Appendix A2:

Technical Requirements for Distributed Generators > 10 kW to be Connected to Kitchener-Wilmot Hydro Inc.'s Distribution System

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A. INTRODUCTION

This document outlines the technical requirements for distributed generators to be connected to Kitchener-Wilmot Hydro Inc.'s distribution system. It is intended to guide the DG proponent in connecting distributed generators into Kitchener-Wilmot Hydro Inc.'s distribution system. The purpose of this document is to ensure public safety, protect Kitchener-Wilmot Hydro Inc.'s system and employees and maintain reliable service to all Kitchener-Wilmot Hydro Inc.'s customers while connecting the distributed generators. This document doesn't contain all details in designing and protecting the generation system. The DG proponent shall ensure the safety of its own facilities.

This document applies only to the distributed generation facilities larger than 10kW.
The micro generation facility (≤10KW) is subject to a simplified connection process with simpler connection requirements, please check Kitchener-Wilmot Hydro Inc.'s Document No. KWHDG-2

This document is for guidance purpose only. Kitchener-Wilmot Hydro Inc. does not accept any responsibility or liability for any of the information provided in this document. And meeting these requirements does not necessarily guarantee an acceptable design. Kitchener-Wilmot Hydro Inc. reserves the rights to amend these requirements at any time.

B. REFERENCE

OEB	Ontario Energy Board – Distribution System Code (DSC)
Ontario Regulation	Ontario Electric Safety Code (OESC)
CSA C22.3 No.9	Interconnection of Distributed Resources and Electricity Supply Systems
IEEE 1547	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.1	Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.2	IEEE Application Guide for IEEE Std 1547, Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.3	IEEE Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
CSA CAN3-C235	Preferred Voltage Levels for AC Systems, 0 to 50,000kV
Hydro One Networks	Distributed Generation Technical Interconnection Requirements
NPCC D12	Northeast Power Coordinating Council, Regional Reliability Reference Directory #12 – Under frequency Load Shedding Program Requirements
IEEE 1453	IEEE Recommended Practice for Measurement and Limits of Voltage Fluctuations and Associated Light Flicker on AC Power Systems
IEEE C37.119	IEEE Guide for Breaker Failure Protection of Power Circuit Breakers

C. TECHNICAL REQUIREMENTS FOR DG INTERCONNECTION

In line with the Appendix F2 of the Ontario Distribution System Code, IEEE 1547 and CSA No.C22.3 No.9, Kitchener-Wilmot Hydro Inc. will review and ensure the DG interconnection requirements at the following 3 stages before final connection.

- Stage of Preliminary Review
- Stage of Connection Impact Assessment
- Stage of Design Review

Additional power quality requirements apply after the DG is in service.

1. STAGE OF PRELIMINARY REVIEW

In the very early stage when a DG proponent is considering the site selection and planning, Kitchener- Wilmot Hydro Inc. will conduct a simple project review based on the limited parameters provided by the DG proponent and high-level distribution system information. The purpose of the preliminary review is to quickly screen some apparently infeasible projects by using some highly simplified rules. The preliminary review does not guarantee the viability of the proposed DG project.

- ***Document Submission Requirements for Preliminary Review***

  Before meeting with Kitchener-Wilmot Hydro Inc. for preliminary review, the DG proponent shall submit the following documents:

  - A copy of completed application form in Appendix C2: DG02.
  - A copy of high level single line diagram of the proposed facility if available;
  - A copy of site plan showing the generation facility and the proposed Point of Connection if available;

- ***Preliminary Review Criteria***

  Kitchener-Wilmot Hydro Inc. is committed to working with the DG proponent on the preliminary review. All existing connected DG projects and all committed DG projects will be included into consideration following the criteria in Table 1. It is advised that these capacity limits might be superseded under special circumstances, and a special engineering review by Kitchener-Wilmot Hydro Inc. will be required before approval. The preliminary review process may be amended to be in line with the directions from Ontario Energy Board and Independent Electricity System Operator when required.

  Kitchener-Wilmot Hydro Inc.'s transmission and distribution system information is available in Appendix B2 to assist the DG proponent developing their plan. The service maps showing K-W Hydro Inc.'s transformer stations and distribution systems and a nearly up-to-date table showing the system capacity available to the potential renewable generation are listed on Kitchener-Wilmot Hydro Inc.'s website at: http://www.kwhydro.ca/generation_connection.asp

Table 1: Preliminary Review Criteria by Kitchener-Wilmot Hydro

<table>
<tr><th>Criteria</th><th>Reference</th></tr>
<tr><td>

1.1 Capacity Limits – Transformer/Distribution Station

Subject to the thermal load limit of other station equipment Kitchener-Wilmot Hydro Inc. will limit DG connected to each station following the criteria:

<table>
<tr><th>Nominal Station Secondary Voltage (PP/PG)</th><th>Max. Allowable Aggregate Capacity on Station Transformer</th><th>Max. Allowable Aggregate Capacity on Station Bus</th></tr>
<tr><td>27.6/16 kV</td><td rowspan="3">60% nameplate rating of station transformer for normal 2-winding station transformer. No reverse flow is allowed for dual secondary winding station transformer due to overheating.</td><td rowspan="3">60% nameplate rating of station transformer + min station bus load for normal 2-winding transformer;

Min bus load for dual secondary winding transformer</td></tr>
<tr><td>13.8/8 kV</td></tr>
<tr><td>8.32/4.8 kV</td></tr>
</table>

</td><td>Kitchener-Wilmot Hydro Inc. requirements</td></tr>
<tr><td>

1.2 Capacity Limits – Distribution Feeder

Subject to the thermal loading limit of other distribution equipment, Kitchener-Wilmot Hydro Inc. will limit DG connected to each feeder following the criteria:

<table>
<tr><th>Nominal Feeder Voltage (PP/PG)</th><th>Feeder Max. Allowable 1-Phase Unit Capacity</th><th>Feeder Max. Allowable 3-Phase Unit Capacity</th><th>Feeder Max. Allowable Aggregate Capacity</th></tr>
<tr><td>27.6/16 kV</td><td>50kW</td><td>10MW</td><td>10MW</td></tr>
<tr><td>13.8/8 kV</td><td>50kW</td><td>5MW</td><td>5MW</td></tr>
<tr><td>8.32/4.8 kV</td><td>50kW</td><td>0.5MW</td><td>1.5MW</td></tr>
</table>

</td><td>Kitchener-Wilmot Hydro Inc. requirements</td></tr>
</table>

2. STAGE OF CONNECTION IMPACT ASSESSMENT (CIA)

After DG proponent decides the site location and develops a project plan, Kitchener-Wilmot Hydro Inc. will conduct the connection impact assessment to determine what adverse impact the proposed DG may have on Kitchener-Wilmot Hydro Inc.'s Distribution System with regard to voltage fluctuation, fault contribution, equipment thermal loading etc. The purpose of the CIA is to determine the viability of the proposed DG project and all necessary upgrades at both Kitchener-Wilmot Hydro Inc.'s System and the DG site to mitigate the adverse impact on Kitchener-Wilmot Hydro Inc.'s System. The connection impact assessment does not consider the system impact on the proposed DG equipment.

- ***Document Submission Requirements for CIA***

  To conduct the Connection Impact Assessment, the DG proponent shall submit Kitchener-Wilmot Hydro Inc., the following:

  - A copy of completed Application Form in Appendix D2: Form DG03.
  - 2 copies of high-level single line diagrams showing the line conductor sizes and distance from the generation interface transformer to the Kitchener-Wilmot Hydro Inc.'s distribution system;
  - 2 copies of site plan showing the generation facility, line routing, isolating device and the proposed Point of Connection;
  - 2 copies of technical description of the operating philosophy of the electrical equipment, protection and control philosophy of the generation system and interconnection device.

  The application form and all above technical documents shall be signed and sealed by a licensed Ontario Professional Engineer.

  Kitchener-Wilmot Hydro Inc. may have additional requirements for CIA and will clarify when signing the Connection Impact Study Agreement.

- ***Impact Assessment Criteria***

  Kitchener-Wilmot Hydro Inc. will conduct the connection impact assessment using the criteria in Table 2. All existing connected DG projects and all committed DG projects with signed Connection Cost Agreement will be considered in the impact assessment.

Table 2: Connection Impact Assessment Criteria by Kitchener-Wilmot Hydro Inc.

Criteria	Reference
2.1 Isolation at the Point of Connection The DG proponent shall provide a means of isolation at the Point of Connection in compliance with the OESC. The isolation device shall be readily accessible by Kitchener-Wilmot Hydro Inc. staff, lockable, and with visible break. The Point of Connection, normally at the HV tap of the connected distribution feeder, will be clarified by Kitchener-Wilmot Hydro Inc. at early stage.	DSC Appendix F.2 Sec.1 OESC rule 84-026 IEEE 1547 Item 4.1.7
2.2 Interconnection Grounding and HV Interrupting Device The generator facilities and the associated interconnection transformer(s) shall be grounded as per manufacturer's recommendation and the OESC. The interconnection grounding shall not cause overvoltage or fault current exceeding the rating of Kitchener-Wilmot Hydro Inc.'s distribution equipment. For wind generation facility, the grounding of wind towers shall not connect to the distribution system neutral. The table below lists the preferred connection for the interconnection transformer and the suggested High Voltage Interrupting Device. Kitchener-Wilmot Hydro Inc. will review each interconnection individually to accommodate the local system restraints and the DG manufacturer's	DSC Appendix F.2 Sec. 2 OESC rule 84-026 CSA C22.3 No.9 rule 7.3.2, 7.4.9 IEEE 1547 Item 4.1.2 Kitchener-Wilmot Hydro Inc.'s requirement

<table>
<tr><th>Criteria</th><th>Reference</th></tr>
<tr><td>recommendations.
<table>
<tr><th>Nominal Feeder Voltage</th><th>Proposed Generator Size</th><th>Preferred Interconnection Transformer (HV-LV)</th><th>Suggested HV Interrupting Device</th></tr>
<tr><td rowspan="3">27.6/16kV (4 wire)
13.8kV/8kV (4 wire)</td><td>>1MW</td><td>Yg-D</td><td>HVI (breaker or switcher) + LV Breaker</td></tr>
<tr><td>>200kW, ≤1MW</td><td>Yg-D or
Yg-Yg (Δ tertiary may be required);</td><td>HVI (breaker or switcher)
or
LV breaker</td></tr>
<tr><td>≤200kW</td><td>Yg-Yg</td><td>Fused load break switch</td></tr>
<tr><td rowspan="2">8.32 kV (4-wire)</td><td>>200kW, ≤500kW</td><td>Yg-D or
Yg-Yg (Δ tertiary may be required);</td><td>HVI (breaker or switcher)
or
LV breaker</td></tr>
<tr><td>≤200kW</td><td>Yg-Yg</td><td>Fused load break switch</td></tr>
</table></td><td></td></tr>
<tr><td>2.3 Steady State Voltage
The DG shall operate satisfactorily within the extreme voltage level variation limits of ± 6% of the nominal voltage at the Point of Connection.
The generation facility shall not intently regulate the voltage at the Point of Connection.
During normal operation and wherever possible, the generator shall be loaded or unloaded gradually to allow adequate time for regulating device to respond so as to avoid unnecessary voltage fluctuation.</td><td>DSC Appendix F.2 Sec. 3, 3.2
CSACAN3-C235 Item 6.1
IEEE 1547 Item 4.1.1</td></tr>
<tr><td>2.4 Voltage Fluctuation
Operating the DG shall not cause a voltage fluctuation of more than ± 5% at the Point of Connection for any normal steady state situations including: with or without the DG generating power under minimum and maximum load conditions.</td><td>DSC Appendix F.2 Sec. 3.1, 3.2
CSA C22.3 No 9 rule 7.4.14.1</td></tr>
<tr><td>2.5 Synchronization
Paralleling or sudden tripping the DG shall not cause a voltage fluctuation of more that ± 5% at the Point of Connection.
For synchronized generators, the interconnection with the distribution system may occur only within the synchronization limits below (from CSA C22.3 No. 9):
<table>
<tr><th>Total DG system</th><th>Frequency Difference</th><th>Voltage Difference</th><th>Phase Angle</th></tr>
<tr><td>0-500 kVA</td><td>0.3 Hz</td><td>10%</td><td>20º</td></tr>
<tr><td>>500-1500 kVA</td><td>0.2 Hz</td><td>5%</td><td>15º</td></tr>
<tr><td>>1500 kVA</td><td>0.1 Hz</td><td>3%</td><td>10º</td></tr>
</table>
For an induction generator or an inverter-based DG, the synchronization shall not create a voltage drop greater than 5% or the voltage flicker. And the induction generator should be brought close to synchronous speed prior to interconnection.

For interconnection to Kitchener-Wilmot Hydro Inc.'s distribution system, the paralleling device shall be capable of withstanding 220% of the interconnection system rated voltage.</td><td>DSC Appendix F.@ Sec. 3.2, 10.6
OESC rule 84-006
CSA C22.3 No. 9 rule 7.4.14, 7.4.2
IEEE 1547 Item 4.1.3, 5.1.2</td></tr>
<tr><td>2.6 Voltage Unbalance
Operation of the generation facility shall not cause objectionable voltage unbalance by more than 3% and current unbalance by 10% at the Point of Connection.</td><td>DSC Appendix F.2 Sec. 3.2
CSA C22.3 No. 9 rule 7.2.5</td></tr>
<tr><td>2.7 Power Factor
The generation facility shall be capable of operating in the preferred power factor range of 0.9 lagging and 0.95 leading unless otherwise requested or approved by Kitchener-Wilmot Hydro Inc. The generation facility of 30 kW and less is not required to be capable of adjusting the power factor. Where Kitchener-Wilmot Hydro Inc. determines that the operation of a generation facility will impact the</td><td>DSC Appendix F.2 Sec. 4
CSA C22.3 No. 9 rule 7.2.4.2</td></tr>
</table>

Criteria	Reference
distribution system voltage levels at the Point of Connection, Kitchener-Wilmot Hydro Inc. may require the DG proponent to limit power factor range or power output of the generation facility or take other compensatory measures (e.g., field-settable fixed and dynamic power factor correction techniques).	
2.8 Equipment Ratings and Requirements The generation facility interface equipment shall be compatible with Kitchener-Wilmot Hydro Inc. equipment ratings and the incorporation of the added generation facility must not result in any distribution system equipment operating beyond its ratings. Kitchener-Wilmot Hydro Inc. will review the ratings of the impacted equipment in the distribution system and transformer stations under all operating conditions including but not limited to the following: - Nominal equipment thermal loading – including feeder conductor/cable, disconnect switch, fuse, station breaker/recloser and transformers etc. - DG fault contribution impact on the equipment rating – including disconnect switch, fuse, station breaker/recloser etc. at phase or ground fault. - Voltage regulating and metering device – if the generation facility causes reversed power flow at feeder level or station level, the feeder/station voltage regulation and metering device shall be capable of handling bi-directional power flow. - DG fault contribution impact on the feeder protection equipment – the DG fault contribution may reduce the fault current through the station breaker and cause the feeder protection malfunctioned. The feeder relay setting adjustment or relay replacement may be required. Kitchener-Wilmot Hydro Inc. will determine all necessary system upgrades required to accommodate the proposed generation facility. The detailed protection coordination and relay setting will be reviewed and approved at Design Review stage.	DSC Appendix F.2 Sec. 5 CSA C22.3 No.9 rule 7.4.2
2.9 Anti-Islanding and Transfer Trip Requirement The generation facility shall automatically disconnect from Kitchener-Wilmot Hydro Inc.'s System upon the loss of utility supply voltage to prevent equipment caused by out-of-phase reclosing. No unplanned or planned islanding is allowed by Kitchener-Wilmot Hydro Inc.. The necessity of anti-islanding device will be determined at this stage. Details be verified and approved at Design Review stage. Kitchener-Wilmot Hydro Inc. use "50%" rule for the installation of DG anti-equipment. If the aggregate DG nameplate rating on the feeder is less than 50% the minimum load on a certain feeder, the islanding situation is supposed not sustain and no special anti-islanding equipment is required. Otherwise, all facilities on this feeder will be required to install anti-islanding protection, like transfer trip scheme. For generation facility ≥ 1MW, a transfer trip scheme from the upstream breaker to the generation facility is required. For generation facility ≤ 500kW, passive anti-islanding protections, like Rate Change of Frequency over Power, Rate of Change of Frequency over Power, Jump methodology may be considered upon Kitchener-Wilmot Hydro Inc.'s approval.	DSC Appendix F.2 Sec. 6.1.2, 6.1.3 CSA C22.3 No.9 rule 7.4.8, 7.4.12 IEEE 1547 Item 4.4.1
2.10 Revenue Metering Kitchener-Wilmot Hydro Inc. will specify the metering requirement and instrument transformer requirements. In general, all metering device shall be Measurement Canada Approved. For generation facility larger than 50kW, 4 Quadrant meter is required. For generation facility larger than 5MW, primary metering is required. The DG proponent shall incorporate the metering requirements into the system design.	DSC Appendix F.2 Sec. 7

<table>
<tr><th>Criteria</th><th>Reference</th></tr>
<tr><td>2.11 Feeder Relay Directioning
The fault on the adjacent feeder may cause sympathetic tripping of the overcurrent protection on the feeder with DG connected due to the fault contribution from the DG.
Kitchener-Wilmot Hydro Inc. will conduct the fault analysis and determine if the DG feeder relay shall be replaced with directional overcurrent relay or distance relay to detect the reverse fault current situation.</td><td>DSC Appendix F.2 Sec. 8</td></tr>
<tr><td>2.12 Monitoring and Information Exchange
The generation facility with aggregate capacity larger than 10 kW shall have provision for monitoring.

All generation facilities larger than 10 kW but less than or equal to 250 kW shall have the provision for monitoring the disconnecting device at the Point of Connection. Provisions for other real-time monitoring signals may be required and shall be determined by Kitchener-Wilmot Hydro Inc.

For all generation facilities larger than 250 kW, Kitchener-Wilmot Hydro Inc. requires real-time monitoring information at Kitchener-Wilmot Hydro Inc. Control Center as summarized in the table below. The Generator shall install a communication terminal (could be SCADA master station, RTU, advanced metering, IED or equivalent) that is capable of communicating with Kitchener-Wilmot Hydro Inc. Control Center using serial DNP 3.0 protocol. The Generator is responsible to provide all the required hardware and software and make arrangements to bring all required signals to the Kitchener-Wilmot Hydro Inc. Control Center, including the communication circuit (typically a Bell circuit) between the generation facility and Kitchener-Wilmot Hydro Inc. SCADA Master Station. Other real-time monitoring signals may be required and shall be determined by Kitchener-Wilmot Hydro Inc.

If Kitchener-Wilmot Hydro Inc. requires additional monitoring information for a certain generation facility, Kitchener-Wilmot Hydro Inc. will specify the requirements in the Connection Impact Assessment Report.

<table>
<tr><th>Remote Monitoring Points</th><th>>10kW ≤250kW</th><th>>250kW</th></tr>
<tr><td>Analog: total MW and MVar</td><td>No</td><td>Yes</td></tr>
<tr><td>Analog: DG 3-phase voltage</td><td>No</td><td>Yes</td></tr>
<tr><td>Analog: DG 3-phase current</td><td>No</td><td>Yes</td></tr>
<tr><td>Status: HVI/LVI Open/Close</td><td>Yes (provision only)</td><td>Yes</td></tr>
<tr><td>Status: Transfer Trip Received</td><td>No</td><td>Yes (if TT required)</td></tr>
<tr><td>Alarm: transfer trip circuit failure</td><td>No</td><td>Yes (if TT required)</td></tr>
<tr><td>Alarm: DG interface protection failure</td><td>No</td><td>Yes</td></tr>
</table>
</td><td>DSC Appendix F.2 Sec. 9
OESC Rule 2-022
IEEE 1547 Item 4.1.6
IEEE 1547.3
CSA C22.3 No.9 rule 7.4.16</td></tr>
</table>

3. STAGE OF DESIGN REVIEW

After DG proponent accepts the Connection Impact Assessment Report and reaches the Connection Cost Agreement with Kitchener-Wilmot Hydro Inc., Kitchener-Wilmot Hydro Inc. will conduct a detailed engineering Design Review to verify the suitability of the DG installation. The purpose of the Design Review is to confirm that all technical requirements in the CIA are met and protection coordination between the DG interface

protection and the distribution feeder protection is sufficient. Kitchener-Wilmot Hydro Inc. will also review the DG commissioning plan at this stage to ensure the testing requirements. Kitchener-Wilmot Hydro Inc. may advise more technical requirements to supplement the information provided in the CIA.

- ***Document Submission Requirements for Design Review***

  After signing the Connection Cost Agreement, the DG proponent shall submit Kitchener-Wilmot Hydro Inc. two (2) copies of the following documents for design review:

  - Single-line diagrams showing ratings of all electrical equipment, such as disconnect switches, bushing potential devices, CVTs, power transformers, grounding transformers, grounding resistors, breakers, etc. The example of single line drawing is shown in Fig. 1.
  - GPR Study and associated station ground design.
  - DC station service schematics showing ratings of all electrical equipment such as batteries, chargers, etc.
  - Switchgear fault ratings
  - HV surge arrestor specification
  - Transformer protection, AC and DC wiring diagrams
  - Disconnect switch or HV breaker AC and DC wiring diagrams
  - LV breaker (transformer & bus tie breakers) AC and DC wiring diagrams
  - Breaker failure schematics (HV breaker, LV breaker)
  - HV equipment operating and protection philosophy.
  - Power transformer and generator nameplate ratings
  - Relay settings including relay logic diagrams, coordination studies and fault calculations.
  - Commissioning Procedure including the partially completed COVER form following the COVER instruction in Appendix F2: Form DG06.
  - Preliminary and final generator data, including excitation system performance, automatic voltage regulator (AVR), power factor regulator, power system stabilizer, static exciter and speed governor to ensure compliance with all applicable reliability standards required under the IESO Market Rules.
  - Generator absorption/deliverance of VARs from/to Kitchener-Wilmot Hydro Inc.'s distribution system to maintain the voltage to a given set point.

  All technical documents for submission shall be signed and sealed by a licensed Ontario Professional Engineer.

  Kitchener-Wilmot Hydro Inc. may have additional requirements and will clarify when signing the Connection Cost Agreement.

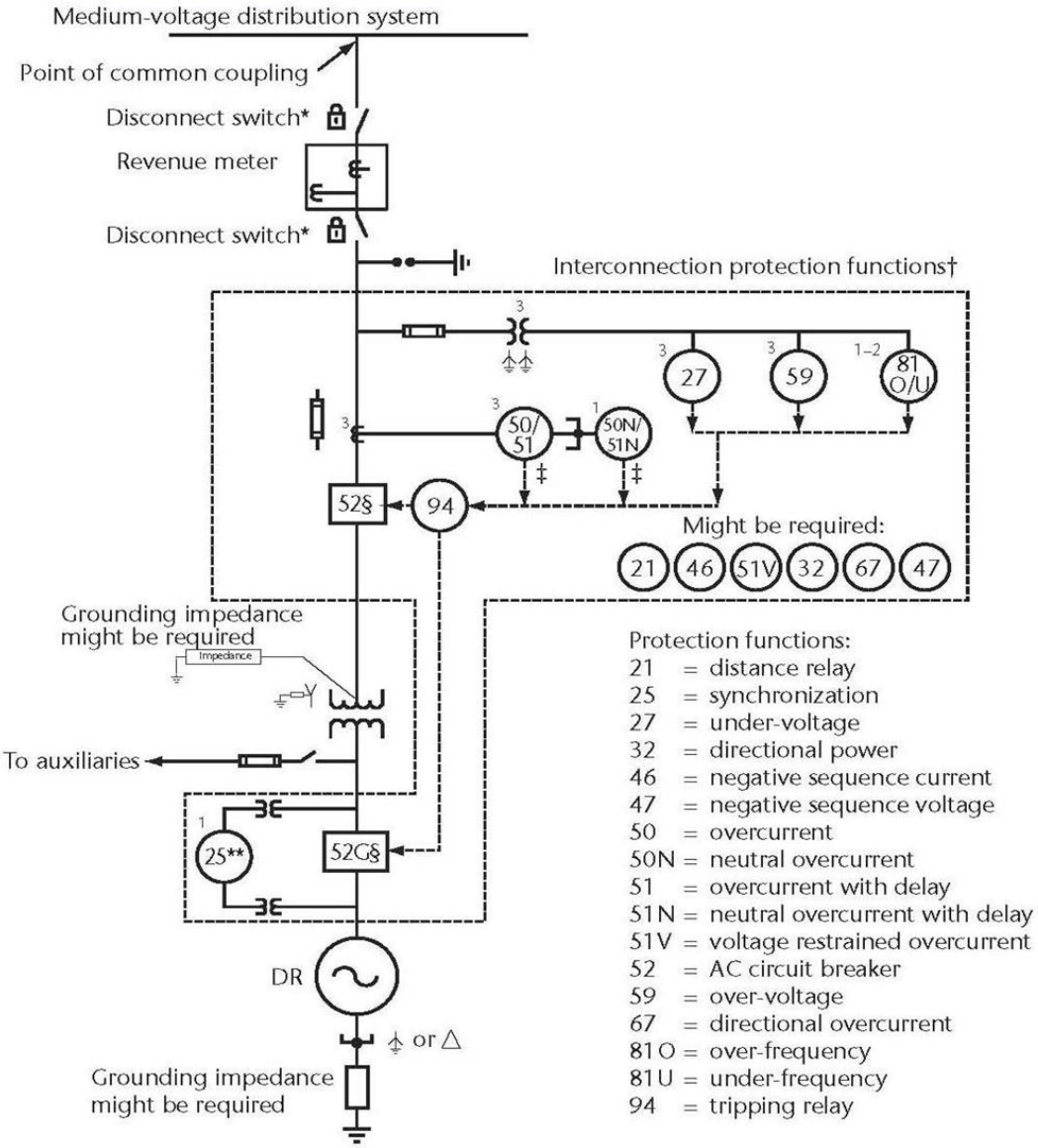
- ***Design Review Criteria***

  Kitchener-Wilmot Hydro Inc. will review the detailed DG protection/control system design and relay settings under various normal operating or faulty conditions and ensure the DG protection system can automatically isolate the generation facility from the distribution system when required.

  In general, the following interface protections will be reviewed by Kitchener-Wilmot Hydro Inc. following the Criteria in Table 3.

ANSI No.	**Description**
25	Synchronization check
27/59	Under/Over voltage (3 phase)
81U/O	Under/Over frequency (1 phase)
50/51	Instantaneous/Timed overcurrent
67	Directional overcurrent
21	Distance (if required)
85	Transfer trip or other anti-islanding device (if required)
DGEO	DG end open (if required)

87	Transformer differential (if equipped)
89	DG isolation device
94	Tripping relay
52BF	Breaker failure

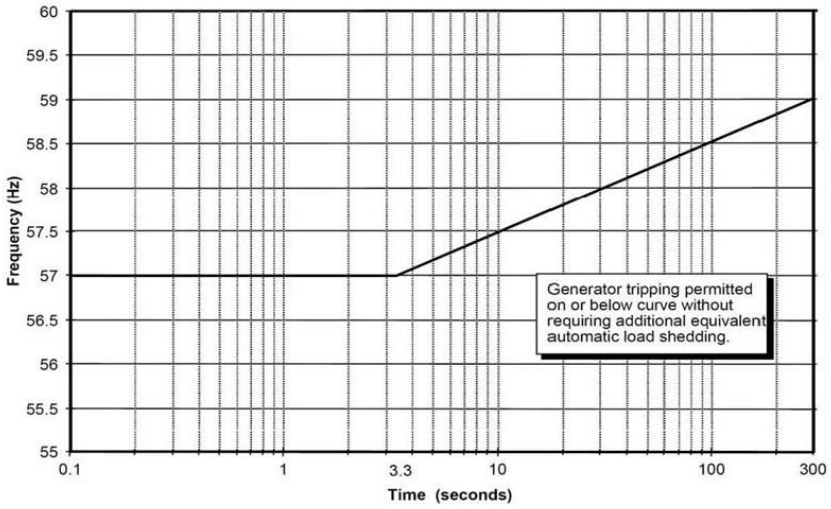


Might be required by the wires owner.
†The measurement for the interconnection protection functions can be done on the secondary side of the transformer (if grounded Y – grounded Y) with the approval of the wires owner.
‡Overcurrent protection functions 50, 51, 50N, and 51N may be replaced by fuses, but might require other protection functions.
§The protection functions can operate the main current breaker (52) or DR breaker (52G) with the approval of the wires owner.
***Synchronizing function (25) is required for some DR technologies.*
Note: *This Figure is informative. It is not to be used as a basis for installation or design.*

Figure 1: Typical single line diagram (Copy of CSA C22.3 No.9 Figure A.3)

Table 3: Design Review Criteria by Kitchener-Wilmot Hydro Inc.

<table>
<tr><th>Criteria</th><th>Reference</th></tr>
<tr><td>3.1 Isolation Device Verification
Kitchener-Wilmot Hydro Inc. will review the isolation device design and ensure the requirements of Criteria 2.1 have been met.</td><td>DSC Appendix F.2 Sec. 1
OESC rule 84-026
IEEE 1547 Item 5.3.2</td></tr>
<tr><td>3.2 Grounding Integration Verification
Kitchener-Wilmot Hydro Inc. will review the DG grounding system design and ensure the requirements of Criteria 2.2 have been met.</td><td>OESC rule 84-026
IEEE 1547 Item 5.3.1</td></tr>
<tr><td>3.3 DG Protection Design Verification
Kitchener-Wilmot Hydro Inc. will review the DG protection/control system design under various faulty conditions and ensure the DG protection system can automatically isolate the generation facility from the distribution system at
- internal faults within the generation facility; and
- external phase / ground faults within the distribution system
All protection devices at the generation facility shall be utility grade. The protection selectivity and sensitivity shall remain over the range of maximum and minimum system fault currents with fault contribution from the generation facility. Relay setting adjustment / relay replacement at both the generation facility and Kitchener-Wilmot Hydro Inc.’s station may be recommended.</td><td>OESC rule 84-014
IEEE 1547 Item 5.3.4
CSA C22.3 No.9 Item 7.4.4</td></tr>
<tr><td>3.4 Reclosing Coordination Verification
Kitchener-Wilmot Hydro Inc. will review the DG disconnection time at faults and ensure the generation facility ceases to energize prior to the auto-reclosure of Kitchener-Wilmot Hydro Inc.’s distribution feeder breaker / recloser.
Typically, the reclosing happens 2 seconds after the feeder breaker trips in 27.6kV / 13.8kV system or 0.67 seconds after the recloser trips in 8.3kV system.</td><td>DSC Appendix F.2 Sec. 6
IEEE 1547 Item 5.3.4</td></tr>
<tr><td>3.5 Over/Under Voltage Protection Verification
Kitchener-Wilmot Hydro Inc. will review the settings of over/under voltage protection. The settings shall follow the requirements in IEEE 1547, as listed below:
<table>
<tr><th>Voltage range (% of base voltage *)</th><th>Clearing time(s)**</th></tr>
<tr><td>V< 50</td><td>0.16</td></tr>
<tr><td>50 ≤ V< 88</td><td>2.00</td></tr>
<tr><td>110 < V < 120</td><td>1.00</td></tr>
<tr><td>V ≥120</td><td>0.16</td></tr>
</table>
*Base voltages are the nominal system voltages stated in ANSI C84.1-1995.
** DR ≤ 30 kW, maximum clearing times; DR > 30kW, default clearing times.</td><td>DSC Appendix F.2 Sec. 6.5
IEEE 1547 Item 4.2.3
CSA C22.3 No.9 Item 7.4.7</td></tr>
<tr><td>3.6 Over/Under Frequency Protection Verification
Kitchener-Wilmot Hydro Inc. will review the settings of over/under frequency protection. The settings shall follow the requirements in IEEE 1547, as listed below:
<table>
<tr><th>DG size</th><th>Frequency range (Hz)</th><th>Clearing time(s)*</th></tr>
<tr><td rowspan="2">≤ 30 kW</td><td>> 60.5</td><td>0.16</td></tr>
<tr><td>< 59.3</td><td>0.16</td></tr>
<tr><td rowspan="3">> 30 kW</td><td>> 60.5</td><td>0.16</td></tr>
<tr><td>< {59.8 – 57.0} (adjustable set point)</td><td>Adjustable 0.16 to 300</td></tr>
<tr><td>< 57.0</td><td>0.16</td></tr>
</table>
*DG ≤ 30 kW, maximum clearing times; DR > 30 kW, default clearing times.
The low frequency settings of the DG facility larger than 250kW shall also meet the low-frequency tripping requirements set in Northeast Power Coordinating</td><td>DSC Appendix F.2 Sec. 6.5
IEEE 1547 Item 4.2.4
CSA C22.3 No.9 Item 7.4.6</td></tr>
</table>

Criteria	Reference
Council (NPCC), "Regional Reliability Reference Directory #12" – Under frequency Load Shedding Program Requirements, as shown in the graph below:  	
3.7 Reconnection Verification Kitchener-Wilmot Hydro Inc. will review the automatic reconnection settings of DG facility. After a disturbance on the distribution system, no reconnection shall take place until the distribution system voltage and frequency are restored within the normal limits, i.e., voltage within ±6% at the Point of Connection and frequency between 59.3 Hz and 60.5 Hz. The generator facility shall include an adjustable delay or a fixed delay of 5 minutes that may delay the reconnection for up to 5 minutes after the power restoration.	DSC Appendix F.2 Sec. 6 CSA C22.3 No.9 Item 7.4.10, 7.4.11, 7.4.20.3
3.8 Monitoring and Information Exchange Verification Kitchener-Wilmot Hydro Inc. will review the DG design and ensure all monitoring and information exchange requirements in Criteria 2.12 have been incorporated into the system design.	DSC Appendix F.2 Sec. 9 IEEE 1547 Item 5.3.3
3.9 Anti-Islanding Protection Verification Kitchener-Wilmot Hydro Inc. will review the DG anti-islanding design and anti-islanding requirements in Criteria 2.9 have been met.	DSC Appendix F.2 Sec. 6.1.2, 6.1.3 CSA C22.3 No.9 rule 7.4.8, 7.4.12 IEEE 1547 Item 4.4.1
3.10 Protection Failure Scheme Verification Kitchener-Wilmot Hydro Inc. will review the DG protection failure scheme and ensure the failure of the interface protection at the generation facility will not disrupt the distribution system. In case of interconnection protection failure, like breaker trip coils fail, auxiliary power is lost, the protection relay is not functional, the generation facility shall cease to energize the distribution system and isolate from the distribution system without delay. If the transfer trip communication function fails, the generation facility shall cease to energize the distribution system in 5 seconds. The affected generation facility shall not return to normal service until the protection failure is resolved and Kitchener Wilmot Hydro Inc. is informed. The DG proponent shall demonstrate in the protection and control philosophy how to cease to energize the distribution system and isolate	Kitchener-Wilmot Hydro Inc. requirements. IEEE C37.119 CSA C22.3 No.9 rule 7.4.20,

Criteria	Reference
the generation facility from the distribution system in case of the protection failure. For generators larger than 200 kW, breaker failure protection shall be considered for HVI and LVI.	

4. ADDITIONAL POWER QUALITY REQUIREMENTS AFTER DG IN SERVICE

The DG proponent shall also consider the power quality requirements listed in Table 4 when designing and testing the generation facility and ensure that the generation facility does not significantly impact the power quality. Kitchener-Wilmot Hydro Inc. will not be able to evaluate the power quality requirements at the design stage. However, if there are negative impacts on the distribution system or other customers once the generation facility is in service, the DG proponent will be required to disconnect the generation facility until the power quality issue is resolved.

Table 4: Power Quality Criteria by Kitchener-Wilmot Hydro Inc.

<table>
<tr><th>Criteria</th><th>Reference</th></tr>
<tr><td>4.1 Flicker
The generation facility shall not cause objectionable flicker for other customers serving by Kitchener-Wilmot Hydro. Indicative values of planning levels for Pst and Pit in Kitchener-Wilmot Hydro's distribution system are shown below following IEEE 1453 (IEC 61000-4-15). The values of Pst and Pit should be measured by an approved flicker-meter in compliance with IEEE 1453 (IEC 61000-4-15).
<table>
<tr><th></th><th>27.6/13.8/8.32kV</th></tr>
<tr><td>Pst</td><td>0.9</td></tr>
<tr><td>Pit</td><td>0.7</td></tr>
</table>
</td><td>DSC Appendix F.2 Sec. 10.1
IEEE 1547 Item 4.3.2
CSA C22.3 No.9 Item 7.2.2
IEEE 1453 Item 4.2.2</td></tr>
<tr><td>4.2 Harmonics
The generation facility shall not inject harmonic current such that it causes objectionable voltage distortion on the distribution system. The distortion at the Point of Connection caused by generation facility shall not exceed the limits below:
<table>
<tr><td>Individual harmonic order, h</td><td>h < 11</td><td>11 ≤ h < 17</td><td>17 ≤ h < 23</td><td>23 ≤ h < 35</td><td>35 ≤ h</td><td>Total demand distortion (TDD)</td></tr>
<tr><td>Distortion, percentage of current*†</td><td>4.0</td><td>2.0</td><td>1.5</td><td>0.6</td><td>0.3</td><td>5.0</td></tr>
</table>
*The current specified in this Table is the greater of
(a) the distribution system maximum load current integrated demand (15 or 30 min) without the DG;or
(b) the DG unit rated current capacity, transformed to the PCC when a transformer exists between the DG unit and the PCC.
†The maximum distortion values specified in this Table are for odd harmonics. To obtain maximum distortion values for even harmonics, the value in the corresponding h-range shall be multiplied by 25%.
</td><td>DSC Appendix F.2 Sec. 10.2 IEEE 1547 Item 4.3.3
CSA C22.3 No.9 Item 7.2.1</td></tr>
<tr><td>4.3 Limitation of DC Injection
The generation facility shall not inject at the point of DR connection a dc current greater than 0.5% of the generator rated output current.</td><td>DSC Appendix F.2 Sec. 10.3
IEEE 1547 Item 4.3.1
CSA C22.3 No.9 Item 7.2.7</td></tr>
<tr><td>4.4 Resonance and Self Excitation
The generation facility shall avoid the potential effects of resonance, including
(a) Ferro-resonance in the interface transformer;
(b) Sub-synchronous resonance due to the presence of distribution capacitor banks or large rotating machines; and
(c) Harmonic resonance with other customers when capacitors are being added as part of the installation.</td><td>CSA C22.3 No.9 Item 7.2.6</td></tr>
</table>

Criteria	Reference
The DG proponent shall assess and address the potential resonance when designing the DG system. Kitchener-Wilmot Hydro Inc. will provide the relevant system information upon request. When induction generators are used, the DG proponent shall also assess and address the potential for self-excitation.	

D. REQUIREMENTS FOR DG COMMISSIONING AND VERIFICATION

After DG installation is completed, the DG proponent shall perform the commissioning of the DG equipment. The commissioning process shall conform to the requirements of IEEE 1547 Section 5 and IEEE 1547.1 - Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems. The commissioning plan shall be reviewed and approved by Kitchener-Wilmot Hydro Inc. before the commissioning.

The DG proponent shall apply for ESA electrical inspections and provide Kitchener-Wilmot Hydro Inc. the Authorization to Connect once all requirements are satisfied.

Kitchener-Wilmot Hydro Inc. will require the DG proponent complete the Confirmation of Verification and Evidence Report (COVER) following the COVER instruction in Appendix F2: Form DG06. The purpose of COVER is to verify the DG interface protection and control equipment meets the design requirements and the DG is ready to connect to the grids. Kitchener-Wilmot Hydro Inc. may also request site witnessing and verification during commissioning if Kitchener-Wilmot Hydro Inc. feels necessary.

E. WARNING SIGNS AND DIAGRAMS

The following warning sign shall be posted on the Point of Connection, generator feeder cell and switch room door as a warning of the presence of DG:

WARNING
TWO POWER SOURCE
PARALLEL SYSTEM

A single line, permanent and legible diagram of the switching arrangement shall be placed at the generation facility's control room and the switch room to indicate the position of the DG(s) and isolation points with the interlocking arrangements.

Operating designations will be assigned to the switching equipment of the generation system in the Connection Agreement as required by Kitchener-Wilmot Hydro Inc. The DG customer shall update the single line electrical diagram and operating diagram to include the assigned operating designations, and the switching equipment shall be identified by the operating designations as well.

F. MAINTENANCE AND REPORTING REQUIREMENTS

More maintenance and reporting requirements will be clarified in the Connection Agreement: