DISTRIBUTED ENERGY RESOURCE TECHNICAL INTERRCONECTION REQUIREMENTS FOR FACILITIES LARGER THAN 20 kW

EI-27

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Eric Cameron P.Eng	R0 December 2024	Initial Release	Scott Glazer	P.ENG	December 2027
			Luke Seewald	Director of Eng Svc.	

Preface

Customers who wish to connect distributed energy resources to London Hydro's distribution system and service territory are required to follow applicable industry standards, the electrical safety code and requirements set forth by London Hydro.

The purpose of this document is to put forth information on how distributed energy resources are to interconnect to London Hydro's distribution system. Processes, schedule outlines and technical requirements are mentioned in this document and shall be followed during the course of the project.

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1 Introduction

1.1 About the Local Distribution Company

London Hydro Inc. (London Hydro) is a Local Distribution Company that services the City of London, Ontario Canada. London Hydro delivers a safe and reliable supply of electricity to residential, institutional, commercial and industrial sectors, spanning 420 square kilometres of service territory.

London Hydro welcomes the opportunity of connecting distributed energy resources to adapt and improve upon our existing distribution system to meet the ever-changing needs of our customers.

1.2 Distributed Energy Resource

Customers may choose to install some form of generation as a new connection or to an already existing connection currently on London Hydro's distribution system. This may be due to the customer looking to, as an example, reduce their electricity costs from the utility, realize additional efficiencies by combining multiple processes within their facility, act solely as a generator or have the capability of islanding.

London Hydro may only connect distributed energy resources within its service territory.

1.3 Codes, Regulations and Laws

Distributed energy resource facilities owned by a Customer are subject to various codes, regulations and laws pertaining to any customer connecting, generating or consuming electricity from an electrical distribution system, and as listed in London Hydro's Conditions of Service.

1.4 Definitions

London Hydro endeavours to follow all Distribution System Code and Hydro One's Technical Interconnection Requirements (TIR) definitions.

1.5 Contact Information

For inquiries related to distributed energy resources, London Hydro can be contacted during business hours, Monday to Friday between 7:30 am and 4:00 pm by calling (519) 661-5800 ext. 5723, or by emailing generation@londonhydro.com.

2 Distributed Energy Resources (DER)

2.1 Use Cases of DERs

London Hydro allows many forms of DERs to be connected to the distribution system for various purposes such as:

- Standby or emergency backup
- Export of power to the distribution grid
- Load displacement/shedding
- Ancillary services, i.e. VAR compensation, power quality, frequency response, etc.
- IESO grid services and demand response

2.2 Energy Sources

Most DER applications will involve the implementation of one of the following energy sources or aggregated sources:

- Wind
- Solar
- Water
- Cogen/combined heat & power (CHP)
- Battery
- Steam
- Natural gas
- Hydraulic
- Diesel
- Anaerobic Digester
- Fuel Cell
- Biomass
- Bio-diesel

2.3 Facility Types for DER Connections

The Ontario market allows customers to choose the type of market they want to be subscribed to as defined in the Distribution System Code.

2.3.1 Emergency backup generation facility

A generation facility that acts as a backup source to a customer and uses a transfer scheme, effectively isolating it from the distribution system, either through open- or close-transition.

2.3.2 Embedded retail generation facility

A generation facility that is not directly connected to the IESO-controlled grid, but is instead connected to a distribution system. The generator does not operate as a wholesale market participant.

2.3.3 Wholesale market participant

The generation facility is registered to sell or purchase electricity or ancillary services through the IESO-administered markets.

For more detailed information on the types of facilities, refer to the Distribution System Code.

2.4 DER Classification

The Distribution System Code defines the classifications of DER connections.

DER Classification	Rating
Micro-embedded generation facility	≤ 10 kW
Small embedded generation facility	≤ 500 kW for facilities connected to < 15 kV system, or ≤ 1 MW for facilities connected to ≥ 15 kV system
Mid-sized embedded generation facility	> 500 kW for facilities connected to < 15 kV system, or > 1 MW for facilities connected to ≥ 15 kV system, rated ≤ 10 MW
Large embedded generation facility	> 10 MW

Table 2-1: DER Classification

2.5 Revenue Metering

London Hydro shall install bi-directional meters that measure energy received and delivered (exported and consumed). Refer to London Hydro's Conditions of Service for more information on metering standards.

2.6 Provision for Future Changes

The Customer shall be responsible to stay aware of future changes to the business environment and technical requirements. In addition, the Customer shall make any necessary changes to the DER facility promptly in response to:

1) New or revised standards and codes, when required.
2) Legislation changes.
3) Safety and performance concerns.

The Customer may be responsible for some or all costs associated with the changes above.

London Hydro will endeavour to keep this document up-to-date as soon as new standards, codes, and policy changes arise.

2.7 DER Connection Process

All proponents who wish to connect any DER will go through the DER connection processes as outlined below, which meet or exceed the OEB processes outlined in the Distribution System Code. All parts of the process shall be followed to ensure timely connection and accurate documentation and safety procedures are followed.

3 Technical Requirements

The technical requirements outlined in this document shall be followed and will help guide the design and construction of a DER facility. The Customer shall ensure that the connection of its DER facility does not materially and adversely affect the safety, reliability and efficiency of London Hydro's distribution system.

Any new or significantly modified existing DER facilities shall meet the following technical requirements:

- Ontario Electrical Safety Code (OESC)
- CSA standards C22.3 No.9, C22.2-107.1
- UL standard UL 1741 SA
- IEEE 1547
- Applicable ancillary CSA and IEEE standards
- Distribution System Code DER Connection Procedures
- Hydro One Distributed Generation Technical Interconnect Requirements (TIR) and its Bulletins
- London Hydro Conditions of Service and related Appendices
- London Hydro DER technical requirements as outlined in this document

London Hydro closely follows Hydro One's TIR and CSA C22.3 No.9 in order to harmonize all DERs connecting to the distribution system. The technical requirements outlined in this document shall meet or exceed standards mentioned above. If an item is not covered in this document, it will be mentioned in either Hydro One's TIR or in C22.3 No.9, and shall be implemented.

Should there be a new or updated standard that supersedes the ones mentioned here, the new standards shall apply until this document has been updated with the relevant information.

3.1 Fault Levels

Maximum fault levels must be maintained within the limits shown below. The DER facility shall not cause these limits to be exceeded. Higher fault values may exist for short times during switching.

Nominal Voltage (kV)	Maximum 3PH Fault (kA)	Maximum SLG Fault (kA)
27.6 (4-wire)	15.131	12
13.8 (Network)	Generation not permitted	
8.32	Contact London Hydro	
4.16	Contact London Hydro	

Table 3-1: Maximum Fault Levels

3.2 Insulation Coordination

The DG Facility shall be protected against lightning and switching surges. Refer to the Hydro One TIR document for requirements on location and sizing of surge arresters.

3.3 Emergency Backup Generation Technical Requirements

Emergency backup generation can be installed to provide a backup source for load when utility supply is not available. The Customer with portable or permanently connected emergency backup generation shall comply with

all requirements in the OESC and, in particular, shall ensure that the DER does not back-feed into London Hydro's distribution system or back-feed through the revenue meter.

The Customer shall connect an emergency backup generation facility through either an open- or close-transition scheme.

For backup generation 50 kW or greater in aggregate output, a declaration form will need to be completed (see Section 3.3.2.5).

3.3.1 Open-Transition

DER facilities connected through an open-transition method shall ensure that the facility does not parallel with or adversely affect London Hydro's distribution system. Grounding and bonding requirements shall meet manufacturer and OESC requirements.

For mechanically interlocked open-transition schemes, London Hydro may request engineering documentation and drawings.

If the DER facility uses an electrically interlocked open-transition scheme, documentation, stamped by a professional engineer in the province of Ontario, shall be submitted. Witness testing, supervised by a London Hydro representative, may be required. The Customer shall notify London Hydro a minimum of 15 business days prior to scheduled commissioning tests in order for London Hydro to witness the commissioning tests.

3.3.2 Close-Transition

3.3.2.1 Close-Transition Documentation

DER facilities intended to be connected through a close-transition method (connected in parallel with London Hydro's distribution system for less than 100 milliseconds) shall submit an application and required documentation that satisfies London Hydro's technical requirements:

- ESA plan review report
- Short circuit and coordination study
- Detailed sequence of operation, including proposed synchronizing scheme
- Single line drawing of the Customer electrical distribution system
- Monitoring requirements

Where required, studies shall be performed by London Hydro, at the expense of the Customer to determine if there are any potential adverse impacts on the distribution system during close-transition.

Customers shall obtain written authorization from London Hydro prior to commissioning the close-transition apparatus.

3.3.2.2 Technical Requirements

1) DER facilities shall have undervoltage protection, which shall ensure the DER facility is not capable of energizing a de-energized distribution system.
2) A timer shall be implemented to ensure that the DER Facility will not parallel with the distribution system for more than 6 cycles (100 ms).
3) Any DER facility that is capable of generating its own voltage while disconnected from London Hydro's distribution system shall require proper synchronization facilities before connection is permitted. Refer to Section 3.9.6.

4) Where multiple emergency backup generators are to be connected, at a single location, through a close-transition scheme, the design and configuration shall minimize the impact to the distribution grid including fault contribution by using techniques such as sequencing the close-transition transfer of generator units, or using a high impedance design or other equivalent methods.

3.3.2.3 Soft-Loading of Generation

DER facilities may request soft-loading of their generation if they require a slower speed (greater than 100 ms) close-transition in order to minimize adverse effects on their loads. This is particularly important for data centre loads, hospitals or other critical facilities, where switching transients may be of concern.

Restricting the Emergency Generator(s)' fault current contributions to values specified in the table below, and requiring the total fault current with the generator(s) connected to be less than the applicable station equipment limit, can ensure station equipment safety limits are not exceeded when the emergency generator(s) are paralleled to the system during this time.

Fault current limits may be exceeded if multiple emergency generators connect at the same time. The transition time shall be limited to a maximum of 10 seconds, and should be set to a lesser time where practicable.

Contact London Hydro for more details on the connection process.

Nominal Voltage Level	Sub-transient Generation Short Circuit Fault Contribution
27.6 kV	32 MVA

Table 3-2: Soft-Loading Generation Fault Limits

3.3.2.4 Signage

Signage shall be installed at the incoming feeder supply and/or main breaker (PCC) and have the following message:

WARNING
TWO POWER SOURCES
MOMENTARY PARALLEL SYSTEMS
(CLOSE-TRANSITION TRANSFER DEVICE IN USE)

Figure 3-1: Close-Transition Warning Signage

3.3.2.5 Reports & Sign-Off

After commissioning is completed, the Customer shall submit all results via one or more reports for record-keeping. A letter of equivalency shall also be signed and stamped by an active professional engineer in the province of Ontario.

An operating agreement may also be required between the Customer and London Hydro.

An Emergency Backup Generator Declaration Form shall be completed and submitted to London Hydro.

3.4 Always-On DER Technical Requirements

DER facilities that do not operate as open- or close transition are considered to be always connected. The Customer shall be responsible for designing and installing a DER facility that ensures the safety of the public and does not materially or adversely affect the safety, reliability and efficiency of London Hydro's distribution system.

This section will outline the minimum requirements for London Hydro to approve a DER to connect to the distribution system.

3.4.1 DER Facility Design

Any electrical service or equipment shall meet or exceed the requirements in London Hydro's Conditions of Service. For DER facilities that are connected through a Customer-owned substation, refer to Appendix D of the Conditions of Service for more detailed information.

3.4.2 Isolation Device

An isolation device shall be installed in order to electrically isolate the DER facility from the distribution system.

The isolation device shall:

1) Be in compliance with OESC, and;
2) Be located between London Hydro's system and the DER facility, upstream of all transformers, generation and high voltage ground sources.
3) Be readily accessible by London Hydro.
4) Not be located in a locked facility.
5) Not be located in a hazardous location as per OESC Section 18.
6) Have a manual override.
7) Have no key interlocks.
8) Have contact operation verifiable by direct visible means
9) Be capable of being operated without exposing the operator to any live parts.

In addition to the requirements above, all DER facility isolation devices shall:

1) Be gang operated and disconnect all ungrounded conductors of the circuit simultaneously.
2) Be motorized and/or electrically operated if the DER facility is 20 kW or larger
3) Have a protection interface for tripping if used as a backup for interrupting device failure (HVI breaker failure or LVI breaker failure).

If the isolation device is required to be motorized, it shall be powered from a reliable source such as a DC battery to power a DC motor, or via a battery-supplied DC/AC inverter to power an AC motor.

The exact location of the isolation device shall be satisfactory to London Hydro's requirements.

3.4.3 DER Interconnect Transformer Configuration

The decision on the type of transformer winding configuration will play a major role on how the generator interacts with the distribution system under steady state and fault conditions. London Hydro's distribution system in particular is mainly a 27.6 kV multi-grounded 4-wire system. The Customer shall ensure the maximum overvoltage on the distribution system is within 125% of the nominal voltage.

The Customer shall choose one of the following transformer winding configurations (based on CSA C22.3 No.9) when connecting to London Hydro's 4-wire distribution system:

System Voltage (kV)	Distribution System Grounding	Preferred Winding Configuration (HV:LV)
27.6, 4.16	Low (effectively grounded)	Wye-ground primary
13.8	Contact London Hydro	
8.32	Contact London Hydro	

Table 3-3: Transformer Winding Configurations

Any other type of interconnect transformer winding configuration shall be reviewed on a case-by-case basis. Refer to Hydro One TIR for additional examples.

3.4.4 Neutral Grounding

In addition to the above, to limit increased ground fault levels on the distribution system, a grounding impedance may be required at the point of common coupling (PCC) or, where acceptable fault levels are achieved, at the intermediate transformer or generator.

3.4.5 Warning Signs & Diagrams

3.4.5.1 Multiple Power Sources

The following warning sign shall be posted at the point of disconnection, DER feeder cell and electrical room/fence door(s) to provide warning of the presence of embedded generation:

WARNING
MULTIPLE POWER SOURCES
PARALLEL SYSTEM

Figure 3-2: Required Warning Sign

3.4.5.2 DER Lockout Notice

The following warning sign shall be posted at the point of disconnection, and DER feeder cell to provide information on how to contact London Hydro when the DER is locked out from generating:

IMPORTANT
IF DER IS LOCKED OUT, CONTACT
LONDON HYDRO SYSTEM OPERATING
CENTRE
(519) 661-5555

Figure 3-3: Required Warning Sign

3.4.5.3 Single Line Diagram

A permanent and legible single line diagram shall be placed at the Customer's control room and electrical room or substation that accurately presents the electrical arrangement, isolation points and any interlocking arrangements.

Any operating designations to be assigned by London Hydro for the switching equipment of the DER facility will be provided and the Customer shall update the single line diagram(s) accordingly.

3.5 Batteries & DC Supply

1) The DER facility shall have a battery-based DC supply with enough capacity to remain operational to ensure that all protection functions operate when the main source of power fails and disconnects the DER facility from the distribution system. It shall also be capable of sustaining continuous telemetry related to the DER facility status and associated teleprotections.
2) The DC supply shall be implemented through the use of a battery and charger system, or via an uninterruptible power supply.

3) The battery voltage shall be monitored, and upon failure or reaching low limits, the DER facility and high voltage ground sources shall be disconnected from the distribution system.
4) Capacitors shall not be used as energy storage in lieu of batteries.

3.6 Load Displacement DER Facilities

For DER facilities installed with the sole purpose of reducing the net load of the associated Customer as seen from the PCC, there are additional items that shall be met in order to ensure there is no power being injected onto London Hydro's distribution system.

3.6.1 Protections

1) Reverse power protections shall be implemented at the PCC such that it does not allow net power export to the distribution system in excess of 10% of the maximum aggregate power output of the DER facility for more than 5 seconds.
2) Current transformer ratios, rating factor and accuracy class shall be chosen to achieve the required accuracy for reverse power protections to operate correctly.
3) A protection relay that has the appropriate resolution and accuracy at low levels of current input shall be installed.

3.6.2 Real-Time Load Following

For load following facilities, the Customer shall ensure that continuous minimum import power (consumption) at the PCC remains within the minimum accuracy levels of the CT.

3.7 Islanding/Micro-Grid Facilities

Customers who wish to install DER facilities for the capability of intentionally islanding from London Hydro's distribution system shall have additional systems and protections in place, and shall be approved by London Hydro.

The DER facility shall not intentionally island with any other Customers or have the capability of islanding London Hydro's distribution feeder. This is to prevent power quality problems to other customers connected to the island, prevent out-of-phase paralleling between the distribution system and the DER system, and to reduce the risk of safety hazards.

3.7.1 Unscheduled Intentional Islands

Unscheduled intentional islands are formed autonomously from local detection of abnormal conditions at the interface(s) with the distribution system. Once formed automatic relay action will trigger switching action to isolate the intentional island rapidly from the distribution system.

London Hydro currently does allow unscheduled intentional islanding.

3.7.2 Scheduled Intentional Islands

Scheduled intentional islands are formed through DER operator or wires owner manual action or other operating dispatch means that trigger the transition from being in parallel and synchronized with the distribution system, to operation as an islanded system. Reasons for forming a scheduled intentional island can include economic and enhanced reliability.

London Hydro currently does allow scheduled intentional islanding.

3.7.3 Adjustments to DER Settings

When operating in an intentional island, participating DER facilities may have to adjust several control and protection settings. These alternate settings and ranges of adjustability shall be enabled only when the intentional

island is isolated from the distribution system. In order to meet this requirement, adaptive protection and control settings may be required. See Section 3.8 for more information.

3.8 Control and Monitoring

All DER facilities greater than 20 kW in size are required to have control and monitoring capability in place in order to ensure a safe, reliable and efficient distribution system.

3.8.1 Control Requirements via Communication

DER facilities shall have provisions for the possibility of real-time control by London Hydro as outlined in CSA C22.3 No.9:20 or later revisions.

The Customer shall design their control systems to meet these control requirements.

3.8.2 Control Requirements via Hardwire

DER facilities shall have provisions for real-time control via hardwired contacts. These provisions will include, but not be limited to:

- The ability to remotely dispatch the DER facility (on/off, permit service)
    - Option A: Dry Contact is sent from London Hydro RTU to DER utility interface protections.
    - Option B: Dry contact is sent from London Hydro RTU to a separate disconnecting means, i.e. contactor, circuit breaker, contactor switch, etc. to prevent the closing coil from being actuated.
- The ability to provide a breaker, contactor, etc. status to London Hydro's RTU (open/close)
    - 52a dry contact is provided from each respective breaker or contactor or from the PCC isolation device/HVI.

The customer shall have a 24-125 VDC supply available, or, in the case of an AC operated coil, 120 VAC, to send a DGEO signal back to London Hydro.

London Hydro shall make the decision either at the design review stage or at the CCRA stage, but may change if real world scenarios do not allow for it to happen.

3.8.3 Monitoring Requirements

DER facilities shall have provisions for real-time monitoring by London Hydro. These provisions will include, but not be limited to:

- Analog quantities
    - Phase to neutral and/or phase to phase voltages
    - Three phase currents
    - Net active (MW), reactive (MVAR) and apparent (MVA) power output flow and direction for each unit and total for the DER facility
    - Frequency
    - Power factor, including direction for each DER unit or total DER facility.
- Device Statuses
    - Connection status at PCC or DER POC
    - Status of individual DER units
    - Status of any breakers/switches between the PCC and DER unit(s)
- Alarms
    - Utility interface protection fail
    - Transfer trip telecommunication circuit fail

- Separate alarm for each circuit supplying the DER facility
- UPS and/or battery alarms
- London Hydro shall determine requirements based on controlling authority and equipment ownership

The mapping of specific telemetry points shall be as a result of project requirements. These monitoring values may come from multiple points within the DER facility, and in some cases, for a behind the meter installation, it may also include non-DER facility monitoring values.

3.8.4 Telemetry Reporting Rates

London Hydro expects frequent updates on telemetry on a continuous basis. Below are the reporting rates required:

Function	Performance	Scan Period
Data measurements	Less than 10 s from change in field monitored quantity	Minimum 4 s
Equipment status change	Less than 10 s from field status change	Minimum 4 s

Table 3-4: Telemetry Reporting Requirements

Note: London Hydro may poll less frequently than the minimum.

3.8.5 Event Capture

Protection relays and meters shall be set up to incorporate event triggers that capture both sequence of events and COMTRADE waveforms on:

- Any protection operation that trips the DER facility offline
- Reconnection of DER facility
- Operation of any circuit breaker or switch at the PCC and/or DER connections

3.8.6 Reliability

1) The delivery of real-time data at the communication demarcation point shall have a:
    a. MTBF (mean time between failure) of four (4) years
    b. MTTR (mean time to repair) of seven (7) days
2) The DER Owner may be required to disconnect the DER facility until problems are corrected if the failure rates or repair time performance in item 1 above fails to achieve their targets by the following significant amounts:
    a. Less than 2 years MTBF
    b. MTTR greater than 7 days
3) If the DG facilities is involved in a special protection system or automated dispatch, the telecommunication MTTR requirement shall be 24 hours.
4) Upon loss of telecommunications, the DER owner is required to immediately report the failure cause and estimated repair time to London Hydro.
5) MTTR time shall start from the time when the communications was lost and not from when it was discovered.
6) The DER owner shall coordinate any planned interruption to the delivery of real-time data with London Hydro.

3.8.7 Connection Point

The customer shall endeavour to design their communications and control system to have only one connection for London Hydro to connect to. The communication and control point shall be located at the same location, in close proximity to the revenue metering for the DER facility.

There may be cases where this is not possible, and shall be approved on a case by case basis.

3.8.8 Medium and Protocol

1) The interconnection of equipment shall be by serial connection only (EIA-232 or EIA-422).
2) A provision for the interconnection of equipment via ethernet connection (RJ-45) shall also be present.
3) Real-time operating information provided to London Hydro may be from an intelligent electronic device (IED) at the DER facility's station to London Hydro's system operating centre (SOC) using Secure Distributed Network Protocol (Secure DNP3) as a preferred means or DNP3 as a suitable alternate.
4) The Customer-owned equipment shall require a time-synchronizing connection, preferably GPS based.
5) The Customer-owned equipment shall act as the "server."
6) The London Hydro owned equipment shall act as the "client."
7) The communications settings of the serial connection shall be:

Setting	Value
Baud rate	19200 baud
Data bits	8
Parity bits	N
Stop bit	1

Table 3-5: Serial Connection Communication Settings

8) Server and client DNP addresses shall be determined at the time of project
    a) As a general rule, the server address shall be 100 and incremented by 1 for any subsequent connections.
    b) The client address shall be 1.
9) Unsolicited messaging shall be turned OFF. However, it may be requested to be turned on at a future date. Unsolicited messages shall only be enabled for specific analog values or status, listed below:

Value	Setting
Voltage	±6% of nominal at PCC
Current	None
Frequency	None
Power	105% of max generation
Power factor (PF)	0.9 lag < PF < 0.9 lead
DER breaker statuses	On change of status

Table 3-6: Unsolicited Message Settings

10) The server shall set the Disable_Controls POU to TRUE.
11) Analog and binary inputs shall be set to the following types and settings:

Value	Setting

Var Obj 1	2
Var Obj 2	2
Event Class	1

Table 3-7: Binary Input Type Settings

Setting	Analog Inputs (W, VAR, VA)	Analog Inputs (V, A, Other)
Var Obj 30	3	4
Var Obj 32	3	4
Event	2	2
Integer Type	32-bit	16-bit
Primary/Secondary	N/A	Primary
Rounding	Nearest single integer (e.g. 1234.56 transmitted as 1235)	

Table 3-8: Analog Input Type Settings

3.8.9 Firmware & Hardware Updates

The Customer shall notify London Hydro prior to the installation of any upgrades of hardware or firmware and shall provide firmware version at the time of commissioning.

3.8.10 Uninterruptible Power Supply (UPS) Requirements

If the DER facility does not utilize a DC/Battery supply for external-facing communications devices, an UPS is required to power the RTU and other miscellaneous devices. London Hydro shall supply and install a UPS at their metering or communications cabinet for their own specific equipment.

The customer shall install a duplex 120V 15A GFCI (where required) outlet/receptacle within the London Hydro cabinet, in accordance with the Ontario Electrical Safety Code.

3.9 Protection & Control Requirements

3.9.1 Measurement Location

Due to the increased functionality of DER facilities, it is becoming more important to not only measure at the point of connection (POC) of the DER facility, but also it is important to measure at the point of common coupling (PCC) in order to protect against abnormal conditions and provide support at the distribution system level.

Monitoring locations for protections shall be defined as per the below table:

DER System	Measurement Location
≤ 30 kVA	Either at the point of DER connection or PCC
> 30 kVA, ≤ 500 kVA	Determined by London Hydro
> 500 kVA	At the PCC

Table 3-9: Measurement Location

3.9.2 Measurement Accuracy

Each DER facility shall meet the minimum steady-state and transient measurement and calculation accuracies as listed below at both the POC and PCC:

Parameter	Steady-state Measurements			Transient Measurements		
	Minimum Accuracy	Measurement Window	Range	Minimum Accuracy	Measurement Window	Range
Voltage (RMS)	± 1% V_{nom}	12 cycles	50% to 120%	± 2% V_{nom}	5 cycles	50% to 120%
Frequency	10 mHz	60 cycles	50 to 66 Hz	100 mHz	5 cycles	50 to 66 Hz
Active Power	± 5% rated apparent power	12 cycles	20% to 105%, bidirectional*	N/A	N/A	N/A
Reactive Power	± 5% rated apparent power	12 cycles	20% to 105%, bidirectional*	N/A	N/A	N/A
Time	1% of measured duration	N/A	5 s to 600 s	2 cycles	N/A	100 ms to 5 s

Table 3-10: Measurement Accuracy (CSA C22.3 No.9)

* The Range shall be 10% to 105%, bidirectional for Load Displacement Facilities in order to ensure near zero export power to the distribution system.

3.9.3 Protection Designs

1) All protection designs must:
    a. Ensure proper coordination with London Hydro's protections.
    b. Be failsafe.
    c. Ensure that both the DER facility and London Hydro's distribution system, customers and general public safety are maintained.
    d. Protections shall be "utility grade" and shall meet the minimum requirements specified in IEEE C37.90. "Industrial grade" relays are not permitted for interconnection.

3.9.4 Breaker Failure

DER facilities with an aggregate output of greater than 500 kW shall have breaker failure protection as outlined in Hydro One's TIR.

DER facilities with an aggregate output less than 500 kW shall be exempted from implementing breaker failure protections, but shall have an alternate means of disconnecting the DER Facility generation energy source from the Distribution System when the associated breaker fails to open for any interconnection protection operations. This can be achieved by the opening of the isolation device, disabling an inverter, or by removing the prime mover and excitation system as appropriate.

3.9.5 Extended Loss of Utility Supply

After two minutes of loss of utility supply, the DER facility shall disconnect either at the PCC, or in the case of a DER facility supplying load for the Customer, at each POC. The DER facility's RTU shall have a dry output contact connected to an input located within London Hydro's RTU cabinet, that will operate when loss of utility supply is detected.

This will trigger the remote dispatch contacts, as outlined in Section 3.8.2, to prevent the DER units from coming back online until London Hydro's operators unblock the signal(s).

3.9.6 Synchronization

1) Any DER facility that is capable of generating its own voltage while disconnected from London Hydro's distribution system shall require proper synchronization facilities before connection is permitted.
2) Interconnection shall be prevented if the DER (synchronous, self-excited induction, or inverter-based) and London Hydro's distribution system are operating outside the specific limits. DERs that produce fundamental voltage before the paralleling apparatus is closed shall only parallel with London Hydro's distribution system when the frequency, voltage and phase angle difference are within the ranges mentioned below, at the moment of synchronization:

Aggregate Rating of DERs (kVA)	Frequency Difference (Δf, Hz)	Voltage Difference (ΔV, %)	Phase Angle Difference ($\Delta\phi$, °)
0 – 500	0.3	10	20
> 500, ≤ 1500	0.2	5	15
> 1500	0.1	3	10

Table 3-11: Synchronization Requirements (CSA 22.3 No.9)

3) A closed transition DER shall not operate in parallel with London Hydro's distribution system longer than 100 ms (6 cycles). A backup timer of 500 ms (30 cycles) shall also monitor the duration of parallel and automatically trip the main or DER breaker(s) once the duration has been reached (maximum parallel duration). The backup timer shall also lockout the transfer system and provide visual indication.
4) For synchronous generators, an approved automatic synchronization device shall be required if the plant is unattended (IEEE device number 25) to ensure that the DG Facility will not connect to an energized feeder out of synchronism.
5) Induction generators and inverter-based generators that do not produce fundamental voltage before the paralleling device is closed, and double-fed generators whose excitation is precisely controlled by power electronics to produce a voltage with magnitude, phase angle, and frequency that match those of the distribution system may not require synchronization facilities.

3.10 Teleprotections

DER facilities whose capacity is 1 MW or larger shall implement a transfer trip scheme, which will be connected to the station feeder breaker(s).

A teleprotection scheme shall also be implemented from the station feeder breaker(s) and/or upstream recloser(s) to the DER facility when any or all of the conditions are met:

1) When the aggregate DER facility capacity is greater than 50% of the minimum feeder load or the minimum load downstream of a recloser.
2) When the aggregate generation, comprising of existing generation, other earlier proposed DER facilities and the concerned DER facility is greater than 50% of the minimum feeder load or minimum load downstream of the recloser.
3) If the existing reclosing interval of the feeder breaker(s) and/or upstream recloser is less than 1 second.

The Customer shall follow the requirements outlined in Hydro One TIR for transfer trip, DER end open, and low set block signal design and operation.

3.10.1 Future Teleprotections Provisions

There may be instances where teleprotections such as transfer trip are required below a DER aggregate capacity of 1 MW. This may be due to system constraints or planned future distribution system changes that can affect aggregate generation on a feeder. These considerations will be made at the time of application. Consult the Hydro One TIR for more information at this time.

3.11 London Hydro Telecommunications

London Hydro uses multiple methods of telecommunications in order to send data to and from the DER Facility and System Operating Centre. The following methods are currently used:

1) Radio frequency telecommunication
2) Fibre optic telecommunications

For most projects, radio will be used, but there may be cases where fibre optic communications may be beneficial for other purposes or for future planning.

3.11.1 Radio Frequency Telecommunications

1) For a flat rooftop radio application London Hydro will provide a non-penetrating roof antenna and mast for mounting at the desired location.
2) The customer shall install the antenna and proper ballast/accessories and shall be located in an area where signal strength is optimal.
3) Any structures associated with telecommunications shall be owned and maintained by the DER Owner.
4) The DER Owner shall be responsible for landing the coaxial cable to the required locations, from the RTU cabinet to the antenna.
5) The DER Owner is responsible for ensuring the structural integrity of the building in order to support the weight of the telecommunications equipment.
6) The typical type of coaxial cable to be installed is Times Microwave LMR-400-DB or RFS LCF12-50JFN.
7) Maximum length of the coaxial cable run shall be no greater than 250 feet (75 metres).
8) The minimum allowable bend radius for the coaxial cable is 125 mm (5 in.).

3.11.2 Fiber Optic Communications

1) London Hydro may opt to use fiber optic medium for telecommunications.
2) The DER Owner shall be responsible for installing and landing the fiber optic cable to the required locations, from the RTU cabinet to the desired fiber optic connection point. London Hydro shall be responsible for the termination of the fiber optic cable. Any splicing between end points shall be completed by the DER Owner.

3.11.3 Last Resort/Backup Communications

Should radio or fiber optic communications not be feasible for the DER facility, a POTS phone line can be used as a backup measure in order to establish communications. The DER Owner shall be responsible for the cost, installation and ongoing costs of the POTS phone line.

3.12 SCADA Cabinet Specifications

1) London Hydro will provide the required SCADA cabinet(s) for obtaining telemetry from the DER facility.
2) The DER Owner shall install the provided cabinet(s), preferably indoors, at a height that is easily accessible in a standing position. Required raceways shall be installed to the respective locations as per each RTU cabinet type.

3) Termination of raceways into the RTU cabinet shall be bottom entry.

3.12.1 SCADA Cabinet With Metering Circuitry

The DER Owner shall install a London Hydro Provided SCADA cabinet with dimensions 30" H x 20" W x 8" D.

An additional 48" x 48" x 12" metering cabinet, minimum NEMA 3R rated, shall be installed by the DER Owner in order for London Hydro to install current and voltage transformers. The current and voltage will be measured via a SEL-2411 within the SCADA cabinet. A NEMA 4X cabinet may be required when installed outdoors.

The DER Owner shall install a raceway between the Metering and SCADA Cabinets for the CT and PT secondary wiring circuits.

3.12.2 SCADA Cabinet Without Metering Circuitry

An additional dedicated circuit and 15A, 120V receptacle shall be installed into London Hydro's revenue metering cabinet or gross load billing cabinet, depending on site-specific considerations. Refer to Engineering Instruction EI-22 and 29 for metering requirements.

3.12.3 Raceway Requirements

There will be a need for multiple raceways to connect equipment to London Hydro's SCADA cabinets. The DER Owner shall install the following raceways to London Hydro's RTU cabinet(s).

Radio Antenna

If a radio antenna requires an underground run, the DER Owner shall install a 2" minimum diameter conduit to allow for a run of type LMR400 coaxial cable to the antenna location. This conduit does not have to terminate at the cabinet, however it must be within 1 m (3 feet) of the cabinet.

Fibre Optic Medium

If fibre optic medium is to be used instead of radio, the DER Owner shall install a 2" minimum diameter conduit to allow for a run of single mode fiber of required London Hydro specifications. Where required, London Hydro shall provide a fiber termination box to be mounted by the DER Owner.

Communications

The DER Owner shall install a minimum 2" diameter conduit to allow for a RS-232 cable and other I/O.

3.12.4 Power Requirements

The DER Owner shall install a dedicated circuit within the London Hydro SCADA cabinet. It shall be installed in accordance with the OESC. No other loads shall be connected to this circuit.

3.12.5 Exceptions

Depending on the type of DER facility, the cabinet and internal contents may change. The number and size of raceways may also change to accommodate for additional wiring.

4 Agreements

There are four main documents to complete throughout the process of connecting a DER:

1) Study Agreement
2) Connection Cost Recovery Agreement
3) Confirmation of Verification Evidence Report (COVER)
4) Connection Agreement
5) Operating Procedures

These documents are required in order to begin installation and connecting the DER to the distribution system.

4.1 Study Agreement

The study agreement outlines the costs and information necessary to perform the required study and work, as well as the responsibilities for each party.

4.2 Connection Cost Recovery Agreement

The connection cost recovery agreement lays out the initial requirements to connect a DER to London Hydro's distribution system. Items that are addressed in such agreement include, but not limited to:

- DER Owner information
- DER specifications
- Connection information
- DER Owner Scope of Work to satisfy London Hydro requirements
- London Hydro Scope of Work to allow the generator to connect to the distribution system
- Hydro One Scope of Work to allow the generator to connect to the distribution system
- Liabilities and Responsibilities
- Costs of connecting the DER Facility to the distribution system

This document is executed after completing a formal CIA Application and receiving a Connection Impact Assessment and Initial Design Review.

4.3 COVER

The COVER is a testing and commissioning checklist document that is completed in its intended order. The document shall be signed and stamped by an active licensed professional engineer in the province of Ontario. The document ensures that any protections and systems are checked prior to connection authorization by London Hydro.

4.3.1 Witness Testing

London Hydro may request to be on-site during specific COVER tests in order for the DER facility to meet acceptability criteria. The DER Owner shall notify London Hydro of their availability at least 10 business days in advance of any required witness testing.

4.4 Connection Agreement

In order to generate on London Hydro distribution system, a connection agreement must be completed, approved and signed by both London Hydro and the DER Owner. The connection agreement is required as per the Ontario

Energy Board Distribution System Code, as laid out in Appendix E. London Hydro has added additional requirements to ensure the safe and reliable operation of the distribution system.

The DER Owner shall not generate until this connection agreement is finalized and executed. This is typically signed at the late stages of connection, usually just after completing offline commissioning, i.e. COVER completion.

4.5 Operating Procedures

For DER facilities 1 MW or greater, an operating procedure between London Hydro and the DER Owner is required to be executed, as their operation becomes more complex in nature. These operating agreements go over details such as, but not limited to:

- DER Owner information
- DER specification
- DER Facility feeder connection
- Protections
- Allowable operation of the DER Facility
- Contact information

This document is executed at the late stages of connection, usually just after completing offline commissioning.

5 Technical Documentation Requirements

Throughout the DER connection process, there will need to be submissions of technical information and authorizations to connect. These documents shall be reviewed and approved by a London Hydro project coordinator or professional engineer. The documents required to submit in order for DER connection (final) are:

- Single line diagrams
- AC and DC wiring diagrams
- Equipment specifications
- Radio path studies for teleprotections
- Ground grid design
- Protection philosophy
- Protection settings
- Operating philosophy
- COVER
- Letter of Equivalency
- ESA Connection Authorization
- As built drawings
- IESO Contract Agreement, when DER Owner is a Wholesale Market Participant

Should there be any changes or modifications to the DER installation, the DER Owner shall submit revised drawings and documentation for review. Note that there may be delays in DER connection if significant revisions are required.

6 Appendix A: Generation Rejection Circuit

As laid out in Section 3.8.2, a hardwired control wiring scheme shall be used to allow or reject generation. The schematic below illustrates a general overview in what is required for this purpose:

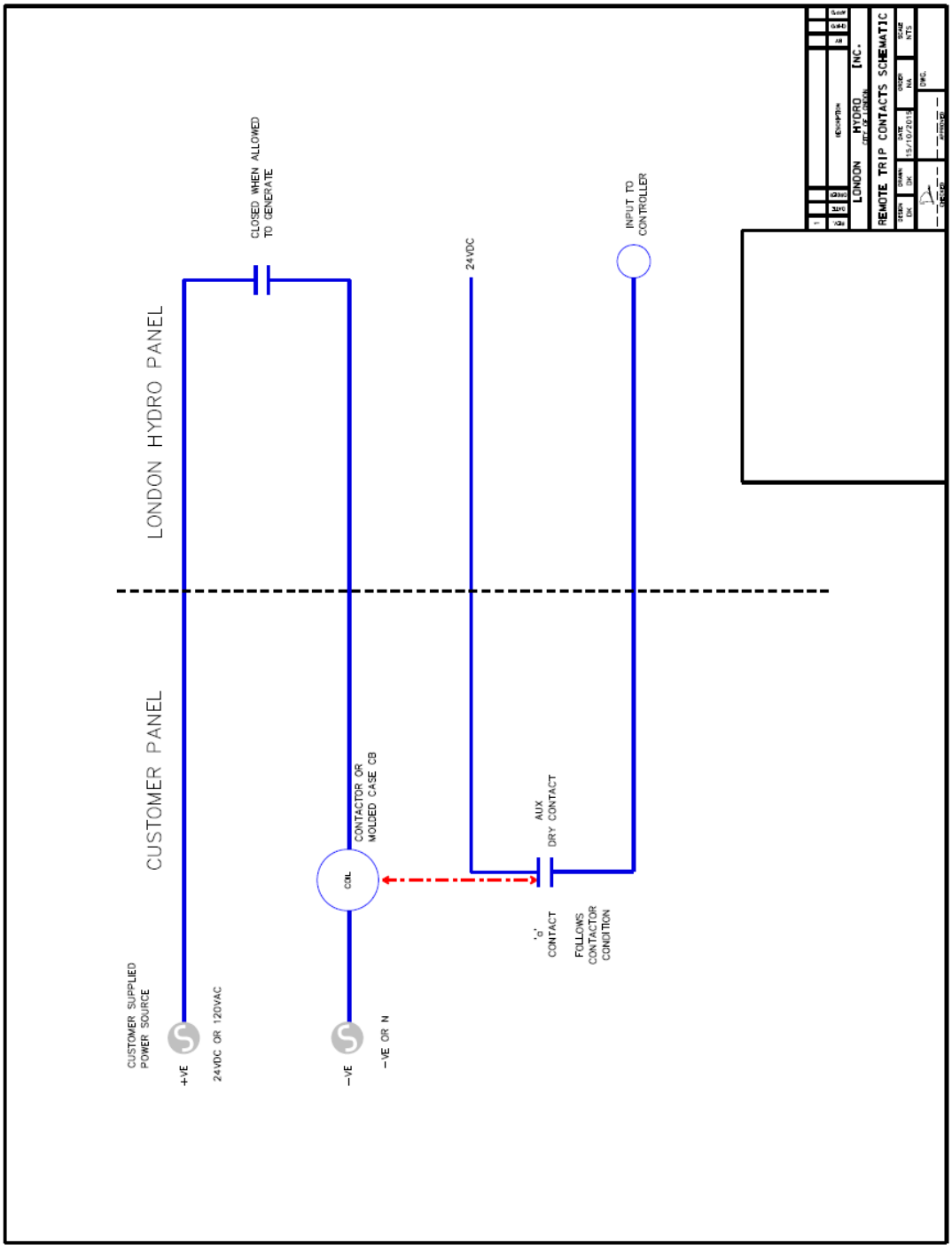

Figure 6-1: Generation Rejection Circuit Drawing