Assessment (CIA) means the utility assessment of a DER's effect on the Distribution System when operating.

Customer is defined in the *Conditions of Service*.

Distribution System is defined in the *Conditions of Service*.

Distributed Energy Resource (DER) a source of electric power that is not directly connected to a bulk power transmission system.

HOL means Hydro Ottawa Limited.

IESO means the Independent Electricity System Operator in the Province of Ontario

Island Operation means the operating condition of a generating unit or generating units when it (they) is (are) supplying a load (loads) that is (are) not paralleled and synchronized with the HOL Distribution System.

Isolating Device means a circuit breaker or disconnect switch of appropriate rating, which may be locked in the open position and whose configuration provides a clear visible point of disconnection between the generating unit and the HOL Distribution System.

Large Generation means generation more than 10 MW.

Micro Generation means generation less than or equal to 10 kW.

Mid-size Generation means generation that is:

- Greater than 500 kW but not greater than 10 MW when the distribution voltage is less than 15 kV, or
- Greater than 1 MW but not greater than 10 MW when the distribution voltage is not less than 15 kV.

Momentarily means less than or equal to 100 milliseconds

OEB means the Ontario Energy Board

Open Transition Transfer Switch means a switch that disconnects load from the Distribution System by breaking parallel and then making parallel between the load and an alternate source.

Ownership Demarcation Point is defined in the *Conditions of Service*.

Parallel Operation means the connection and operation of the DER in electrical parallel with the HOL Distribution System.

Permanently means greater than 100 milliseconds

Point of Common Coupling (PCC) — the point on the Distribution System that is electrically closest to the power producer's facility, where other Customers are connected or can be connected.

Point of DER Connection (POC) — the point where an interconnection system is electrically connected to the power producer's facility.

Professional Engineer means a person who holds a license or temporary license under the Ontario *Professional Engineers Act*

Small Generation means generation that is:

- Greater than 10 kW but not greater than 500 kW when the distribution voltage is less than 15 kV, or
- Greater than 10 kW but not greater than 1 MW when the distribution voltage is not less than 15 kV.

Soft Transition Switch means a switch that momentarily or permanently connects the generating unit(s) to the Distribution System by making parallel and then breaking parallel.

Synchronism means the condition that exists when the voltage magnitudes, phase rotation, and phase angles of the HOL Distribution System are identical to that of the DER(s) or the DER transformer(s) at the point where the units are synchronized.

5. Interconnection

5.1. Isolation at the Point of Common Coupling

The Point of Common Coupling (PCC) and Point of DER Connection (POC) shall be identified in the design and on the single line diagram. HOL shall coordinate design, construction, maintenance and operation of the facilities on its side of the Point of Common Coupling. The Customer is responsible for the design, construction, maintenance and operation of the facilities on its side of the PCC unless described otherwise in a generator connection agreement.

The equipment on the Customer's side of the PCC shall be approved in accordance with Rule 2-024 of the Ontario Electrical Safety Code (OESC).

A disconnecting means must be provided by the Customer and must be in compliance with the OESC. Additionally, HOL must be able to isolate all parts of the Customer's electrical system with this disconnecting means to satisfy safety and safe working procedures. To comply with these requirements, the Customer must install a disconnect switch that can be opened, locked and tagged by the utility. This switch must be a "load-break" switch with the appropriate ratings and conform to OESC Rule 84-024. Where the DER connects to the Distribution System side of the customer's main disconnect, the DG System Fused Disconnect Switch must be service entrance rated.

The disconnect switch must be readily accessible to the utility at all times and must meet OESC requirements for clearances. The location of the disconnect switch shall be agreed upon by the Customer and HOL. The disconnect switch must be capable of providing a visible point of disconnect either through a viewing window or by opening the front cover.

5.2. Grounding

DER and their associated interconnection systems must be grounded according to the manufacturer's recommendations and meet requirements set out by the OESC.

Interconnection of three-phase transformers, and transformer grounding systems on three-phase Distribution Systems shall be co-coordinated with HOL and shall not cause voltage disturbances or disrupt co-ordination of the Distribution System ground fault protection.

6. Power Quality

The DER shall not significantly impact the power quality at the PCC and shall meet all the requirements set out in CSA C22.3 No. 9 regarding power quality. If there are negative impacts once the DER is in service, they will be required to disconnect until appropriate measures have been taken to prevent negative impacts to the Distribution System and the Customers it serves.

All costs required to mitigate problems due to power quality will be the responsibility of the Customer.

6.1. Harmonics

DERs shall remain below the allowable harmonic distortion limits set forth in CSA-C22.3 No.9. If the DER exceeds these limits, corrective action by the Customer will be required unless otherwise deemed by HOL.

6.2. Voltage Flicker

Voltage flicker caused by the Customer's DER must remain within the limits set in HOL's ECG0008 guideline. In the event that voltage variations are experienced due to the presence of the DER, HOL will require the Customer to either remedy the problem or disconnect the equipment.

Loss of synchronism protection may be required to be incorporated by the Customer to limit flicker.

6.3. Voltage Regulation

The Customer is to ensure that their connected DER shall meet HOL's standard ECG0008 for system voltage - including satisfactory operation within the extreme voltage level variation limits and power quality.

6.3.1. Fundamental Frequency

The DER must operate at a nominal frequency of 60 Hz with a maximum frequency drift of +/- 0.05%.

6.3.2. Steady-state Voltage

The steady state operating voltage of the DER must be maintained within the limits set out in ECG0008.

HOL has a responsibility to provide appropriate Distribution System steady state service voltage levels to all Customers, with or without a DER, connected to a HOL feeder as per CSA Standard CAN3-C235.

6.3.3. Voltage Fluctuation

Adequate voltage regulation shall be maintained under a variety of operating conditions. During normal operation, and whenever possible, the DER shall be loaded and unloaded gradually to allow adequate time for regulating devices to respond. Details will be provided by HOL throughout the connection process.

6.3.4. Voltage Unbalance

The operation of single and three phase DERs shall not cause objectionable voltage unbalances as per CSA C22.3 No. 9.

Where the Distribution System supplies single-phase loads, some unbalances are inevitable. The DER shall be capable of operating under these conditions and shall at all cost not cause further deterioration of existing unbalanced conditions.

6.4. Power Factor

To prevent the embedded DER from significantly influencing system voltages, the DER power factor setting to consider should ensure that the power factor at the PCC meets the requirements of ESG0008, unless otherwise stated by HOL (see Distribution System Support section herein). A lagging power factor is interpreted as the DER supplying Reactive Power to the Distribution System.[1] A leading power factor below 0.9 at the PCC also affects the Customer's bill; a lagging power factor is presently not monetarily compensated for by the utility.

If the DER disturbs the Distribution System voltage levels at the PCC then the Customer may be required to operate its facility within a smaller power factor range or take other compensatory measures. Field settable fixed and dynamic power factor correction techniques may be used if consultation with HOL reveals no adverse effect on the Distribution System.

Generation excitation equipment shall be capable of operating in an automatic voltage control mode and power factor control mode. HOL may require specific power factor settings for the DER.

For inverter based DERs the power factor of the unit shall be greater than or equal to 0.85 lagging and to 0.95 leading as per CSA C22.2 No. 107.1 and limits will be as given in the Natural Resources Canada MicroPower Connect guidelines.

6.5. Limitation of DC Injection

Per IEEE 1547, the DER shall not inject a DC current greater than 0.5% of the unit rated output current after a period of six cycles following energizing of the Distribution System.

6.6. Protection from Electromagnetic Interference

Per CSA C22.3 No. 9, the influence of electromagnetic interference should not interfere with operation of the DER's interconnection system.

6.7. Surge Withstand Performance

Per CSA C22.3 No. 9 and OESC 84-014, the interconnection system shall have the capability to withstand voltage and current surges.

6.8. Paralleling Device

Per IEEE 1547, the interconnection system paralleling-device shall be capable of withstanding 220% of the interconnection system rated voltage.

7. Protection

HOL requires that any element of the interconnection system external to the DER, but ahead of the PoC be installed in a fail-safe manner with self-checking features or redundant protection functions.

The Customer shall provide a document describing the protections in place to detect and compensate (see Distribution System Support section herein) or clear the following conditions as per CSA C22.3 No. 9:

a) Balanced and unbalanced system faults;
b) Frequency variations;
c) Voltage variations; and
d) Unauthorized Islanding conditions

[1] IEEE 1547.2-2008 Section 8.1.1.2

Additional protection schemes might be required to detect additional conditions and shall be at the discretion of HOL for the purpose of maintaining Distribution System integrity and employee safety.

All fault current interrupting devices shall be adequately sized to account for fault contributions from the DER system and the Distribution System. HOL shall provide present and anticipated fault contributions from the Distribution System at the PCC or shall provide the necessary information to calculate the fault contributions at the PCC.

The primary connection of the DER transformer should be considered when selecting and setting DER protections. HOL will verify settings at PCC if applicable. The Customer must conduct commissioning tests witnessed by HOL, and provide all test results to HOL for review prior to energisation of the DER. A letter sealed by a Professional Engineer in good standing indicating that all protections have been applied and tested per the protection schema provided to and accepted by HOL shall be provided,

7.1. Protection Requirements

The protection requirements in this section are the minimum requirements for protecting HOL's people, equipment and Distribution System. Though not reviewed by HOL, the Customer shall also consider any additional protection needed to also comply with ESA obligations keeping in mind people, equipment and process safety and loss. .

7.1.1. Minimum protection

All DERs shall have the following protections as a minimum to meet CSA C22.3 No. 9:

a) Undervoltage
b) Overvoltage
c) Underfrequency
d) Overfrequency
e) Overcurrent

Definitions and trip requirements for each of these can be found in CSA C22.3 No. 9.

The subsequent sections shall specify more protections based on the type of DERs.

7.1.2. Single Phase DERs

All single phase DERs shall meet the minimum protection requirements in Table 15-1.

Table 15-1: Single-Phase Minimum DER Protection Requirements

ANSI Device ID#:	Description
21*	Distance Relay
25**	Synchronizing Verification
27	Undervoltage
50/51***	Overcurrent
59	Overvoltage
81O	Overfrequency
81U	Underfrequency
	Additional (unauthorized) Anti-Islanding as required

* To be determined for each project
** Required for synchronous generators and other types which have stand-alone capability
*** Relay can be replaced by an internal Overcurrent setting when set appropriately.

7.1.3. Three-Phase DERs

All three-phase DERs shall meet the minimum protection requirements in Table 15-2 with the goal of maintaining balanced three-phase output under all operating conditions - unless authorized by HOL -,

detecting low voltage in one or more phases and automatically cease to energize all phases from the interconnected system when a fault is detected.

Table 15-2: Three-Phase Minimum DER Protection Requirements

ANSI Device ID#:	Description	Synchronous	Induction	Inverter Based
25	Synchronizing Verification	X	X[a]	X[a]
21	Distance Relay	To be determined for each project		
27	Undervoltage	X	X	X
32R	Reverse Power	X[c]	X[c]	X[c]
46	Negative Sequence Current	X	X	X[d]
50	Instantaneous Overcurrent	X	X	X[b]
51V	Voltage Restrained Time Overcurrent	X	X	X[b]
59	Overvoltage	X	X	X
60*	Voltage or Current Balance	To be determined for each project		
67	Directional Phase Overcurrent	X	X	X
67N	Neutral Directional Overcurrent	X	X	X
69	Close Blocking Relay	To be determined for each project		
78	Voltage Phase Angle Measuring	≥ 500 kW	≥ 500 kW	
81O	Overfrequency	X	X	X
81U	Underfrequency	X	X	X
81R	Rate-of-Change Frequency	≥ 500 kW	≥ 500 kW	
85	Transfer Trip	To be determined for each project		

[a] – Required if not controlled by power electronics to match HOL system voltage with magnitude, phase angle, and frequency
[b] – Not required if DER has appropriately set overcurrent setting
[c] – Not required for exporting DERs
[d] – See section 7.2 for loss of phase relay requirements.
* - Loss of potential protection is required where there are upstream fuses used as protective devices (such as for transformer protection). The loss of potential relays shall consist of three single-phase relays.

7.1.4. Soft Transition Switching

DER systems that are parallel with the Distribution System for six cycles or less shall have the following protection functions:

a. Undervoltage protection, which shall ensure that the DER system is not energizing HOL's de-energized Distribution System;
b. a six-cycle maximum delay timer to prevent paralleling with HOL Distribution System longer than six cycles;
c. a manual or automatic synchronization check, and;
d. MCB for monitoring the following, see Section 9 for details.
    i. transition breakers (main, DER) to ensure that paralleling is not > 100 ms.
    ii. the power output of the DER (V, A, kV·A, kVAR) .

The Customer is responsible to protect their DER per ESA requirements in addition to the above functions.

7.2. Phase and Ground Fault

The DER shall be able to detect and cease energization of the Distribution System as stated in CSA C22.3 No. 9.

Single-phase inverter based DERs connecting to a single-phase Distribution System shall not require an independent loss-of-phase device.

An independent loss-of-phase (LoP) device, in addition to the inherent feature of the DER, shall be required if one or more of the following apply:

- The HOL side of the Interface Transformer is of delta or tee configuration;
- There is more than one inverter in the DER configuration;
- It is deemed required by OESC or ESA;
- There is an Intermediate Transformer present between the Interface Transformer and the inverter(s).

The LoP should be installed on the DER side of the DG Source Disconnect immediately after the Monitoring and Control Box (MCB) sensors (when applicable). In the case where no MCB is present, the LoP is to be installed directly after the DG Source Disconnect. All Customer owned equipment is to be installed on the DER side of the LoP.

When present, the same Customer owned sensors and contactors for the MCB can be used for this LoP device.

7.3. Synchronization

The DER shall parallel with the Distribution System only when they meet the voltage and frequency requirements specified by CSA C22.3 No. 9 and IESO requirements.

The Customer shall conform to the OESC rule 84-006 which covers the synchronization of parallel DERs.

7.4. Anti-Islanding Protection

The Customer shall not island without permission from HOL. The DER shall comply with CSA C22.3 No. 9.

8. Cease to Energize

HOL makes use of automatic reclosers to maintain the reliability of the Distribution System. The Customer must be aware of line re-closing when designing the system protection schemes to ensure that their DER disconnects from the Distribution System prior to automatic re-close of the Distribution System's breakers or line reclosers. HOL shall review to ensure that the Customer's design shall de-energize the DER prior to auto-re-close operation of feeder tripping devices.

After a disturbance on the Distribution System, no reconnection shall take place without satisfying Synchronization requirements discussed herein. At anytime a DER is to re-connect to the Distribution System, the re-connection must be delayed for a period prescribed by Hydro Ottawa, which will be included in the DER connection agreement. The reason for the time delay is to allow the Distribution System to return to, or remain in, a normal operating state in the event of a prior disturbance.

HOL will review the Customer's proposed design to ensure that the DER will cease to energize automatically from the Distribution System's supply under the conditions described in this section.

8.1. Loss of Supply

The Customer's DER shall cease to energize the Distribution System following the loss of Distribution System supply resulting in an unintentional island.

For all inverter based systems paralleled to the utility, the inverter must be anti-islanding and tested in accordance with Underwriters Laboratory UL 1741. Inverters shall be UL or CSA certified to UL 1741. The inverter name plate must be visible during commissioning to verify certification. In the event that the Customer wishes to operate under conditions where the Distribution System supply is not available, an Open Transition Transfer Switch must be installed between the load and the normal utility supply.

See section 7.2 for loss-of-phase device requirements.

8.1.1. Transfer Trip

A HOL-installed Transfer Trip (TT) and associated communication equipment may be required to facilitate the detection of the loss of supply resulting in an unintentional island and provide a disconnect signal to the Customer. Determination of TT requirements will be made at the Connection Impact Assessment phase of the process.

Presently, TT is required for DER projects greater than 500 kW on HOL's 13 kV system and greater than 1 MW on all other voltages. .

8.2. Overcurrent Condition

Any element of the interconnection system external to DER, but ahead of the PoC, should be installed in a fail-safe manner with self-checking features or redundant protection functions for large DERs.

Equipment and conductors shall be provided with overcurrent protection from each source of supply. The DER protection system shall be capable of automatically isolating the DER from the Distribution System for the following:

- internal faults within the facility; and/or
- external faults within the Distribution System.

The protective device selectivity and sensitivity shall be maintained over the range of minimum to maximum fault currents with input from the DER.

8.3. System voltage or frequency changes outside of limits

Over and under voltage, plus over and under frequency protection is required at the DER PoC.

The set points and clearing times for over or under voltages, plus over or under frequencies are dependent upon the magnitude of voltage and frequency variations and DER size as shown in IEEE 1547. DERs generating greater than 10 MW are required to follow voltage set points and clearing times specified by the IESO.

9. Monitoring and Control

HOL requires that all sources of energy connected to the Distribution System 50 kW or greater be monitored by HOL with provisions for future control capabilities, and that all sources of energy 200 kW or greater have provision for HOL to disconnect the energy source from the Distribution System. These requirements ensure the safe and reliable operation of the electricity Distribution System.

HOL may also require the use of monitoring and control equipment when the DER is connected to an HOL substation that has technical limitations. An HOL representative shall inform the Customer at the time of the CIA if an MCB is required.

Monitoring equipment shall be provided by HOL at the Customer's cost. It shall have provision for monitoring connection status, Real Power output, Reactive Power output, and voltage at the PoC. The monitoring and control equipment shall either be installed, or there shall be adequate provision in the design, to allow future installation of such equipment if not required at the time of interconnection.

For Medium and Large DERs, HOL will install equipment to integrate the DER with HOL's supervisory control system for continuous monitoring and control. The Customer must make provisions to enable the following minimum monitoring functions; depending on the Customer's DER application, HOL will provide detail and may define others through the interconnection process:

1. Status of all breakers or load break switches that parallel the DER to the Distribution System.

2. DER output voltage (per phase), current (per phase), power factor, frequency and harmonic distortion

3. Provision will be made to all of the synchronizing breaker close coil circuits for the installation of a "close-blocking" relay, provided by HOL, so that hold-offs can be secured from the generating facility.

4. Transfer Trip equipment as required for the project.

At the Customer's side of the point of connection the monitoring equipment shall be inspected according to Rule 2-004 of the OESC and approved according to Rule 2-024 of the OESC.

The MCB must be installed indoors.

10. Equipment Ratings and Requirements

The DER interface equipment shall be compatible with HOL equipment ratings at the connection voltage (maximum voltage, basic impulse limit, short circuit ratings, capacity etc.) and the incorporation of the added DER must not result in any Distribution System equipment operating beyond the Distribution System's operational rating. HOL shall review the equipment ratings for the purpose of assessing integration of the facility with the Distribution System. The equipment ratings to be reviewed include, but are not limited to, the following:

10.1. Equipment Thermal Loading

All of HOL's existing equipment in both distribution and transmission stations shall not be overloaded beyond acceptable limits under all operating conditions of the DER. This equipment includes feeder conductor, line voltage regulators, regulating stations, reclosers, circuit breakers and transformers.

HOL conducts a load flow study based on minimum system load conditions and maximum Customer generation, including all existing DERs already existing on the Customer feeder. The load flow study will identify the potential overload of the existing equipment.

10.2. Impact of DER Fault Contribution on Equipment Rating

The HOL Distribution System's interrupting devices shall be able to interrupt the maximum fault current that will flow through all devices. As such, all electrical equipment must be able to withstand the fault current passing through it for the required time so protection measures clear the fault.

The fault interrupting rating of the existing interrupting devices and the fault withstand rating of the electrical equipment shall be higher than the maximum fault current possible flowing through the equipment.

The addition of a DER will contribute to the total fault current on the existing Distribution System.
If the DER causes these limits to be exceeded, Distribution System equipment replacement or fault current limiting devices may be required.

10.3. Voltage Regulating

The HOL Distribution System has been designed for the unidirectional flow of power, from source (i.e., station) to the Customer. As such, the voltage regulating and metering devices are designed to correctly operate in these conditions. The connection of DER facilities to the distribution feeder could cause the power flow to be reversed through equipment and this could create difficulties with the equipment capability, including proper voltage regulation or energy measurement.

Where the possibility exists for flow reversal through the existing voltage regulating devices and/or the metering points, incompatible equipment shall be replaced with those capable of bi-directional flow.

The direction of the power flow through voltage regulating devices connected between the DER and the transformer station shall be verified including line voltage regulators, regulating stations and transformers' under load tap changer, at the distribution station and transformer station.

11. Revenue Metering

Bi-directional meters measuring energy delivered and energy received shall be installed by HOL. The cost of the installation will be the responsibility of the Customer.

All Embedded Generation 1 MW and above, requires IESO-approved metering installations. Metering installation for DERs below 1 MW shall be specified and supplied by HOL and shall meet the requirements of HOL standard GCS0008. The costs associated with the metering installation will be the responsibility of the Customer.

The Customer will provide a lockable/sealable enclosure space within an Indoor facility to install instrument transformers as required. This enclosure shall be readily accessible to HOL personnel.

Additionally, the Customer shall provide space for HOL to mount a wall mounted enclosure for the meter. This space should be as close as possible to the location of the instrument transformers if they are required.

12. Feeder Relay Direction

HOL's existing protections in the Distribution System are typically designed non-directional to clear faults occurring downstream from their location. When connecting a DER, HOL shall review the existing protection to prevent unnecessary operation of upstream protection. This may require the replacement of non-directional relays with directional equivalents.

13. Additional Requirements

13.1. Connection Limitations

Based on the impacts of generation to short circuit levels, voltage deviations and operational issues, HOL has set connection limits to any circuit or substation in ECG0008.

13.2. Synchronizing Facilities

The generation connection must be supplied with adequate synchronizing facilities to properly operate and commission installation.

All breakers that are equipped with synchronizing abilities must include a visual means of showing synchronicity and are to include the following aspects in their design:

1. Synchronizing relay that has a visual indication on the front of the relay in the form of lights or light emitting diodes (LEDs) that indicate when the two voltages are in phase.
2. The synchronizing breaker cell will be equipped with an analog or digital synchronizing scope ("Sync. Scope") with two lights that indicate the voltage across the synchronizing voltage transformers (bus and line).

   OR

   A digital display providing the information described in points one and two above.

Where embedded generation is added in existing connection facilities (i.e. building or campus vaults etc.) that employ load break switches, the following design details are required:

1. All load break switches that are able to make or break parallel either by design or incidentally shall be upgraded to circuit breakers with 125 VDC (DC – direct current) trip and close solenoids. The breakers will be equipped with synchronizing facilities as described in this section.

OR

2. Load break switches will be modified to include a Kirk-key interlocking scheme that is linked to the DER circuit breaker. The scheme will be designed such that the Kirk key will be released when the DER circuit breaker is in the open position at which point all load break switches can be operated.

   If this is not possible then an isolating disconnect switch will be installed upstream of the DER breaker and the disconnect switch will be equipped with the Kirk-key interlock.

All load break switches or breakers will be equipped with auxiliary status contacts (IEEE 52a) indicating the position of the load break switch or circuit breaker. The contacts will be rated for operation at 125 VDC, five amperes.

13.3. Remotely Operated DER Disconnecting Device Requirements

All circuit breakers or contactors used for remotely disconnecting the DER must be sized to adequately carry the rated full load current of the DER. In addition, circuit breakers shall be rated to interrupt the total available fault current from the DER and the utility.

Circuit breakers shall be equipped with trip and close coils (rated at most 125 VDC) as well as sufficient auxiliary contacts (rated at least 125 VDC, 5 A) for Customer use and HOL use.

In the event that a circuit breaker is equipped with manual breaker operating control (example: pushbuttons on the front of the breaker), the manual "Close" function will be physically disabled or removed.

13.4. DER Distribution System Support

If the DER is a smart inverter, the settings and monitoring for Distribution System support will be assessed and prescribed by HOL when required and in consultation with the Customer.