VUNTUT GWITCHIN FIRST NATION

REQUEST FOR PROPOSAL

Name of Competition:	Old Crow Solar Project - PV Solar System
Competition Number:	OCSP-2018-01
Issue Date:	Friday, March 2, 2018
Closing Date and Time:	Monday, March 19, 2018, 14:00:00 HRS PST
VGFN Representative:	Joe Linklater, Executive Director Email: energy@vgfn.ca

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SECTION 1. INTRODUCTIONS AND DEFINITIONS

1.1 Vuntut Gwitchin First Nation (VGFN) Background

The Vuntut Gwitchin First Nation is located in the northern Yukon. The village of Old Crow is the only permanent community in the traditional territory, and the only community in the Yukon without road access. Old Crow has a population of approximately 220 people, the majority of which are beneficiaries of the Vuntut Gwitchin First Nation.

The Vuntut Gwitchin First Nation Final Agreement and the Vuntut Gwitchin Self Government Agreement were settled in 1993. The Constitution of the Vuntut Gwitchin First Nation and the Vuntut Gwitchin Governance Act set forth the mandate, and establish the Vuntut Gwitchin Government (VGG) as the government of the Vuntut Gwitchin First Nation.

The Old Crow Solar Project will be constructed on community lands owned by the Vuntut Gwitchin First Nation.

Additional information can be viewed on the website at https://www.vgfn.ca/index.php.

1.2 Purpose

The Old Crow Solar Project will enable VGFN to reduce diesel reliance and improve energy security in Old Crow; improve air quality and reduce noise and odour pollution; generate economic opportunities; and create jobs and opportunities for skills training. The project will reduce the social and environmental risks associated with the transportation of diesel to the community, improving the efficiency of existing diesel generators and the flexibility and resiliency of the Old Crow power system, and reducing global warming impacts.

The electricity will be sold to ATCO Electric Yukon (ATCO) in accordance to the Yukon Independent Power Production Policy.

The project described in these Request for Proposals (RFP) documents is the supply and install of the Solar PV System at Old Crow, as described in Section 4.

1.3 Intent

It is the intent of the VGFN to obtain the best overall solution, services and value through an RFP process that provides a high level of responsiveness, quality Proposals, and a Proponent that has a proven track record of meeting its client's needs. Proponents are to use the forms and follow the methodology as provided in this document. Deviations from form and factor may lead to a downgrade in scoring or a worst case scenario, no scoring consideration given.

Your company is invited to submit a Proposal on a competitive basis in the format described in these RFP documents.

1.4 Acknowledgement

The VGFN thanks all Proponents for responding to this RFP. It recognizes the time, resources and energy that it takes to complete and submit a Proposal for consideration. The VGFN does not take lightly the endeavour and effort made to provide a Proposal and appreciates your response to this RFP.

In no way or manner should this RFP be considered a repudiation or statement of dissatisfaction with any current company providing services to the VGFN. This RFP is an ongoing business commitment and demonstration ensuring that the VGFN undergoes scrutiny and diligence that can withstand review and audit. The VGFN is committed to the highest standards of business practice and services and appreciates your company helping the VGFN achieve these goals.

Thank you in advance for participating in this RFP process.

1.5 Definitions

"Closing Time" or "Closing Date and Time" means the date and time specified in Section 2.4 of this RFP.

"Contract" means the agreement between the VGFN and Consultant/Contractor as embodied in all the Contract Documents.

"Consultant/Contractor" means the successful Proponent that is awarded a Contract as a result of this RFP process.

"Consultant's/Contractor's Representative" means the person appointed by Consultant/Contractor as its representative, and unless advised otherwise in writing, Consultant's/Contractor's Representative (a) has full authority to act on behalf of and bind the Consultant/Contractor, and (b) may in writing, delegate any or all of his or her authority to any other person.

"VGFN" means Vuntut Gwitchin First Nation.

“VGFN's Delegate” means the person appointed by the VGFN who has responsibility for managing the Questions and Queries in the preparation of the proposal

"VGFN's Representative" means the person appointed by the VGFN who has responsibility for managing the submission of all proposals.

"Day" means a calendar day, unless specifically stated otherwise.

"Proponent" means a person or organization who submits a Proposal in response to this RFP.
"Proposal" means the documents, if any, that Proponent delivers to the VGFN proposing to perform the Work.

"RFP" means this Request for Proposal process.

"RFP Documents" means all sections of this RFP.

"Work" means all or any part of the services and obligations required to be performed by the Consultant/Contractor under a Contract

SECTION 2. INSTRUCTIONS TO PROPONENTS

2.1 Letter of Intent to Respond

After reviewing this RFP, the VGFN requests that all potential proponents who intend to respond to this RFP identify themselves using the letter of intent to respond (the "Letter of Intent") provided in Appendix A of this RFP. Only those companies/individuals submitting a Letter of Intent will receive subsequent information, addenda, and Q&A information.

2.2 Proposal Delivery

All proposals are to be submitted by email as indicated in Subsection 2.6 Electronic Proposal Submission.

2.3 VGFN'S Delegate

For the purposes of this RFP process, the VGFN's Delegate is:

Alex Vigneault, Delegate
Email: energy@vgfn.ca
Phone: 778-232-6202

E-mail communications are preferable.

2.4 Closing Date and Time

The date and time of RFP closing is Monday, March 19, 2018, 14:00:00 HRS PST. Strict adherence to this deadline will be maintained. In order to be considered, Proposals must be received on or before the RFP Closing Date and Time. Proposals received after the Closing Date and Time will be rejected and remain unopened.

2.5 Proposal Submission

Proponent(s) should clearly identify in their proposal email the name and address of the Proponent, the RFP number, the title of the RFP and the RFP Closing Date and Time.

To enable the VGFN to effectively evaluate submissions, Proponents are requested to submit Proposals with adherence to the form and format within the RFP Documents, referencing the section(s) and clause(s), as necessary, to facilitate accurate and expedient evaluations.

2.6 Electronic Proposal Submission

Submissions should be in accordance with these Electronic Proposal Submission requirements. Only electronic submission will be accepted. In order for your Proposal to be considered, your Electronic Proposal Submission must:

1. Be received by the VGFN's Representative at the email addresses indicated above, on or before the Closing Date and Time. For validation purposes the time of receipt shall be identified as the time when the incoming email first hits the VGFN outward facing firewall;
2. Include, at a minimum, a duly executed copy of the Forms of Proposal, signed by authorized Representative(s) of the Proponent's organization.

Proponents should note that the VGFN's e-mail system will not accept emails in excess of 25 MB. The VGFN prefers all attachments to be in PDF format. It is the responsibility of Proponents to ensure that e-mails are of a size that can be received by the VGFN and in a format that can be read by the VGFN.

The VGFN is not responsible for, and the Proponent assumes all the risks associated with, the receipt of and/or confidentiality of any documents delivered by electronic submission.

The VGFN is not responsible for, and the Proponent assumes all the risks associated with, the electronic submission of documents including, but not limited to:

1. Receipt of incomplete document(s);
2. Lack of access to or availability of the email receiving equipment;
3. Defective receiving equipment;
4. Incompatibility between sending and receiving equipment;
5. Delay or interruption in transmission or receipt of the transmitted document(s); and
6. Illegibility of all or any part of the document(s).

Proposals received after the Closing Date and Time will not be considered, and will be deleted.

2.7 Verification of Proposal Receipt

Proponents may verify that their Proposal has been received prior to the Closing Date and Time by contacting the VGFN's Representative. The Proponent must identify their company name before any information will be released. No other information concerning the RFP other than confirmation of Proposal receipt will be released.

2.8 Questions and Queries

There will be a bidder's conference call which will be held on Monday, March 5, 2018, 10:00 AM PST.

Call information: 1-866-969-8429; Conference ID: 613 41 44

Proponents may submit questions via e-mail to the VGFN Delegate as specified in section 2.3 until March 15, 2018, 14:00 Hours PST. Questions submitted after this date and time may not be responded to.

Questions will be responded to in a timely manner if possible, and answers from all proponents questions will be distributed to all bidders via email.

If the VGFN, in its sole discretion, determines that information generated from any question will be of interest to all, a summary of anonymous questions and answers will be made available to all proponents in the form of an addendum. The source of all questions will be kept confidential.

If a proponent believes that disclosure of a question and response would expose a proprietary aspect of its proposal, the proponent may submit the question with an advisory to the VGFN explaining why it should not be included with the posted anonymous questions and answers. If VGFN concurs with the request, the question will be answered in confidence and will not be posted. If VGFN does not concur with the request, the proponent will be asked to restate the question, and if this is not possible, the proponent has the option to withdraw the question.

Proponents will not contact or ask questions of any other VGFN personnel. Information obtained from any person or source other than the VGFN's Delegate cannot be relied on for the purposes of this RFP process and cannot be incorporated into a Proposal. The VGFN may disqualify any Proponent who solicits information from any person other than the VGFN's Delegate.

The VGFN will review the questions and where the information is not already provided, will issue an addendum to all Proponents under this Section. The VGFN will make a reasonable effort to have the responses issued within 48 hours of the defined closing date for questions.

2.9 Proposal Withdrawals

Proposals may be withdrawn at any time prior to the Closing Date and Time by submitting a written withdrawal request to the VGFN's Representative at the same address to which the Proposal was submitted. The Proposal will be deleted.

2.10 Proposal Amendments

Where a Proposal has been received by the VGFN before the RFP Closing Date and Time, amendments by email are acceptable provided that such amendments are received in writing at the location specified herein prior to the RFP Closing Date and Time.

Amendments to Proposals should clearly state the name and address of the Proponent, the RFP number, and the name of the RFP in accordance with these Instructions to Proponents. Any amendment must be duly signed by an authorized signatory of the Proponent.

2.11 Proposal Details

Proponents should provide complete and accurate information and details for all aspects of their Proposal. Failure to respond to any requests for information, costs, qualifications or clauses will be deemed to be a negative response and may disqualify the Proposal or cause the Proposal to receive a lower rating through evaluations.

2.12 Proposal Opening

The opening of Proposals will be closed to the public. Information on Proponent's names and/or prices received may be released at the VGFN's absolute discretion. In the event the Proponent's names and/or prices are released, this information may be released in a timely fashion and only to qualifying Proponents after Proposals are opened and evaluated, and a Contract is awarded to the successful Proponent.

2.13 Addenda

All addenda and/or question and answer series issued during this RFP will become part of the RFP. Proponents should identify all addenda and/or question and answer series received during the RFP process as requested in the Forms of Proposal.

2.14 Extensions

The VGFN may extend the Closing Date and Time of the RFP by issuing a written addendum to all Potential Proponents.

2.15 Irrevocability

Proposals shall be irrevocable for a period of ninety (90) days from the closing date and the Proponent shall not have the option of revoking its Proposal until the expiry of the irrevocable period.

2.16 Site Visit

A site visit has not been scheduled.

2.17 References / Searches / Contacts

Proponents are requested to include a list of at least three (3) references of clients, complete with the contact person(s) and their contact information, for which they have done work, similar in scope and size to the Work outlined in the RFP, within the past three (3) years.

Proponents, responding to this RFP, authorize the VGFN to contact any references (current and past), whether the reference was listed by the Proponent as one of the Proponent's references in the Forms of Proposal, or not.

2.18 Health and Safety / Environment

Health and safety for all project participants will be of the highest priority, and all participants shall abide by Yukon Occupational Health Act and Yukon Safety Regulations.

SECTION 3. EVALUATION PROCESS AND CRITERIA

3.1 Evaluation Committee

An evaluation committee comprised of VGFN staff and project participants will evaluate Proposals received. The VGFN reserves the right to include subject matter expert(s) and/or external consultant(s) as part of the evaluation committee, at the VGFN's absolute discretion.

3.2 Evaluation Methodology and Process

Proposals will be evaluated on the information received in the Proposal, only if received by the Closing Date and Time. The evaluation committee will review each Proposal to ensure compliance with the requirements of the RFP. The committee will use specific evaluation criteria to rate the various components of the Proposals.

Proposals may be further evaluated on information received through the RFP process, including but not limited to clarifications, additional information, telephone conversations, Proponent presentations, interviews and/or meetings with short listed Proponents.

3.3 Proponent Interviews

The VGFN reserves the right to conduct Proponent interviews as part of the evaluation process. The VGFN will not necessarily select any or all of the Proponents to take part in this process. Proponent(s) selected for interviews will be from a selection process through the evaluations and at the absolute discretion of the VGFN.

3.4 Evaluation Criteria

For the purposes of Proposal evaluation, the VGFN may take into account, in its absolute discretion, any or all of the information received from the Proponent under or pursuant to the RFP Documents, VGFN's knowledge of, and/or past experience with the Proponent (including Proponent's performance on previous contracts with the VGFN, if any), and any information about the Proponent received from third parties and deemed reliable by the VGFN.

The Proposal Evaluation Criteria, indicated below, describes the criteria which will be used by the VGFN to evaluate Proposals received in response to this RFP.

The VGFN shall have no obligation to inform Proponents of the details of its evaluation process, or of the specific ranking assigned to any evaluated Proposal.

Number	Criteria	Comment
1.	Corporate System Design	Ability of the design to meet all components of the scope
2.	Team Experience	Key members responsible for work: • Demonstrated experience in Solar PV generation design, procurement, construction and commissioning. • Demonstrated experience in working in the Yukon, remote communities, and cold climate.
3.	Work Approach and Methodology	• Demonstrate an understanding of project work. • Methodology to safely and fully complete the Scope of Work during the design, procurement, construction and commissioning phases of work activities.
4.	Project Schedule	Provide a detailed schedule in logical sequence for all work phases.
5.	Local Labour	Inclusion of VGFN members in any phase of work will result in increased value
6.	References	Three (3) relevant references will be evaluated
7.	Price	Lowest price has maximum points

SECTION 4. SCOPE OF WORKS

4.1 Scope of Works

The Scope of Works is detailed in the document in Appendix C.

4.2 Project Schedule

The proposed high level project schedule is shown below:

	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19
Issue RFP														
Review and Contract Award														
Detailed Design														
Civil Construction														
Procurement & Supply														
- E Building Construction														
Installation on Site														
- E Building Install														
- BESS & Micro Controller														
Commissioning														

The Proponents proposed project schedule will be based on an estimated Contract signing date as indicated below. If the Contract signing date is delayed, the VGFN expects that any associated dates will be delayed by the same amount of time.

4.3 Payment Schedule

VGFN requires the proponents to accept the following payment schedule in their proposed contract:

- 20% on signing contract
- 40% on acceptance of materials at site
- 40% once commissioned and accepted

4.4 Proposed Alterations / Optimization

Proponents wishing to submit alternate innovative methods or operational Proposals that they feel will benefit the VGFN are encouraged to do so. It is requested that alternative Proposals be shown separately and submitted in the form provided in Section 6.

SECTION 5. FORMS OF PROPOSAL

Proponents are requested to provide comprehensive information as outlined in the RFP Documents to enable complete and accurate evaluation of their Proposal. Omission of any information that the VGFN deems as pertinent to the Proposal may cause the Proposal to receive a lower rating through evaluations, or may cause the Proposal to be disqualified at the VGFN's absolute discretion.

1. Addenda and Questions and Answer Acknowledgement
2. Proposal Submission
3. Fixed Cost for Scope of Work
4. Proposed Alterations / Optimizations
5. Proposed Project Work Schedule
6. Technical Documents / Information
7. Rate Sheet-Ongoing Work I Change Orders I Additional Work
8. Proposed Personnel
9. Experience in Similar Work
10. Form of Contract

For templates for the above forms, see Appendix D.

By submitting a Proposal, the Proponent warrants:

1. Proponent has carefully examined the RFP Documents together with all other factors affecting the Work and proposes to furnish the services as outlined in the RFP.
2. At the time of submitting this Proposal, there is no actual, apparent, or potential conflict of interest with VGFN, except as disclosed in these Proposal Forms.
3. In the event of Proponent's Proposal being accepted, the Proponent agrees to accepts the terms and conditions as per the contract attached and enter into a Contract with the VGFN for the amounts specified in the Pricing Sheet(s) and/or Rate Sheet(s) (if applicable), or as otherwise agreed between the parties in a subsequent Contract.
4. This proposal, including pricing, shall remain valid and open for acceptance for a minimum of Ninety days (90) Business Days from the Closing and shall together with the RFP and Contract Template document attached form the basis of any contract which may be entered into between the Corporation and the selected Proponent.

5. Proponent acknowledges that the Corporation is subject to the Personal Information Protection and Electronic Documents Act ("PIPEDA"), and declares the following information and records submitted in its Proposal to constitute trade secrets or information, the disclosure of which could reasonably be expected to harm significantly its, or a third party's, competitive or negotiating position or result in any undue financial loss or gain.

SECTION 6. CONDITIONS

1. VGFN reserves the right to not accept any Proposal.
2. The Proponent is responsible for all of its costs to submit a Proposal and to negotiate and finalize a contract for the Work.
3. The acceptance of a Proposal is subject to the negotiation and signing of a contract for the Work.
4. VGFN anticipates negotiating and signing the contract for the Work prior to March 31, 2018.

Appendix A: Letter of Intent to Respond

LETTER OF INTENT TO RESPOND

Old Crow Solar PV Project - PV Solar System	
Send to the Following Email:	energy@vgfn.ca
This document certifies that the following proponent intends to respond to the above-noted Proposal	
Name of Company/Individual:	
Street Address:	
City:	
Province/Sate:	
Postal Code/Zip:	
Telephone Contact Number:	
Email address:	
Signed By:	
Name: (Please Print):	
Title::	
Note: Only those Proponents who indicate their intent to respond will receive subsequent information	

Appendix B: Relationship Disclosure Form

RELATIONSHIP DISCLOSURE FORM

This form must be completed by the Proponent Team on its own behalf and on behalf of each member of the Proponent Team.

The Proponent declares on its own behalf and on behalf of each member of the Proponent team that:

(a) This declaration is made to the best of the knowledge of the Proponent and, with respect to relationships of each member of the Proponent Team, to the best of the knowledge of that member;

(b) The following is a full disclosure of all known relationships the Proponent and each member of the Proponent Team has, or has had, with:

1. The Corporation:;
2. Any current employees, shareholders, directors or officers, as applicable, of the Corporation;
3. Any former shareholders, directors or officers, as applicable, of the Corporation, who ceased to hold such position within two calendar years prior to the Submission Time for the Submission; and
4. Any other person who, on behalf of the Corporation, has been involved in the Competitive Selection Process or the design, planning or implementation of the Project.

Name of Proponent Team Member	Name of Party with relationship (e.g., List Corporation, Other Party)	Details of the Nature of the Relationship with the Party/Person (e.g., Proponent Team Member was an advisor to the Party from 2009-2011)

(Each Proponent Team to submit one Relationship Disclosure Form. Add additional pages as required. Corporate disclosures only need to be provided once and not repeated for every individual of that company).

Name of Proponent: _____

Name of Proponent Firm: _____

Address: _____

Email Address: _____

Telephone: _____

Name of Authorized Signatory for Proponents: _____

Appendix C: Scope of Works

Vuntut Gwitchin Government

Vuntut Gwitchin First Nation

Old Crow Solar PV Project

Old Crow Airport, YT

PV Solar Plant Package

Scope of Works

Competetion No. OCSP-2018-01

March 2, 2018

FINAL

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REVISION HISTORY

Revision	Document Status – Revision Description	Date
R00	Final	2018-03-02

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1. INTRODUCTION

The purpose of this document is to define the Engineering, Procurement, Fabrication, Construction, installation and Commissioning Scope of Work to be executed for Old Crow Utility Scale PV Project in Yukon. The installation site is located in Old Crow, north of Air Strip, green field.

The purpose of the project is the development of a 450 kW Solar PV plant for the Vuntut Gwitchin First Nation (VGFN) and the community of Old Crow. The project is located north of the Arctic Circle in the Yukon. The electricity utility in the remote community is ATCO Electric Yukon. The PV plant will interconnect with ATCO's off grid diesel system, with ATCO being ultimately responsible for distribution of the power to customers.

This document covers the minimum requirements for the design, engineering, assembly, supply, installation, inspection, testing, packing and shipping of a PV solar package as described herein.

This specification covers the minimum requirement for the PV solar arrays, structure support, junction boxes, inverters, AC distribution panel and associated auxiliary electrical equipment and bulk material. PV solar array sets shall be mounted outdoor on a rigid structure base suitable for the site condition. The PV solar system should be designed with necessary features to comply with the interconnection requirements as per ATCO standards.

2. REFERENCE STANDARDS

1. IEC 61215 - Crystalline Silicon Terrestrial Photovoltaic (PV) Modules - Design Qualification and Type Approval; 2005.
2. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electric Power Systems; 2003, with Amendment 1, 2014.
3. IEEE Std 929-1988 IEEE Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
4. NECA 412 - Standard for Installing and Maintaining Photovoltaic (PV) Power Systems; 2012.
5. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
6. CSA Z462 - Workplace Electrical Safety Standard
7. UL 489B - Outline of Investigation for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures for Use with Photovoltaic (PV) Systems; Current Edition, Including All Revisions.
8. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

9. UL 1699B - Outline of Investigation for Photovoltaic (PV) DC Arc-Fault Circuit Protection; Current Edition; Current Edition, Including All Revisions.
10. UL 1703 - Flat Plate Photovoltaic Modules and Panels; Current Edition, Including All Revisions.
11. UL 1741 - Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources; Current Edition, Including All Revisions.
12. UL 2579 - Low-Voltage Fuses - Fuses for Photovoltaic Systems; Current Edition, Including All Revisions.

3. CONFLICTS, DEVIATIONS AND AMENDMENTS

1. Any deviation from the design standards and requirements laid out in this specification will be considered but will not be acceptable unless agreed to in writing by the Owner. The Proponent shall submit data sheets as part of the proposal. Proposed deviations shall be clearly highlighted with other alternatives and fully supported in the documents offered by Proponent.
2. Compliance with this specification shall not relieve the Proponent of the responsibility of furnishing the equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.
3. Conflicts, errors or discrepancies found in the specification and other associated documents shall be brought to the Owner's attention for resolution.
4. In the event of any conflict between this specification, data sheets, related international/ national standards, codes etc., most stringent requirement is applicable. However the Proponent should refer the matter to the Owner for clarifications. The Proponent shall proceed with the manufacture/ supply of such items only after obtaining necessary clearance from Owner.
5. Owner reserves the right to amend / update this specification at any stage but before fabrication and Proponent would ensure compliance to it.

4. PROJECT DESCRIPTION

This section is intended to provide the tenderers with the project scope – refer to Scope of Work below for minimum Design Requirements.

The total installed capacity shall be around 2 x 450 kW DC. The arrangement for the panels on site shall be 45° with one row facing east and the other row facing west, in a back to back arrangement. This arrangement shall supply a maximum of 450 kW regardless of where the sun is positioned in the sky (ie only 50% of the panels will be generating at a time).

The equipment shall be designed, manufactured and tested in accordance with the latest revision of the IEC, IEEE, UL and other standards as applicable. The Proponent shall be fully responsible for meeting General and Specific requirements in respect of both materials and services. All components utilised in the construction of the equipment shall be of the latest design, new and in current production. Material used shall be approved by appropriate authority where applicable.

4.1 Site design conditions

All Equipment and the Project shall be capable of continuous operation between the following ambient conditions ("Site Design Conditions"):

Table 1: Site Design Conditions – Parameters

Description	Parameter
Installation type	Outdoor service Ambient Temperature Range
Ambient Temperature Range	-55 °C to +40 °C
Elevation above sea level	1000 meter or less
Seismic Information	Sa(0.2)=0,54, Sa(0.5)=0.353, Sa(1)=0.196, Sa(2)=0.03, PGA=0.261
Annual Total Precipitation *(Fort McPhearson data)*	315 mm
Rain Load 1/50 (S_r) *(Fort McPhearson data)*	0.1 kPa
Snow Load 1/50 (S_s) *(Fort McPhearson data)*	3.2 kPa
Wind load	Hourly wind pressure, q_{wind} (1/50 years) = 0.50 kPa Average annual wind | speeds = 7km/h
Ground condition	Muskeg and swamp in summer over permafrost, frozen in winter

Note: Fort McPhearson data used from National Building Code of Canada 2015 for precipitation; rain load and snow load as it is the closest data point with the same latitude to Old Crow.

4.2 Scope of Work

The scope includes the design, engineering, procurement and supply of the solar package as well as the installation and testing on site.

4.2.1 Design and Engineering of PV Solar Plant

Proponent is responsible for all engineering required to ensure the full integration of the various equipment and systems into a fully functional 450 kW solar plant.

PV system package study including system modeling and simulation shall be performed by the Proponent. The Proponent shall demonstrate that the proposed PV solar package is optimized and will meet the design requirement of 450 kW at 0.9pf inverter output voltage, and VARs requirements at the Point of interconnection with ATCO and shall take into consideration all system losses and auxiliary power.

The proponent shall include in their proposal a detailed sizing calculation of the PV Solar package including power losses at the inverters. The scope of supply is limited up to the AC distribution panel interconnecting all inverters. The scope of work shall include installation at site, wiring and testing of the performance of the PV solar package.

Proponent shall produce certified Issue For Construction (IFC) drawings including installation layout drawings, detailed wiring diagrams, structure and panels assembly and installation details, cable routing and cable schedule details, bill of material. A site survey shall be conducted prior to issue final IFC drawings.

4.2.1.1 Minimum design requirements

Proponent shall comply with the minimum design requirement listed below:

Table 2: Minimum Design Requirement

Description	Unit	Value
PV Plant Spec		
Maximum kW @ 0.9 pf at inverter output	kW AC	450
Desired Total Installed PV Capacity	kWp DC	900
Desired Installed PV Capacity - West Facing	kWp DC	450
Desired Installed PV Capacity - East Facing	kWp DC	450
String Max Voc	V DC	1000
Inverter Spec & Configuration		
Input		
Input Voltage (maximum)	V DC	1000

Description	Unit	Value
Desired Ratio PV installed Capacity/ Inverter Installed Capacity	kWp/kW AC	2
Configuration		
– Individual string must contain PV modules facing one direction only		
– MPPT should be connected to strings facing one direction only		
– Individual MPPT should not be DC oversized (only the inverter)		
Output		
Voltage	V AC - 3 phase	480
Frequency	Hz	60
Inverter Combined Installed Capacity (Output) at 0.9 Power factor	kVA	500
Individual Inverter Installed Capacity (Output)	kW AC	By Proponent
Minimum Adjustable Power Factor +/-		0.9
Communication & Control		
Master inverter must be able to be controlled by an external microgrid controller, via:	DNP3.0 - RS-485 or Ethernet or Modbus - RS-485 or Ethernet	

4.2.1.2 1000 VDC Collector system configuration

Proponent shall design the 1000 VDC collector system according to the following configurations (Refer to 1):

Strings shall be brought into and individually fused in row combiner boxes. The output of the combiner boxes shall be connected by DC Home Runs to the disconnect switches at the inputs of the inverter re-combiner (located in the E-Building).

Proponent shall ensure that a minimum quantity of the Modules in each Array may be disconnected and re-connected by the Inverter for the purposes of preventing tripping of Inverters due to high PV array voltage.

All combiner boxes and any switching device shall be rated adequately for maximum loading, short circuits and shall be rated for use in 1000VDC circuits.

All combiner boxes shall be supplied with a suitably-rated load-break disconnect switch to disconnect the outgoing positive polarity main conductor.

PV Module lead extensions, cables from string terminals to the combiner boxes as well as cables from combiner boxes to the inverter shall be CSA-certified RPVU photovoltaic cable, which shall be XL-insulated and rated for 1000 VDC minimum, copper, 90°C wet/dry. Cable jackets shall bear the markings of “Sunlight Resistant”/”Sun Res” as well as “PV Wire”/”PV Cable”/”Photovoltaic Wire”/”Photovoltaic Cable”.

DC home run cables shall be RWU90, XLPE-insulated, single-phase. They shall be rated for 1000V, copper, 90°C wet/dry continuous operation. DC Home Run cables shall be equipped with an overall PVC jacket. DC home run cable sizes shall also comply with the requirements of the Inverters and the combiner boxes.

All DC cables used for outdoor application shall be designed to run in extreme cold weather condition as specified in this document.

Cables shall run parallel to PV array and all crossing together to the E-Building. Refer to Figure 2.

Termination in the inverters and combiners boxes shall be using compression-type lugs only. The use of screw terminals for these connections is strictly prohibited.

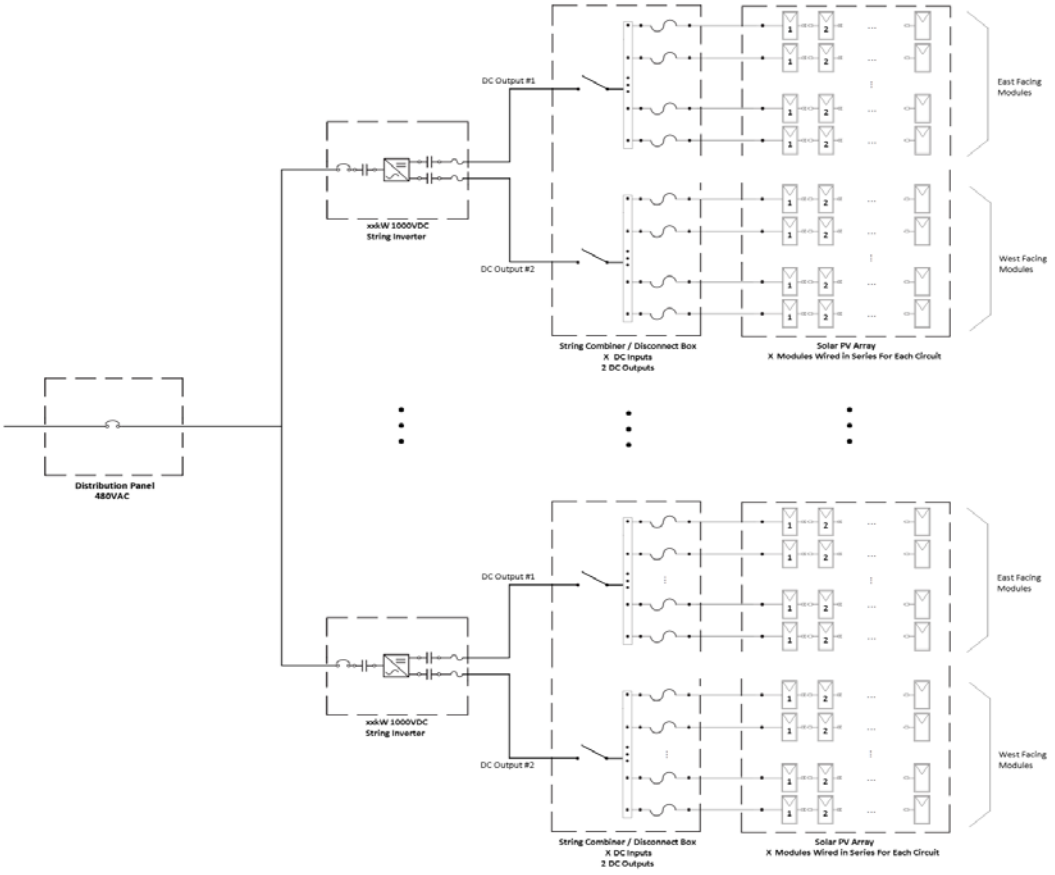

Figure 1: PV Solar Plant Configuration

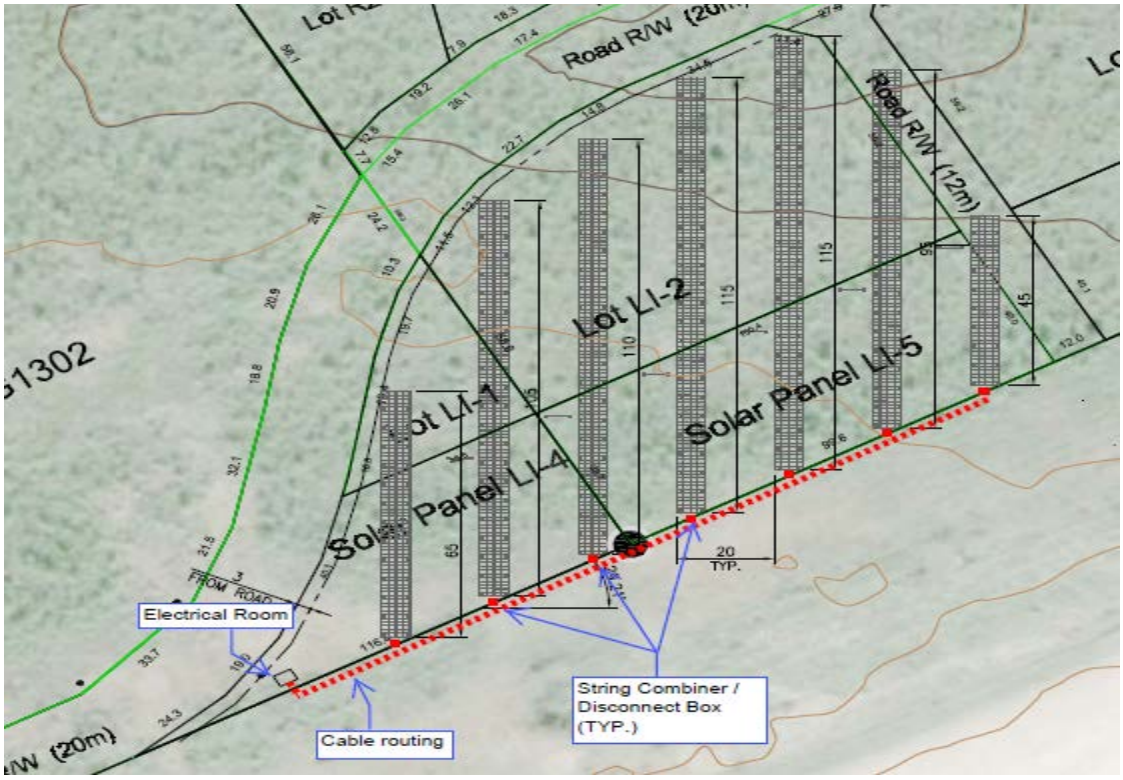

Figure 2: Cable routing

4.2.1.3 PV System Simulation:

Using PVSyst, PV Sol, or other equivalent software, simulate the PV output (kWh) for each month and per year (kWh/month and per year) and monthly maximum power production (kW) using the PV modules, string, and inverter configurations selected by the Proponent.

The simulation should use the following parameters:

- Proponents PV datasheet & inverter datasheet
- Inuvik, NWT as climate location
- 45^{o} PV modules inclination, half PV modules facing East, half facing West
- Assume no soiling losses
- Use albedo factor for ground reflection of 0.2
- Shading losses optional. If shading included, use 20 m spacing row to row, all rows are at the same elevation
- Assume that the grid can take all the power produced

This simulation should be included in the proposal.

4.2.1.4 System communication:

Proponent to provide communication architectural diagram with their proposal. For reference, refer to .

Separate network shall be provided for communication with ATCO. Proponent shall comply with ATCO communication protocol, port, interface cables etc. As minimum, the following functionality shall be included in the inverter:

- Remote control of kW: Inverters shall be designed to receive remote kW control signals from ATCO communication system and adjust the kW demand accordingly.
- Remote control of kVar: Inverters shall be designed to receive remote kVar control signals from ATCO communication system and adjust the kVar demand accordingly.
- KW capability: Inverters shall estimate the maximum kW available at any time and should communicate this information to ATCO through the communication system.
- Annunciation: Inverters shall communicate metering data (Voltage, Current, kW, kVar, Frequency, Status, etc) and alarms to ATCO through the communication system.

Local network shall be provided to communicate with the PV system locally and remotely through internet.

Smart logger, ATCO communication interface, Ethernet switch, cables and other devices shall be shipped to E-Building contractor for installation and testing prior to shipping of the E-Building. Proponent shall coordinate with the E-Building contractor.

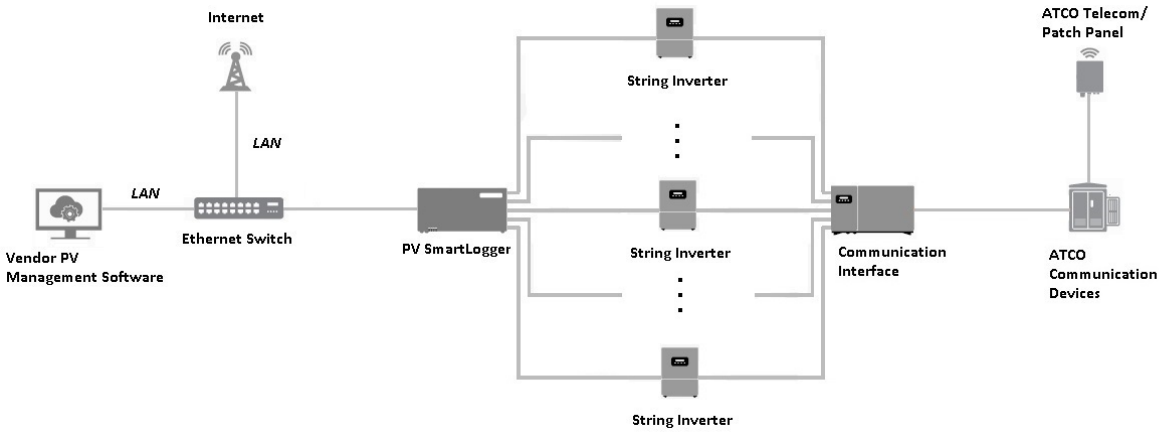

Figure 3: Communication diagram

4.2.1.5 Grounding

Proponent shall provide a grounding system design and installation package for the PV solar plant to ground the PV solar module structures, E-Building, transformer, etc. The design package shall be submitted to the Client for review and acceptance. The report shall include all pertinent certified drawings, soil resistivity measurement results as well as any calculations, models, assumptions and approximations made in the design of the grounding system for the PV package. All electrical equipment including enclosures, junction boxes, structures, etc., shall be appropriately grounded.

4.2.1.6 Fencing and Bird Management

Proponent shall design and install fencing around each row of panel frames as per applicable requirements including electrical codes and all regulations. Proponent shall design, procure and install all necessary safety signage on all electrical infrastructure fencing and in all other areas, where required.

Proponent shall design and install bird management spikes on the apex of the frames.

4.2.1.7 Electrical interconnection – ATCO requirements

Proponent design must comply with all aspects of the ATCO Distributed Generation Interconnection Guide – Refer to Appendix A.

Proponent shall fulfill all Owner obligations, requirements and deliverables related to electrical interconnections as per ATCO interconnection agreement. Some key points of the interconnection guide are summarized below:

1. Meet all design requirements as specified in the ATCO guide.
2. Comply with ATCO Interconnection, operation, Protection and control Philosophy
3. Installation conforms to the current edition of Part I of the CEC. The PV solar package facility must meet all applicable national, provincial and local construction and safety codes.
4. Coordination with ATCO for equipment certification
5. Be familiar with ATCO's current corporate standards and practices, as they relate to the interconnection
6. Provide all required information as per ATCO interconnection requirements
7. The PV solar package inverters shall be equipped with protection so as to protect the installation in such a manner that distribution system outages, short circuits or other disturbances, including excessive zero sequence currents and ferroresonant over-voltages, do not cause damage. The PV solar package inverters must also prevent excessive or unnecessary tripping that could affect the reliability of the distribution system or power quality to other customers.

8. The PV solar package shall operate at 60 Hertz (Hz) Alternating Current (AC). Frequency variations are typically 59.0 Hz to 61.0 Hz for small contingencies that cause modest disturbances. Variations of 58 Hz to 66 Hz or greater can occur for larger contingencies; these variations are system dependent and subject to change.
9. All equipment must comply with the ATCO's standards for power quality.
10. The PV solar inverter protection scheme must comply with the ATCO protection requirements.
11. The PV solar inverter shall comply with ATCO requirements for Synchronisation, anti-islanding, voltage and power factor.
12. Inverter generators must meet the applicable criteria in IEEE 929 and be certified to UL 1741 and CSA 22.2 #107.1.

4.2.1.8 Design Engineering Project Deliverable List:

To be submitted for approval during engineering phase:

1. All documents submitted with the quotation shall be revised and resubmitted
2. Certified engineering outline drawings showing dimensions and weight of each transportable unit, cable termination position, fixing details, racking system, grounding layout, bill of material, sizing calculations.
3. Nameplate details
4. Certified engineering detailed circuit wiring diagrams showing all connections and details (including cable sizes) with wiring identification numbers.

4.2.2 Procurement and Supply of PV Solar Plant

The Scope of procurement and supply shall be as per this specification and will generally include as minimum:

- PV solar modules: factory assembled Photovoltaic Modules including accessories, complying with UL 1703.
- Support structure for PV arrays: Anodized Aluminum support structure and associated hardware suitable for location. The arrangement for the panels on site shall be 45° with the rows in a back to back arrangement.
- Foundation for the PV solar supports will be installed by others.
- Refer to PV solar structure drawing included in the Commercial Terms document - Appendix E.
- Proponent shall coordinate with Owner for the final design of the foundation.

- Photovoltaic Combiner Boxes: Provide combiner boxes for termination of strings as required for the array configuration installed.
- Photovoltaic Inverters: 3 phase system inverter. Provide inverter as required for connection of the photovoltaic array DC system to the 480 VAC system. Inverts shall be equipped with Maximum power point tracking (MPPT) and capable of power factor control (full circle: 0 to 1 pu).
- AC Distribution panel: Provide 480VAC distribution panel as required for connection of the inverters AC system to the electrical system.
- Communication and Monitoring System: Provide a system and devices as required to allow local and remote communication and monitoring of the PV solar system. A data historian shall be included. Proponent shall assume internet connection is provided.
- Bulk material: includes wire, cable, electrical devices, junction boxes, earthing, lightning and surge protection, fuses, conduit, cable tray, and other electrical bulk materials as required by the Project Specifications.

All equipment and materials shall be supplied by Proponent and will require approval by the Client. The proponent shall provide equipment specification, sizing calculation, data sheets and drawings to the Client for review and approval prior to placing any procurement order.

The inverters, AC distribution panel and communication devices with all accessories (including interconnection cables) and installation drawings shall be shipped to the E-Building contractor. The E-Building contractor will install and wire the inverters, the AC distribution panel and the communication devices inside the electrical building before to be shipped to site. For more high level details Refer to Figure 3.

Provision to support E-Building during installation and testing shall be included in the proposal.

PV vendor should include in his proposal mobilization of the inverter manufacture to the E-Building facility to perform functional testing of the invertor. PV vendor shall coordinate will E-Building contractor for the installation and testing schedule.

4.2.2.1 Equipment specification

4.2.2.1.1 Photovoltaic system requirements

1. Capacity of the PV array as per table 2.
2. Array: Designed to fit within the area designated on Site Plan in the Commercial Terms document - Appendix E.
3. Fire Resistance Rating: Provide photovoltaic module and mounting system combination that together form a system listed in accordance with UL 1703.
4. Products listed shall be classified, and labelled as suitable for the purpose intended.

5. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system.
6. DC photovoltaic arc-fault protection devices shall comply with UL 1699B as required for compliance with CSA Z462. / CEC 22.1.
7. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and CSA Z462. / CEC 22.1.

4.2.2.1.2 Photovoltaic modules

1. Photovoltaic Modules: Factory assembled; consisting of photovoltaic cells, frame, junction box, cables for series connection, and bypass diodes for shade tolerance; rated for a minimum of 1000 V DC; listed as complying with UL 1703.
2. Monocrystalline or polycrystalline Silicon Photovoltaic Modules: Comply with IEC 61215.
3. Frame: Anodized aluminum.
4. Factory-Installed Junction Box: Weatherproof, with factory-installed terminals and bypass diodes.
5. Factory-Installed Cables: Type USE-2 or listed photovoltaic (PV) wire with polarized locking connectors and suitable for the site conditions as per section 3 of this document.
6. Unless otherwise indicated, specified module performance characteristics are rated under Standard Test conditions (STC).

4.2.2.1.3 Balance of system components

Photovoltaic module mounting system:

1. Provide complete ground mounting system compatible with modules to be installed and suitable to properly install them in the location indicated, including all necessary hardware and accessories.
2. PV module mounting system to be mounted on concrete plinths sized to withstand overturning and sliding forces from applicable design loads.
3. Support Structure and Associated Hardware Materials: Use anodized aluminum where possible to keep weights to minimum as there is no road access to site. All materials to be flown to site. Designed to consider all applicable design loads.
4. Provide minimum clearance of 1000 mm (39 inches) between ground and module to allow for snow accumulation during the winter.

4.2.2.1.4 Combiner boxes

1. Combiner box(es) for termination of strings as indicated or as required for the array configuration installed.
   - Rated for 1000 V DC; current ratings suitable for connected strings; equipped with fuse holders and; listed as complying with UL 1741.
2. Fuse holders: Touch-safe; suitable to accept fuses indicated.
3. Number of Input Circuits: As indicated or as required for termination of strings.
4. Enclosure: NEMA 250, Type 3R, unless otherwise indicated.
5. Provide integral load-break rated disconnect.
6. Provide with capability of current monitoring for individual strings.

4.2.2.1.5 Inverters

1. Provide inverter(s) as indicated or as required for connection of the photovoltaic array DC system to the AC system indicated.
2. Inverters: Suitable for the requirements of the connected array; output configuration compatible with connected system; listed as complying with UL 1741; furnished with the following features:
   a. Maximum power point tracking (MPPT)
   b. LCD display
   c. Integral AC disconnect
   d. Integral DC disconnect
   e. Integral DC ground fault detection and interruption (GFDI)
   f. Communications Interface: As required for connection to system indicated.
3. Grid-Tied Inverters: Comply with IEEE 1547, including over/under grid voltage and frequency protection, and anti-islanding protection to automatically disconnect upon loss of utility power and to remain disconnected until utility power is restored Total Harmonic Distortion: Less than five percent as per IEEE 519.
4. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations

4.2.2.1.6 Surge protective devices

1. Surge Protective Devices for DC System:
   a. Rated for 1000 V DC
   b. Listed and labeled as complying with UL 1449, Type 1

c. Surge Current Rating: Not less than 50 kA per mode

d. UL 1449 Nominal Discharge Current (I-n): 20 kA

2. Fuses for Protection of Photovoltaic Strings and Arrays: Photovoltaic fuses listed as complying with UL 2579.

4.2.2.1.7 Monitoring system

1. Provide a cloud based monitoring platform solution for the PV solar plant including all sensors, dataloggers, connections, software, equipment and accessories necessary for a complete operating system. The system shall be able to provide alarm notification via e-mail or instant message.
2. A dedicated communication means shall be provide for ATCO remote communication.

4.2.2.2 Procurement and Supply Deliverable List:

To be submitted before the installation of the equipment:

1. All (issue for construction) IFC drawings (Sealed and signed)
2. Inspection and test plan
3. Field quality control test reports
4. Factory Test reports
5. Operation, installation and maintenance manuals
6. On-site commissioning instructions
7. List of Spare parts for start-up, commissioning and two years normal operation.

4.2.3 System construction, installation and testing at site

The Scope of Work covers the installation, construction, start-up, testing of the 450 kW PV solar plant at site. The Proponent shall furnish all materials, equipment, labor and supervision required to perform the work. Proponent shall be responsible for the accommodation and transportation of labour performing work on site.

Proponent shall include cost estimate for the commissioning activities at site in his proposal.

Proponent shall properly pack (suitable for air freight and meeting climate conditions as per Section 3 of this document) and ship all equipment and materials to site (except inverters and AC distribution panel that shall be shipped to the E-Building contractor).

The Proponent shall be responsible for the installation of the PV solar package at site and wire all equipment as per the installation drawings up to the inverters and AC distribution panel inside the E-Building.

Proponent shall recommend and supply spare parts as part of their scope of supply. A list of the same should be provided with the proposal as well as included in the final Proponent documentation. The Proponent shall recommend and submit their priced spare parts list for two years of operation. Proponent shall include one (1) spare inverter in their proposal.

The Proponent shall include in their contract an option for yearly maintenance service with the owner.

For cable installation between combiner boxes to the inverters in the E-Building, Proponent shall provide details on how they intend to route, install and protect the cables to meet codes and taking permafrost into consideration. Refer to figure 2.

Proponent to identify power and utility requirements during site installation. Information should be included in the proposal.

4.2.3.1 Minimum Installation Requirements

1. Perform work in a neat and workmanlike manner in accordance with NECA 1 (general workmanship) and NECA 412.
2. Install products in accordance with manufacturer's instructions.
3. Mount equipment such that the highest position of any operating handle for circuit breakers or switches does not exceed 2000 mm (79 inches) above the ground, or working platform.
4. Circuiting Requirements
    a. Wiring Methods:
        - Unless otherwise indicated, use exposed type USE-2/RHH/RHW-2 single-conductor cable (not routed inside building) for wiring between string(s) and combiner box(es). All cable shall meet site design conditions.
        - Secure exposed cables in accordance with CSA Z462. Where possible, conceal behind array.
        - Use suitable twist-on insulated spring connectors, mechanical connectors, or compression connectors for photovoltaic circuit splices and taps.
    b. Photovoltaic DC System Conductor Color Code:
        - Ungrounded System:
            1) Positive: Red
            2) Negative: Black

c. Maintain separation of photovoltaic and non-photovoltaic circuits in accordance with CSA Z462.

5. Grounding and Bonding Requirements:

   a. Ensure that there is only one AC System bonding connection between grounding system and grounded/neutral conductor, including external connections and connections internal to equipment.

   b. Grounded DC Systems: Ensure that there is only one point of system grounding connection to the grounded conductor, including external connections and connections internal to equipment.

   c. Provide auxiliary electrodes for photovoltaic array grounding in accordance with CSA Z462.

6. Identification Requirements:

   a. Color for Photovoltaic System Identification Nameplates and Labels: White text on red background.

   b. Use identification nameplate or means of identification acceptable to authority having jurisdiction to identify the presence of multiple power sources and the location of main service disconnecting means and each photovoltaic system disconnecting means, as well as required rapid shutdown initiation method. Locate at main service disconnecting means, at each photovoltaic system disconnecting means. Verify format and descriptions with authority having jurisdiction.

   c. Use identification nameplate to identify each photovoltaic system disconnecting means with text "PHOTOVOLTAIC SYSTEM DC DISCONNECT" or "PHOTOVOLTAIC SYSTEM AC DISCONNECT" as applicable.

   d. Use identification nameplate or identification label to identify each photovoltaic system DC disconnecting means with the following information:

      - Rated maximum power-point current (operating current)
      - Rated maximum power-point voltage (operating voltage)
      - Maximum system voltage
      - Short-circuit current

   e. Use identification nameplate or identification label to identify the interactive system point of interconnection at the disconnecting means as a power source and with the rated AC output current and the nominal operating AC voltage.

   f. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for photovoltaic system disconnecting means. Include the word message "Warning - Electric Shock Hazard; Do not touch terminals; Terminals on both the line and load sides may be energized in the open position" or approved equivalent.

g. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for photovoltaic systems equipped with DC ground-fault protection in accordance with CSA Z462. Include the word message "Warning - Electric Shock Hazard; If a ground fault is indicated, normally grounded conductors may be ungrounded and energized".

h. Use wire and cable markers to identify photovoltaic system source, output, and inverter circuit conductors at all points of termination, connection, and splices.

i. Use voltage markers, identification labels, stenciled text, or suitable permanent marking approved by authority having jurisdiction to identify exposed raceways, cable trays, pull boxes, junction boxes, and conduit bodies with the text "Photovoltaic Power Source" at maximum intervals of 3 m (10 feet) in accordance with CSA Z462.

SUPPLIED BY VENDOR		INSTALLED BY VENDOR		INSTALLED BY OTHERS	
1	PV Solar Panels & Supports	1	PV Solar Panels & Supports	3	E-House
2	Combiner JB	2	Combiner JB	5	AC/DC Inverter
4	1kV DC cable	4	1kV DC cable, inter-equipment	6	AC Panel, 480VAC, 800A
5	AC/DC Inverter	4	1kV DC Cable, field to E-House		
6	Distribution Panel, 480VAC				

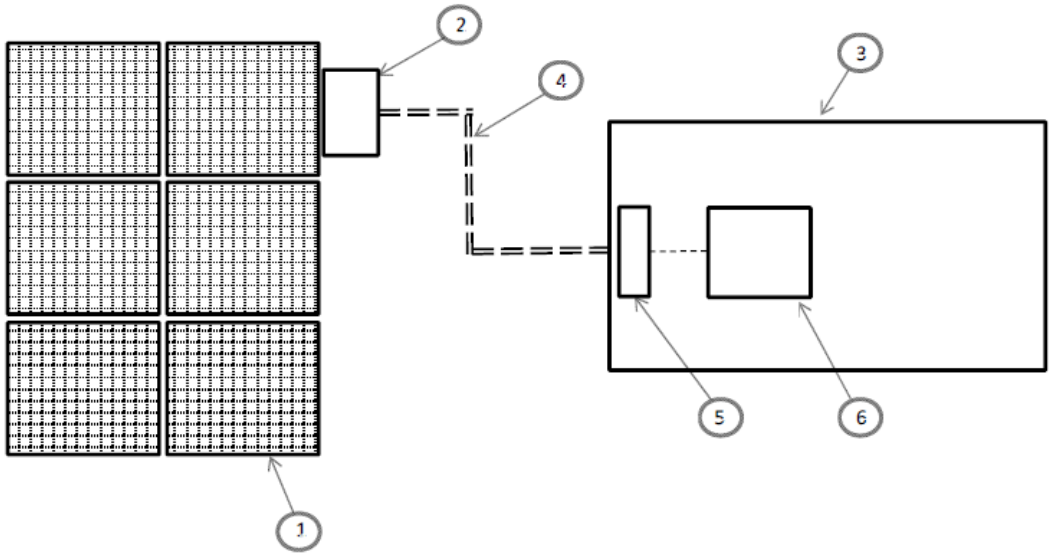

Figure 4: Simplified PV solar package arrangement

4.2.3.2 Field quality control

1. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.

2. Inspection and testing to include, at a minimum:
    a. Inspect each system component for damage and defects.
    b. Verify that equipment enclosures, boxes, and associated connections installed outdoors are weatherproof.
    c. Verify proper wiring connections have been made and check for conductor continuity. Verify proper polarity.
    d. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
    e. Perform insulation resistance tests.
        – Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
    f. Measure and record ambient conditions, including date and time, ambient temperature, cell temperature, solar irradiance in the module plane, and wind speed.
    g. Measure and record open circuit voltage of each string.
    h. Measure and record voltages at the inverter AC and DC inputs.
    i. Measure and record operating current for each string, sub-array, and array.
    j. Measure and record AC output power.
    k. Perform inverter functional test.
        – Grid-Tied Inverters: Include simulation of loss of utility power and subsequent power restoration.
    l. Verify proper operation of monitoring system.
3. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
4. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
    a. Record all system operations and malfunctions.
    b. If a malfunction occurs, start diagnostic period over after correction of malfunction.
5. Submit detailed reports indicating inspection and testing results and corrective actions taken.

4.2.3.3 Installation and Testing Project Deliverable List:

To be submitted after the installation and testing of the equipment:

- Field quality control dossier
- Mechanical completion certificate

- Site Testing reports
- Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, wiring, and final equipment settings. Certified project record documents
- Hand over package

4.2.4 Operational Support and Maintenance

4.2.4.1 Closeout activities

1. Demonstration: Demonstrate proper operation of system to Owner and ATCO Electric Yukon, and correct deficiencies or make adjustments as directed.
2. Training: Train Owner's personnel on operation, adjustment, and maintenance of photovoltaic system.
3. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
4. Provide minimum one day of training.
5. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed system.
6. Location: At project site.

4.2.4.2 Maintenance requirements

1. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of photovoltaic system for two years from date of Substantial Completion, to include the work described below. Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
2. Conduct site visit at least at regular interval to perform inspection, testing, and preventive maintenance. Conduct tests similar to those made during original field quality control testing. Submit report to Owner comparing test results with those of original tests along with evaluations and recommendations.
3. Provide trouble call-back service upon notification by Owner:
    a. Include allowance for call-back service during normal working hours at no extra cost to Owner.
    b. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

4.2.5 Work excluded

- Design, engineering, installation of the E-Building at site;
- Interconnection of 2.4 kV system with ATCO
- Foundation, design and installation.

5. QUALITY ASSURANCE

1. Comply with ATCO requirements for interconnection.
2. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
3. Structural Designer Qualifications: Registered structural engineer licensed in the Yukon Territory.
4. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience and over 100 MW of deployment.
    a. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

6. WARRANTY

The Proponent should provide details of warranty information for equipment as part of the proposal:

1. Specified warranties indicate minimum requirements. Provide additional warranties or extended warranty periods where required, to qualify for rebate and incentive programs.
2. Photovoltaic Modules:
    a. Provide minimum ten year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
    b. Provide manufacturer warranty guaranteeing minimum 90 percent of rated power output for 10 years and minimum 80 percent of rated power output for 25 years.
3. Photovoltaic Module Mounting System: Provide minimum 10 year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
4. Photovoltaic Combiner Boxes: Provide minimum five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
    c. Photovoltaic Inverters: Provide minimum ten year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

7. INFORMATION TO BE INCLUDED IN PROPOSAL

The following documentation shall be provided by the Proponent as a minimum as part of the proposal:

1. Equipment Data sheets (inverter, PV modules, communication devices , combiner boxes, cables, etc)
2. Single line diagram
3. Communication diagram
4. Bill of material with ratings and makes of components
5. Outline drawing of the equipment (PV modules, Invertors, combiner boxes) with its certified maximum dimensions and weight.
6. PV system simulation
7. Typical schematic or diagram circuits showing as a minimum:
    a. Number of modules per string
    b. Number of strings per container box
    c. Number of trunks per inverter
    d. Number of inverters
8. Type test certificates for similar equipment
9. Guarantee / Warranty details for equipment

Appendix A: ATCO Draft Interconnection Guide

This may be amended during or after the proposal period

ATCO Electric Yukon's IPP (Distributed Generation)

Interconnection Guide

The ATCO Distributed Generation Interconnection Guide provides guidelines for connecting a generation facility to Yukon isolated diesel communities via a Wires Owner's distribution system, and assists in determining the technical and operating requirements of the facility.

The Guide was developed by ATCO without regard to whether its adoption may involve patents on articles, materials or processes. Such adoption does not assume any liability to any patent owner, nor does it assume any obligation whatsoever to parties adopting this Guide.

While every precaution has been taken in preparing the Guide, it may contain inadvertent inaccuracies or inconsistencies. The authors assume no liability for errors or omissions, or damages resulting from the use of or reliance upon the information contained herein.

Draft Version Oct 2017

In this document…

Part 1 – General Interconnection Information

In this part…

1.0 Introduction

1.1 Intent

The intent of the ATCO Distributed Generation Interconnection Guide (Hereinafter referred to as “the Guide” or “this Guide”) is to:

1. Inform and provide guidelines for anyone wishing to connect a generation facility to the isolated diesel communities; and
2. Assist operators, technical staff, consultants and contractors in determining the technical and operating requirements of the facility.

This Guide does **not**:

3. Establish commercial or cost-sharing agreements.

1.2 Guiding Principles

This Guide was developed in accordance with the following principles:

1. The interconnection process must provide competitive, fair and equitable access for all DG Owners.
2. The interconnection must not create a safety hazard to other customers, the public or operating personnel.
3. The interconnection must not compromise the reliability or restrict the operation of the electric system.
4. The interconnection must not degrade power quality below acceptable levels.

DRAFT

2.0 Terms and Definitions

The following terms are defined to assist understanding of Distributed Generation:

This term …	Is defined as …
Accredited Certification Organization	An organization that has been accredited by the Standards Council of Canada to operate a certification program for electrical equipment, such as the Canadian Standards Association (CSA).
AEUC	The Alberta Electrical Utility Code.
YUB	Yukon Utilities Board.
Bi-Directional Meter	A meter that measures real and reactive power and energy in both directions.
CEA	The Canadian Electricity Association.
CEC	The Canadian Standards Association's C22.1-98 Safety Standard for Electrical Installations Part 1, also known as the Canadian Electrical Code.
CSA	The Canadian Standards Association.
Distributed Generation or Distributed Generator (DG)	Unregulated electric generators connected to a distribution system through the Point of Common Coupling (PCC).
DG Owner	The entity which owns or leases the Distributed Generation facilities.
Distribution System	Any power line facilities under the operating authority of the Wires Owners. Distribution power line facilities generally operate at or below voltages of 35kV nominal, line to line.
Electric Utilities Act	Legislation passed in Yukon
Generator	A device that produces AC power. In the case of inverters, the document uses the term Generator to refer to the AC inverter, not the DC source.
IEEE	The Institute of Electrical and Electronics Engineers, Inc.
Interval Meter	A meter that measures transmission of electric energy and stores data in 15-minute intervals.
Island	A condition in which a portion of the Wires Owner's system which is electrically separated from the rest of the Wires Owner's system is energized by one or more distributed generators.

DRAFT

This term …	Is defined as …
Load Flow Study	A steady-state computer simulation study of the voltages and currents on the electric system.
Micro Grid Controller	Device that communicates to System Controller and controls the DG's connection to the grid. The Wires Owners assign this device on the DG's system.
Operating Authority	The individual within the Wires Owner's organization and within the DG Owner's organization who is responsible for the safe and orderly operation of electric system facilities.
Parallel Operation	The operation of a generation facility while connected to an electric power grid in such a way that both the grid and the generation facilities supply electric power to the loads at the same time.
Point of Common Coupling (PCC)	The point at which the Wires Owner's facilities are connected to the DG Owner's facilities or conductors, and where any transfer of electric energy between the DG Owner and the Wires Owner takes place.
Safety Codes Act	The Yukon's Electrical Protection Act and regulations under that Act.
Stabilized	The state of the distribution system after voltage and frequency has returned to normal range for a period of at least five minutes (or another period of time, as coordinated with the Wires Owner) following a disturbance.
System Controller	The grid operating authority for dispatching load and generation in real time.
Tariffs	Published rates, including terms and conditions and electric service agreements for the sale of electric energy and energy services regulated by the YUB.
Telemetering	The transmission of metering data using telecommunication systems.
Visible-Break Disconnect	A switch or circuit breaker by means of which the generator and all protective devices and control apparatus can be simultaneously disconnected under full load entirely from the circuits supplied by the generator. All blades or moving contacts must be connected to the generator side, and the design of the disconnect must allow adequate visible inspection of all contacts in the open position.
Wires Owner	The utility owning the distribution system.

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3.0 Responsibilities

Refer to Appendix A for a block diagram of the approval process for connecting a generation facility to a Wires Owner's distribution system.

3.1 DG Owner Responsibilities

The DG Owner is responsible to:

☒ Provide technical information to the Wires Owner as specified in Appendix B;

☒ Design, install, operate and maintain the interconnection facility:

Ensure all necessary designs and drawings are signed and stamped by a licensed, professional engineer;

Have equipment certified by an accredited certification organization; and

Verify that the installation conforms to the current edition of Part I of the CEC;

☒ Pay the costs of interconnection, (including but not limited to the system impact study) in accordance with the commercial terms established by the Wires Owner;

☒ Obtain all required permits and licenses:

Ensure that the local inspection and enforcement authorities accept the installation, or that the installation falls under the jurisdiction of an accredited corporation under the Act;

Before commissioning and commencing parallel operation, obtain the approval of the Wires Owner and establish a Joint Operating Agreement with the Wires Owner, similar to the generic Joint Operating Agreement provided in Appendix C, covering the technical and operating requirements;

Obtain approval and order to connect, and provide the approval and order numbers to the Wires Owner

☒ Obtain written approval from the Wires Owner before commencing parallel operation and before making any modification to the generation facility;

☒ Ensure metering requirements are met (see section 4.0); and

☒ Negotiate the timing and any testing requirements for the commissioning process with the Wires Owner,

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3.2 Wires Owner Responsibilities

The Wires Owner is responsible to:

- ☒ Completion of load flow studies and system impact studies as defined by the wires owner within a reasonable period;
- ☒ Prepare a Joint Operating Agreement with the DG Owner, similar to the generic Joint Operating Agreement provided in Appendix C;
- ☒ Prepare a commercial agreement
- ☒ Inform the DG Owner of the Wires Owner's current corporate standards and practices, as they relate to the interconnection;
- ☒ Ensure metering requirements are met (see section 4.0); and
- ☒ Provide the DG Owner with the information specified in Appendix D.

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4.0 Metering Requirements

Both the DG Owner and the Wires Owner must meet requirements related to metering.

The DG Owner is required to:

☒ Install an electric meter to measure active energy and reactive energy flowing *out of* the generation facility *to* the distribution system. The Wires Owner retains the right to obtain this data for internal use.

The Wires Owner is required to:

☒ Install an electric meter to measure power, active energy and reactive energy flowing *from* the distribution system *into* the generation facility. The DG Owner retains the right to obtain this metering data for internal use. (under normal commercial terms and conditions)

As agreeable between the parties, one physical bi-directional meter may be used to fulfill the requirements of both parties.

Metering service companies are available in Alberta. These include distribution Wires Owners, as well as independent metering companies. Measurement Canada is responsible for testing and certification of meters.

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5.0 Operating Requirements

5.1 Operating Authority

The Wires Owner and the DG Owner must each identify, by name or by job title, the individual within their organizations who is their "Operating Authority." The Operating Authority is responsible to establish operating procedures and standards within each organization.

The Operating Authority negotiates and signs the Joint Operating Agreement described in section 5.3. This individual also ensures that the Operator in Charge (see below) is competent to operate their respective system and aware of the provisions of any other operating agreements and any regulations that may apply.

5.2 Operator in Charge

The Wires Owner and the DG Owner must each identify the individual, by name or by job title, who is the "Operator in Charge" of their facilities and operates their portion of the interconnection facility. This individual must be familiar with the Joint Operating Agreement, and also aware of the provisions of any other operating agreements and any regulations that may apply. The Operating Authority and the Operator in Charge may be the same person.

5.3 Joint Operating Agreement

A Joint Operating Agreement must be established between the Wires Owner and the DG Owner to provide for the safe and orderly operation of the interconnection facility. The Agreement must include, but is not necessarily limited to, the following:

- ☒ A high-level technical description of the DG Owner's generation facility, equipment and protection.
- ☒ A high-level technical description of the Wires Owner's distribution system facilities and protection.
- ☒ A description of how the generation facility will operate (e.g., parallel or islanded).
- ☒ The DG Owner's intent in operating the generation facility (e.g., sales, demand reduction).
- ☒ The name, title and telephone number(s) of the Operating Authority and the Operator in Charge for each party to the Agreement.
- ☒ Provision for the Wires Owner to disconnect the generation facility if it fails to meet technical and/or power quality requirements, or if the operation of the generation facility is or may become dangerous to life or property.
- ☒ Reference to safety procedures for joint work.
- ☒ Identification of responsibility for maintaining current operating information.
- ☒ Isolation procedures for work on the facilities.
- ☒ Notification requirements, if required before synchronization.
- ☒ Any controller or control setting parameters that could affect the interconnection (e.g., voltage and frequency).
- ☒ The approval of both the Wires Owner and the DG Owner.

A generic Joint Operating Agreement is provided in Appendix C.

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Part 2 – Guide for Generator Interconnection

In this part…

1.0 Purpose

The second part of this Guide establishes the criteria and technical requirements for interconnecting generation facilities with distribution systems (35kV or lower). Specifically, it addresses the performance, operation, testing, safety considerations and maintenance requirements of the interconnection.

These requirements cover a broad spectrum of interests. Interconnecting generation facilities to a distribution system may change the system and its response. Attaining a technically sound and robust interconnection mandates diligence on the part of everyone involved, including designers, manufacturers, users, owners and operators of both the generation facilities and the distribution systems. All of the above-mentioned groups need to reach a cooperative understanding of and meet the requirements established herein.

This Guide was developed with reference to international standards, such as the IEEE Standard P1547 DRAFT Standard for Distributed Resources Interconnected with Distribution Systems. It is subject to regular review and revision, as necessary to conform to evolving Yukon and international standards, such as those developed by the IEEE.

This Guide is not a design handbook. Anyone considering development of a generation facility intended for interconnection to a distribution system should engage the services of individuals qualified to provide design and consulting services for electrical interconnection facilities.

2.0 Limitations

The criteria and requirements established by this Guide are applicable to all DG technologies and to the primary and secondary voltages of the distribution systems. Installation of DG facilities on the radial primary and secondary distribution systems is the main focus of this version, although network distribution systems are considered. For this version, the requirements must be met at the Point of Common Coupling (PCC), although the protective devices may not necessarily be located at that point.

This Guide establishes the **minimum** requirements for the interconnection. Additional requirements may need to be met by both the DG Owner and the Wires Owner to ensure that the final interconnection design meets all local and national standards and codes, and that the design is safe for the intended application. The Guide does not address any liability provisions agreed to elsewhere by both parties in a commercial agreement, or through tariff terms and conditions.

3.0 General Interconnection and Protection Requirements

The DG Owner's generation and interconnection facilities must meet all applicable national, provincial and local construction and safety codes. See Appendix E for a complete listing of commonly used codes and standards.

Anyone may operate a 60 Hertz, three-phase or single-phase generation facility, in parallel with the Wires Owner's distribution system and in accordance with the Joint Operating Agreement established with the Wires Owner, provided the requirements of this Guide are met or exceeded.

The DG Owner is required to install, operate and maintain in good order and repair at all times, in conformity with good electrical practice, the equipment required by this Guide for the safe parallel operation with the Wires Owner's distribution system.

The following three sections, 3.1, 3.2, and 3.3, define the technical requirements for the distribution system, the generation facility and the interconnection facility respectively. These requirements promote safe operation and minimize the impact of the interconnection to the Wires Owner's distribution system and its other customers.

This Guide is not intended to provide protection for the DG Owner's generation facility. It is the responsibility of the DG Owner to protect their facility in such a manner that distribution system outages, short circuits or other disturbances, including excessive zero sequence currents and ferroresonant over-voltages, do not cause damage. The DG Owner's protective equipment must also prevent excessive or unnecessary tripping that could affect the reliability of the distribution system or power quality to other customers.

Refer to Tables 1, 2 and 3 and Appendices F and G for interconnection protective function requirements.

3.1 Distribution System

3.1.1 System Frequency

The wires operator operates at 60 Hertz (Hz) Alternating Current (AC). Frequency variations are typically 59.0 Hz to 61.0 Hz for small contingencies that cause modest disturbances,

Variations of 58 Hz to 66 Hz or greater can occur for larger contingencies.,
These variations are system dependent and subject to change.

3.1.2 Voltage Regulation

CSA Standard CAN3 C235 83: Preferred Voltage Levels for AC Systems 0 to 50,000V provides general guidance as to appropriate performance.

3.1.3 Power Quality

All interconnected equipment must comply with the Wires Owner's standards for power quality.

The following industry standards may provide guidance as to appropriate performance:

☒ **Voltage Flicker** - IEEE Std. 519-1992 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

☒ **Harmonics** - Wires Owner's Guide for the Connection of Non-Linear Load.

3.1.4 Voltage Unbalance

Distribution systems are typically three-phase systems incorporating single-phase distribution taps. The voltage unbalance on a distribution system under normal operating conditions may reach three per cent, due to the unbalanced loading and single-phase regulation. Voltage unbalance will be calculated using the following formula, as derived from NEMA MG1-1993 14.35:

Unbalance (%) = 100 x (deviation from average) / (average).

3.1.5 Fault Levels

Fault levels and maximum allowable fault levels vary significantly through a distribution system and must be considered in the design of the interconnection. Fault levels and X/R ratios must be evaluated for the equipment selected.

3.1.6 System Grounding

Isolated distribution systems are typically operated as ungrounded . Other configurations are occasionally found.

Distribution system grounding must conform to the AECUC (formerly the Alberta Electrical and Communication Utility System Regulation 44/1976, or future amendments).

3.1.7 Fault and Line Clearing

To maintain the reliability of the distribution system, the Wires Owner uses automatic re-closing. The DG Owner must take this

into consideration when designing generator protection schemes to ensure the generator is disconnected from the Wires Owner's system prior to the automatic re-close of breakers. The DG Owner may reconnect when the Wires Owner's system is stabilized.

To enhance reliability and safety, with the Wires Owner's approval the DG Owner may employ a modified relay scheme with tripping or blocking using communications equipment between the DG facility and distribution system facilities.

3.2 Generation Facility

3.2.1 Mitigation of Adverse Effects

Interconnecting distributed generation can adversely affect the electric service to existing or future customers. The DG Owner must work with the Wires Owner to mitigate any adverse effects.

If a generation facility is affecting customers adversely, the Wires Owner may disconnect it until such time as the concern has been mitigated. The DG Owner is responsible for any costs incurred as a result.

3.2.2 Synchronism

Any generation facility that can create an AC voltage while separate from the electric system must have synchronization facilities to allow its connection to the electric system.

Inverter-type, voltage-following equipment that cannot generate an AC voltage while separate from the electric system does not require synchronization facilities; nor do induction generators that act as motors during start-up, drawing power from the electric system before generating their own power.

The DG Owner is responsible to synchronize and maintain synchronization to the Wires Owner's system. The Wires Owner's system cannot synchronize to the generation facility. A proposed synchronizing scheme must be submitted and outlined in the Joint Operating Agreement and attachments.

Distribution and transmission systems typically allow for automatic re-closing of electrical circuits after a variable time delay. The DG Owner is responsible for protecting their own facility from the impacts of such re-closing.

Generators can automatically restart following automatic re-closing of distribution system equipment, if agreed to by the Wires Owner. Generators that automatically restart must have a time delay on restart, adjustable up to 60 minutes or as agreed to by the Wires Owner. The Wires Owner will coordinate the settings of generator restart time delays so that generators on any feeder restart in staggered order. If required a Micro Grid controller assigned by the Wires Owner may be installed on the DG Owners equipment to accommodate synchronizing

3.2.3 Voltage Regulation and Power Factor

The DG Owner is responsible to ensure that the voltage levels at the PCC are maintained within the guidelines prescribed by the Wires Owner and/or are at least equal to the voltage levels at all feeder load conditions, prior to the interconnection.

Synchronous generators connected to the distribution system must be equipped with excitation controllers capable of controlling voltage. The generator-bus voltage setpoint must be stable at and adjustable to any value between 95 per cent and 105 per cent so that the Wires Owner can maintain CSA voltage limits on the distribution system.

Induction generators do not have voltage or reactive power control and consume reactive power (VAR). Therefore, the generator must provide reactive compensation to correct the power factor to 0.90 at the PCC, unless other terms are negotiated with the Wires Owner.

Inverter-type generating equipment can control the power factor over a wide range, typically 0.75. An inverter-type generator connected to the distribution system must be capable of adjusting the power factor in the range of +/- 0.9. The DG Owner may operate outside that range by agreement with the Wires Owner.

The Wires Owner will define voltage and reactive power control requirements on a project-by-project basis. Together, the Wires Owner and the DG Owner must identify the exact transformer ratio to allow optimum voltage regulation on the system.

In order to coordinate with its existing voltage control devices, the Wires Owner may require the generator to operate in a power factor control mode (i.e., within a constant power factor setpoint range). The voltage/ power factor regulator must be capable of controlling the power factor of the generator between +0.90 and -0.90. The Wires Owner will determine the actual set point between these limits.

In power factor control mode, the voltage regulator must have a voltage override that causes it to reduce excitation if the voltage at the PCC exceeds an upper limit to be specified by the Wires Owner. The normal upper limit is 105 per cent of nominal; however, the voltage regulator must have provision to adjust this upper limit to between 100 per cent and 110 per cent of nominal. The voltage regulator must also have provision for a time delay between sensing an excursion of the upper voltage and initiating control action. The power factor control equipment must have provision to allow for the adjustment of this time delay between 0 and 180 seconds. The Wires Owner will specify the required time delay.

3.2.4 Frequency Control

An interconnected generation facility must remain synchronously connected for frequency excursions, as identified in this Guide and the table below.

Generators that serve remote isolated systems must be capable of controlling the frequency of the system to between 59.7 Hz to 60.2 Hz for normal operation. Under-frequency and over-frequency relaying that automatically disconnects generators from the wires owner must not operate for frequencies in the range of
59.0 to 61.0 Hz.

The frequency of the electric system is controlled by all synchronous generator governor systems that connect to the electric system. Such governor systems respond automatically to changes in system frequency to prevent further deviation.

The load control of synchronous generators and other generators with stand-alone capability will be controlled by the Micro Grid control of the wires owner.

Generators connected to the grid that protect for off-nominal frequency operation should have relaying protection that accommodates, as a minimum, under- frequency and over-frequency operation for the time frames specified in the following table*. Note these values are subject to change based on actual system variables at the time of installation*

Under Frequency Limit	Over Frequency Limit	Minimum Time
60.0-59.5 Hz	60.0-60.5 Hz	N/A (continuous operating range)
59. 4-58.5 Hz	60.6-61.5 Hz	3 minutes
58.4-57.9 Hz	61.6-61.7 Hz	30 seconds
57.8-57.4 Hz		7.5 seconds
57.3-56.9 Hz		45 cycles
56.8-56.5 Hz		7.2 cycles
less than 56.4 Hz	greater than 61.7 Hz	Instantaneous trip

Systems with generators that do not meet the above requirements must automatically trip load to match the anticipated generation loss, at comparable frequency levels.

3.2.5 Voltage Unbalance

Any three-phase generation facility must have a phase-to-phase voltage unbalance not exceeding one per cent, as measured both with no load and with balanced three-phase loading. Voltage unbalance is calculated using the following formula, as derived from NEMA MG1-1993 14.35:

Unbalance (%) = 100 x [(deviation from average)/(average)].

Single-phase generators must not adversely unbalance the three-phase system. When they are connected in multiple units, an equal amount of generation capacity must be applied to each phase of a three-phase circuit, and the group of generators must maintain balance when one unit trips or begins generating before or after the others.

A single one-phase generator may be connected alone only if it does not cause voltage unbalance on the distribution system in excess of two per cent.

3.2.6 Resonance and Self-Excitation of Induction Generators

A) The DG Owner should consider resonance in the design of the generation facility, as certain resonance can cause damage to existing electrical equipment, including the electrical equipment of the DG Owner. Engineering analysis by the DG Owner should be a part of the design process to evaluate the existence of, and to eliminate the harmful effects of:

   a) ferroresonance in the transformer (Appendix H, Note 1);

   b) resonance with other customers' equipment

B) In the event that an induction generator is used by DG Owner, the adverse effects of self-excitation of the induction generator during island conditions must be assessed and mitigated. The intent is to detect and eliminate any self-excited condition (Appendix H, Note 4.)

C) The engineering analysis of resonance and the assessment of the self-excitation effects of induction generators must be submitted to the Wires Owner for approval or further evaluation.

3.3 Interconnection Facility

3.3.1 Safety

Safety of personnel, the public and equipment is of primary concern in the design of the interconnection facility.

3.3.2 Point of Common Coupling (PCC)

The PCC must be identified in the design and on the Single Line Diagram. The Wires Owner will coordinate the design, construction, maintenance and operation of the facility on the distribution side of the PCC. The DG Owner is responsible to coordinate the design, construction, maintenance and operation of the facility on the generation side of the PCC. All voltage and frequency parameters specified in this section must be met at the PCC unless otherwise stated.

The DG Owner is responsible for any incremental costs to the transmission/distribution systems caused by the interconnection. The Wires Owner will carry out the engineering, design and constructions required for its installation, and charge those costs back to the DG Owner. Ongoing O&M costs incurred on the distribution feeder side will also be recovered by the Wires Owner.

3.3.3 Point of Disconnection

The disconnect switch can be located on the high or low voltage side of the interconnection transformer. When the interconnection involves three-phase generators, the disconnect switch must be gang operated to simultaneously isolate all three phases.

High Voltage Disconnect Switch

The disconnect switch on the distribution side of the interconnection transformer (e.g., 25 kV airbreak) must be installed, owned and maintained by the Wires Owner.

Low Voltage Disconnect Switch

The disconnect switch on the generation side of the interconnection transformer must be installed, owned and maintained by the DG Owner.

The disconnect switch must be a manual, visible-break disconnect that provides safe isolation for the Wire Owner's personnel from the generators and all other possible customer sources of power. Appendices F and G show sample configurations.

All low voltage disconnect switches must:

☒ Be adequately rated to break the connected generation/load;

- ☒ Be located within five meters (horizontal) of the PCC, unless otherwise approved by the Wires Owner;
- ☒ Provide a direct, visible means to verify contact operation;
- ☒ Allow simultaneous disconnection of all ungrounded conductors of the circuit;
- ☒ Plainly indicate whether the switch is in the “open” or “closed” position;
- ☒ Be lockable in the “open” position;
- ☒ Be capable of being energized from both sides;
- ☒ Be readily accessible to the Wires Owner operating personnel;
- ☒ Be externally operable without exposing the operator to contact with live parts;
- ☒ Be capable of being closed without risk to the operator when there is a fault on the system;
- ☒ Be labeled with the Wires Owner’s switch number;
- ☒ Meet all applicable CSA Part II standards and all applicable codes; and
- ☒ Undergo annual inspections and maintenance.

If the site interconnects multiple generators, one disconnect switch must be capable of isolating all of the generators simultaneously. There may be other means of meeting this requirement; however, the Wire’s Owner’s approval must be obtained before using other means.

The DG Owner must follow the Wires Owner’s switching, clearance and tagging procedures. The Wires Owner is responsible to instruct the DG Owner in this regard.

3.3.4 Phasing

Phasing is not standardized across distribution systems. Therefore, the phase sequence and the direction of rotation must be coordinated between the Wires Owner and the DG Owner.

3.3.5 Interconnection Grounding

Grounding configurations must be designed to provide:

☒ A solidly grounded distribution system or an ungrounded distribution system; whichever exists.;

☒ Suitable fault detection to isolate all sources of fault contribution, including the generator, from a faulted line or distribution facility;

☒ A circuit to block the transmission of harmonic currents and voltages; and

☒ Protection of the low voltage side from high fault current damage.

The preferred configuration is a Delta connection on the Wire Owner's side of the transformer. If this configuration is not possible, the configuration chosen must still address the above concerns. The winding configuration for DG interconnection transformers should be reviewed and approved by the Wires Owner.

3.3.6 Interrupting Device Ratings

The design of the generation facility must consider the fault contributions of both the distribution system and the generation facility itself, to ensure that all circuit fault interrupters are adequately sized. The Wires Owner will inform the DG Owner of the present and anticipated future fault contribution from the interconnected electric system.

3.3.7 Phase and Ground Fault Protection

The DG Owner must install protective devices to detect and promptly isolate the generation facility for faults occurring either in the generation facility itself or on the distribution system. "Virtual devices" (i.e., computer or programmable-logic controller systems) are acceptable provided they meet standard utility practice for system protection and they have been type tested and approved by an independent testing laboratory.

The protective devices in the generation facility must fully coordinate with the protective relays on the distribution system unless otherwise agreed. The DG Owner must calculate the protective device settings and submit the relay characteristics and settings to the Wires Owner for review and approval.

The generation facility must be able to detect the following situations and isolate itself from the distribution system:

☒ A short circuit between any phase(s) and ground. (if distribution system is a grounded system).

☒ A short circuit between phase(s).

☒ Loss of any phase(s).

3.3.8 Over-Voltage and Under-Voltage Protection

The DG Owner must operate its generation facility in such manner that the voltage levels on the Wires Owner's system are in the same range as if the generation facility was not connected.

The DG Owner must install necessary relays to trip the circuit breaker when the voltage, measured phase-to-ground, is outside predetermined limits. Under-voltage relays should be adjustable and should have a settable time delay to prevent unnecessary tripping of the generator on external faults. Over-voltage relays should be adjustable and may be instantaneous.

The DG Owner's interconnection facility must cause the generator to cease to energize the Wires Owner's system within the trip times indicated in the following table. ("Trip time" is the period of time between the start of the abnormal condition and the moment the interconnection device ceases to energize the Wires Owner's system. *Note these values are subject to change based on actual system variables at the time of installation*

Response to Abnormal Voltages	
RMS Voltage	**Trip Time**
RMS Voltage: V=<60 (V=<50%) Trip time: Instantaneous	
RMS Voltage: 60<V<108 (50%<V<90%) Trip time: 120 cycles	
RMS Voltage: 108=/<V=/<127 (90%<V<106%) Normal Operation	
RMS Voltage: 127<V<144 (106%<V<120%) Trip time: 30 cycles	
RMS Voltage: V>=144 (V>=120%) Trip time: Instantaneous	

The DG Owner may reconnect when the distribution system is stabilized (i.e., voltage and frequency have returned to normal range for a time as identified by the Wires Owner).

3.3.9 Over-Frequency and Under-Frequency Protection

The DG Owner must install frequency selective relays to separate the generation facility from the Wires Owner's system in cases of extreme variations in frequency.

Under-frequency and over-frequency relaying that automatically disconnects generators from the distribution system must be time delayed, in accordance with the Wires Owner's requirements as per section 3.2.4. The DG Owner may reconnect when the distribution system is stabilized.

3.3.10 Anti-Islanding

The DG Owner's generation facility must be equipped with protective hardware and software designed to prevent the generator from being connected to a de-energized circuit owned by the Wires Owner.

In most cases, the generation facility will routinely operate as a part of the interconnected system. A problem on the system could lead to the generator becoming islanded (i.e., the generator becomes the sole supplier of power to one or more of the Wires Owner's customers). The resulting irregularities in power quality could cause damage for other customers.

To prevent this possibility, the DG Owner must use teleprotection signals from the distribution system or another reliable means to separate the generator from the distribution system in the event of islanding. If other means are used to detect islanding, the scheme must consist of reliable primary and backup functions using different quantities.

The DG Owner is responsible for damage caused as a result of failure to safely separate during an islanding event.

Where there could be a reasonable match between the DG Owner's generation and the islanded load, conventional methods may not be effective in detecting the islanded operation. In this case, the Wires Owner will require the addition of transfer trip communication facilities to remotely trip-off the DG Owner's generation upon opening the distribution feeder main circuit breaker or circuit recloser.

3.3.11 Telemetry

Where a generator could adversely affect the distribution system (e.g., by providing inflow into a fault) the DG Owner must have systems in place to inform the Wires Owner of the protective operations that occurred or failed to occur. Note a Micro Grid control assigned by the Wires Owner may accomplish this task.

"Significant" is presently defined as a capacity of 20% of wires owner smallest diesel (dispatchable) generator or greater, although in some sensitive areas, the Wires Owner may require telemetry or transfer trip for smaller generators. See Table 2.

3.3.12 Requirements for Transfer Trip

Where transfer trip protection is required, the transfer trip protection must ensure that the generator does not “island” in the event of substation breaker or intermediate OCR operation. General requirements are:

- ☒ Generator lockout within 0.6 seconds of breaker or OCR operation; and
- ☒ Fail-safe lockout within 6 seconds of communication loss.

Responsibility of transfer trip protection will be determined by the Wires owner and may be carried out by the Wire Owners Micro Grid controller or the DG Owners equipment.

Transfer tripping requirements are also applicable to induction generators, unless the DG Owner can demonstrate that that there is no potential for self-excitation.

3.3.13 Special Interconnection Protection

In some cases, provision for generator-specific protection and controls will be necessary, such as out-of-step or loss of synchronism.

Additionally, the DG Owner needs to be aware that unbalance conditions can occur in the distribution system, especially under system fault conditions, and the design of the interconnection facility should take this into account.

For Star-Delta interconnection transformers, the unbalance fault current could damage the generator interconnection transformer under certain fault conditions. This is a result of the circulating current, which occurs in the Delta winding of the interconnection transformer in an attempt to balance the fault current. Protection for the transformer may be required to address this issue.

3.3.14 Flicker

The DG Owner must not cause excessive voltage flicker on the distribution system. The flicker must not exceed the Wires Owner’s flicker guidelines.

3.3.15 Harmonics

In accordance with IEEE 519, the total harmonic distortion (THD) voltage must not exceed five per cent of the fundamental 60 Hz frequency, nor three per cent of the fundamental for any individual harmonic, when measured on the Wires Owner’s side at the PCC.

3.3.16 Inadvertent Energization of Wires Owner's Facilities

The DG Owner's generator must not energize the Wires Owner's facilities when the Wires Owner's facilities are de-energized.

3.3.17 Protection from Electromagnetic Interference

The influence of electromagnetic interference (EMI) must not result in a change in state or misoperation of the interconnection facility.

3.3.18 Surge Withstand Performance

The interconnection facility must have the capability to withstand voltage and current surges in accordance with the environments described in IEEE/ANSI C62.41 or C37.90.1.

3.3.19 Synchronization

Connection must be prevented when the DG Owner's synchronous generator and/or power system is operating outside of the following limits:

Aggregate Ratings of Generation (kVA)	Frequency Difference (Hz)	Voltage Difference (%)	Phase Angle Difference (degrees)
0-500	0.3	10	20
>500 – 1500	0.2	5	15
>1500	0.1	3	10

3.4 Typical Interconnection Requirements

While the typical interconnection requirements for safely operating the DG Owner's generation facility in parallel with the Wires Owner's distribution system are specified below, specific interconnection locations and conditions may require more restrictive protective settings or hardware, especially when exporting power to the Wires Owner's system. The Wires Owner must make these deviations known to the DG Owner as soon as possible. An example of one such restrictive area for DG interconnection is with utility secondary network systems. The DG Owner will need to work closely with the Wires Owner to determine whether interconnection and operation within a specific network system is possible.

Protective relays, electric conversion devices and other devices can comply with this Guide by demonstrating the required protective function, as specified in Tables 1, 2 and 3.

3.4.1 Single-Phase Generators

Table 1 shows the protective function requirements for single-phase generators. Inverter-type generators must meet the criteria established in IEEE 929 Recommended Practice for Utility Interface of Photovoltaic (PV) Systems, and be certified to UL 1741 and CSA 22.2 #107.1.

3.4.2 Three-Phase Synchronous Generators

Table 2 shows the protective function requirements for three-phase synchronous generators of various sizes.

The DG Owner's generator circuit breakers must be three-phase devices with electronic or electromechanical control.

The DG Owner is solely responsible for properly synchronizing its generator with the Wires Owner's system.

The DG Owner is also responsible for ensuring that the interconnection protection device settings coordinate with the Wires Owner's protective device settings.

3.4.3 Three Phase induction Generators and Three-Phase Inverter Generators

Table 2 shows the protective function requirements for three-phase induction and inverter generators of various sizes.

Induction generators may be connected and brought up to synchronous speed (as an induction motor) if it can be demonstrated that the initial voltage drop measured on the Wires Owner's side at the PCC is within the flicker limits. Otherwise, the DG Owner may be required to install hardware or utilize other techniques to bring voltage fluctuations to acceptable levels.

Inverter generators must meet the applicable criteria in IEEE 929 and be certified to UL 1741 and CSA 22.2 #107.1.

Line-commutated inverters do not require synchronizing equipment. Self-commutated inverters, whether of the utility-interactive type or stand-alone type, must be used in parallel with the Wires Owner's system only with synchronizing equipment. Direct Current (DC) generation must not be directly paralleled with the Wires Owner's system.

3.4.4 Generators Paralleling for Six Cycles or Less (Closed Transition Switching)

Table 3 shows the protective function requirements for generators which parallel with the Wires Owner's system for six cycles or less.

Generators meeting this description must apply for **Parallel Operation**, sign a Joint Operating Agreement, sign an Operating Schedule and meet all other requirements of this Guide.

3.4.5 Mitigation of Protection Scheme Failure

Relays with self-diagnostic features provide information on the integrity of the protection scheme and should be used whenever possible.

The protection scheme must be designed by a qualified engineer or a competent technical person, working with the Wires Owner's engineers, to ensure that the self-diagnostic feature is integrated into the overall protection scheme for the safe and reliable operation of the distribution system.

Depending on the scheme and its design, where relays with the self-diagnostic feature do not trip the appropriate breaker(s), sufficient redundant or backup protection must be provided for the distribution system. The malfunctioning relay must also send a signal to notify operating personnel to investigate the malfunction.

Older electro-mechanical relays are generally not equipped with self-diagnostic features. Design of protection and control schemes must therefore be of a fail-safe nature to maintain the integrity of the protection in the event there is a malfunction.

3.4.6 Maximum Generator Power to be Exported

DG Owner's generation capacity must not exceed the load-carrying capacity of the generator interconnection at the PCC, or exceeds the capacity of the Wire Owner's system connected to the generator,

3.4.7 Interconnection Protection Approval

The DG Owner must provide the Wires Owner with complete documentation of the proposed interconnection protection scheme for review against the requirements of this Guide, and for potential impacts to the Wires Owner's system.

The documentation should include:

- ☒ A completed application form;
- ☒ An overall description of how the protection will function;
- ☒ A detailed Single Line Diagram;
- ☒ Identification details of the protection components (i.e., manufacturer, model, etc.);
- ☒ The protection component settings (i.e., trigger levels and time values); and
- ☒ Identification details of the disconnect switch (i.e. manufacturer, model and associated certification).

The DG Owner must revise and re-submit the protection information for any proposed modification.

4.0 Construction

4.1 General

The DG Owner's generation facility must be constructed and installed to meet all applicable regulations. All permitting and safety code requirements must be completed and copies of inspection reports provided to the Wires Owner prior to energizing the PCC.

All Single Line Diagrams provided to the Wires Owner must be drawn in accordance with IEEE standards and conventions, and stamped by a licensed, professional engineer assuming responsibility for the design.

5.0 Metering

5.1 General

Metering must comply with Measure Canada requirements and be approved by the Wires Owner.

The primary side (i.e., the side connected to the Wires Owner's distribution system) of the interconnection transformer is the Measuring Billing Point for distributed generation export conditions, and the low side (i.e., the side connected to the DG Owner's generation facility) of the interconnection transformer is the Measuring Billing Point for distributed generation import conditions.

The metering equipment must be:

- ☒ Suitable for use in the environmental conditions reasonably expected to occur at the installation site over the course of a typical year; and
- ☒ Appropriate for the power system characteristics reasonably expected to exist at the installation site under all power system conditions and events.

5.2 Meter Requirements

An interval meter must be installed at all distributed generation sites,

The meter must:

- ☒ Be Measurement Canada approved under Section 9(1), Section 9(2) or Section 9(3) of the Electricity and Gas Inspection Act;
- ☒ Be verified and sealed in accordance with the Electricity and Gas Inspections Act, subject to the terms and conditions of any applicable dispensation(s);
- ☒ Be capable of maintaining the interval boundaries within 60 seconds of the hour and every quarter hour thereafter.
- ☒ Measure all quantities required to determine active energy and reactive energy transferred in the required directions at the Measuring Billing Point;
- ☒ Provide a separate register to maintain the continuously cumulative readings of the active energy and reactive energy transferred in the required directions at the Measuring Billing Point;
- ☒ Retain readings and, if applicable, all clock functions for at least 14 days in the absence of line power;
- ☒ Have an accuracy class rating for active energy measurement that equals or exceeds the values specified in Appendix I, Schedule 1, for non-dispensated metering equipment and Schedule 2 for dispensated metering equipment;

- ☒ Have an accuracy class rating for reactive energy measurement that equals or exceeds the values specified in Appendix I, Schedule 1 for non-dispensated metering equipment and Schedule 2 for dispensated metering equipment; and
- ☒ Have "LOSS COMPENSATED" clearly indicated, if the meter is internally compensated for line or transformer losses.

5.3 Measurement Transformers

The applicable winding(s) of the current and potential instrument transformers must:

- ☒ Be Measurement Canada approved under Section 9(1), Section 9(2) or Section 9(3) of the Electricity and Gas Inspection Act;
- ☒ Be burdened to a degree that does not compromise the accuracy required by this Guide; and
- ☒ Have an accuracy class rating that equals or exceeds the values specified in Appendix I, Schedule 1 for non-dispensated metering equipment.

5.4 Remote Communications Equipment

Remote communications equipment may or may not be an integral part of the meter or the recorder, but must incorporate protocol schemes suitable for the type/nature of the communications media/path that will prevent data corruption during interval data transmission.

5.5 Password Protection

Two or more levels of password protection are required for each meter data collection agency: one for full access to set time functions; and one for read-only access to interval data, the event log and meteorological quantities.

5.6 Safety Requirements

The installation must conform to:

- ☒ Measurement Canada Standard Drawings;
- ☒ CSA Standard C22.2; and
- ☒ ANSI/IEEE C57.13-1983 IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

6.0 Inspection

The DG Owner must maintain a quality control and inspection program satisfactory to and approved by the Wires Owner.

In addition to the DG Owner's normal inspection procedures, the Wires Owner reserves the right to witness the manufacturing or fabrication of, or any work involving, the subject equipment; to inspect materials, documents, manufacturing operations and installation procedures; to witness tests and to evaluate the results of non-destructive examinations.

The DG Owner must supply the Wires Owner with a complete set of detailed drawings to assist the Wires Owner in its inspection of equipment during testing.

7.0 Testing

7.1 General

The DG Owner must notify the Wires Owner in writing at least three weeks prior to the initial energization and start-up testing of the DG Owner's generation facility, and the Wires Owner may witness the testing of any equipment and protective systems associated with the interconnection. The tests and testing procedures must generally align with the requirements specified in IEEE P1547.

This section is divided into **type testing** and **verification testing**:

- **Type testing** is performed or witnessed once by an independent testing laboratory for a specific protection package. Once a package meets the type testing criteria described in this section, the design is accepted by the Wires Owner. If any changes are made to the hardware, software, firmware or verification test procedures, the manufacturer must notify the independent testing laboratory to determine what, if any, parts of the type testing must be repeated. Failure of the manufacturer to notify the independent testing laboratory of any changes may result in withdrawal of approval and disconnection of units installed after the change was made.
- **Verification testing** is site-specific, periodic testing to assure continued acceptable performance.

These testing procedures apply only to devices and packages associated with protection of the interconnection between the generation facility and the Wires Owner's system. Interconnection protection is usually limited to voltage relays, frequency relays, synchronizing relays, reverse current or power relays and anti-islanding schemes. Testing of relays or devices associated specifically with protection or control of generating equipment is recommended, but not required unless the devices impact the interconnection protection.

Protection testing must include procedures to functionally test all protective components of the protection scheme, up to and including tripping of the generator and/or PCC. The testing must verify all protective set points and relay/breaker trip timing.

At the time of production, all interconnecting equipment and discrete relays must meet or exceed the requirements of ANSI /IEEE C62.41-1991 Recommended Practices on Surge Voltages in Low Voltage AC Power Circuits or C37.90.1 1989 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems. If C62.41-1991 is used, the surge types and parameters must be applied to the equipment's intended insulation location, as applicable.

The manufacturer's verification test and the appropriate dielectric test specified in UL 1741 must also be performed.

7.2 Type Testing

All interconnection equipment must include a type testing procedure as part of the documentation. The type testing must determine if the protection settings meet the requirements of this Guide.

Prior to type testing, all batteries must be disconnected or removed for a minimum of 10 minutes. This test will verify the system has a non-volatile memory and that the protection settings are not lost. A test must also be performed to determine that the failure of any battery used to supply trip power will result in an automatic shutdown.

All inverters must be non-islanding, as defined by IEEE 929. Inverters must, at the time of production, meet or exceed the requirements of IEEE 929 and UL 1741.

7.3 Verification Testing

Prior to parallel operation of a generation facility, or whenever the interconnection hardware or software is changed, verification testing must be performed. The verification test must be performed by a qualified individual in accordance with the manufacturer's published test procedure. Qualified individuals include: licensed, professional engineers; factory-trained and certified technicians and licensed electricians experienced in testing protective equipment. The Wires Owner reserves the right to witness the verification test or to require written certification that the test was performed.

Verification testing must be performed annually. All verification tests prescribed by the manufacturer or developed by the DG Owner and agreed to by the Wires Owner must be performed. The DG Owner is responsible to maintain the verification test reports for inspection by the Wires Owner.

Inverter generator operation must be verified annually, by operating the load break disconnect switch and verifying that the generation facility automatically shuts down and does not restart for five minutes after the switch is closed.

Any system that depends on a battery for trip power must be checked for proper voltage and logged monthly. Once every four years, the battery must either be replaced or a discharge test performed.

7.4 Protective Function Testing

Protection settings that have been changed after factory testing must be field verified to show that the device trips at the measured (actual) voltage and frequency. Tests must be performed using secondary injection, applied waveforms or a simulated utility. Alternatively, if none of the preceding tests can reasonably be done, a settings adjustment test can be performed if the unit provides discrete readouts of the settings.

The non-islanding function, if available, must be checked by operating a load break switch to verify that the interconnection facility ceases to energize its output terminals and does not restart for the required time delay after the switch is closed.

A reverse power or minimum power function, if used to meet the interconnection requirements, must be tested using secondary injection techniques. Alternatively, this function can be tested by means of a local load trip test or by adjusting the DG output and local loads to verify that the applicable non-export criterion (i.e., reverse power or minimum power) is met.

7.5 Verification of Final Protective Settings Test

If protective function settings have been adjusted as part of the commissioning process, then, at the completion of the adjustment, the DG Operating Authority must confirm all devices are set to the Wires Owner's approved settings.

Interconnection protective devices that have not previously been tested as part of the interconnection facility with their associated instrument transformers, or that are wired in the field, must be given an in-service test during commissioning. This test is to verify proper wiring, polarity, sensing signals, CT/PT ratios and operation of the measuring circuits.

For protective devices with built-in metering functions that report current and voltage magnitudes and phase angles or magnitudes of current, voltage, and real and reactive power, the metered values can be compared to the expected values. Alternatively, calibrated portable ammeters, voltmeters and phase-angle meters may be used.

7.6 Hardware and Software Changes

Whenever changes are made to interconnection hardware or software that can affect the functions listed below, the potentially affected functions must be retested:

- ☒ Over-voltage and under-voltage.
- ☒ Over-frequency and under-frequency.
- ☒ Non-islanding function (if applicable).
- ☒ Reverse or minimum power function (if applicable).
- ☒ Inability to energize dead line.
- ☒ Time delay restart after Wires Owner outage.
- ☒ Fault detection, if used.
- ☒ Synchronizing controls (if applicable).

To ensure that commissioning tests are performed correctly, the Wires Owner may wish to witness the tests and receive written certification of the results.

Refer to Appendix H for an example of a protective settings commissioning document.

7.7 Switchgear and Metering

The Wires Owner reserves the right to witness the testing of installed switchgear and metering.

The DG Owner must notify the Wires Owner at least 15 working days in advance of any testing.

8.0 Data Requirements

The following table identifies the drawings and data the DG Owner is required to submit to the Wires Owner when applying for interconnection to the Wire's Owner's system.

Drawing/Data	Proposal	Approval*	Verified
Manufacturer's equipment data sheet			X
Control schematic		X	X
Single Line Diagram indicating proposed protection settings	X	X	X
Description of protection scheme	X	X	X
Generator nameplate schedule		X	X
Fuse and protective relay coordination study & settings		X	X
Current transformer characteristic curve		X	X
Commissioning report c/w protection settings			X
Plot plan showing location of lockable, visible disconnect switch	X	X	X

*The minimum time requirement for reviewing this information is generally 15 working days.

9.0 Marking And Tagging

The nameplate on the switchgear must include:

- ☒ the manufacturer's name; and
- ☒ the manufacturer's serial number.

In addition, the disconnect switch must be clearly marked "DG Disconnect Switch" and tagged with an identification number approved by the Wires Owner.

10.0 Maintenance

All of the equipment, from the generator up to and including the PCC, is the responsibility of the DG Owner.

The DG Owner must maintain the equipment to accepted industry standards, in particular the Part 1, paragraph 2-300 of the CEC. Failure to do so may result in disconnection of the generator.

The DG Owner must present the planned maintenance procedures and a maintenance schedule for the interconnection protection equipment to the Wires Owner, and keep records of such maintenance.

Maintenance procedures for the Wires Owner's system up to the PCC must be in compliance with the Wires Owner's published "Guidelines for Connecting Generators to the Wires Owner's Distribution System."

Table 2:

Interconnection Protective Function Requirements[5]
Three-Phase Connected to Secondary or Primary System

	Generator size classifications:	
Device #		
	Disconnect Device	X
	Generator Disconnect Device	X
25	Synchronizing Check(note 1)	Y
		Auto.
	Qty.	(1)
27	Under-Voltage Trip	Y
	Qty.	(3)
32	Power Direction/Reverse Power	Y(note 3)
	Qty.	(1)
46	Negative Phase Sequence Overcurrent	X
	(Phase unbalance, reverse phase sequence) Qty.	(1)
51V	Overcurrent, voltage restrained	X
	(Optional, to prevent nuisance trips) Qty	(1)
50/51	Inst/Timed Overcurrent	X
	Qty:	(3)
50N	Instantaneous Neutral Overcurrent	X
	Qty:	(1)
	Ground Over-Voltage Trip (note 6)	
	Or	X
51G	Ground Over-Current Trip (note 6) Qty:	(1)
TT	Transfer Trip (note 4)	Y(note 4)
	(Based on impact to IPP and utility)	
	Telemetry data communication	Y(note 4)
	Automatic Voltage Regulation (AVR) (note2)	X
	Qty:	
59I	Instantaneous Over-Voltage Trip	Y
	(For ferroresonance conditions) Qty:	(3)
59T	Over-Voltage Trip	Y
	Qty:	(3)
60	Voltage Balance Relay	
67/67N	Directional Overcurrent	Y(note 2)
	Qty	(3)/(1)
81/O, 81/U	Over/Under Frequency Trip	Y
	Qty	(3)
	(3) Anti-islanding for inverters	Y
	IEEE 929 and UL 1741	

Table 2 (Continued):

Interconnection Protective Function Requirements[5]
Three-Phase Connected to Secondary or Primary System

Notes:

1. For synchronous and other types of generators with stand-alone capability.
2. As required by Wires Owner
3. If exporting, frequency blocks under voltage trip with agreement of Wires Owner.
4. Transfer trip with fail-safe design required for synchronous machines.
5. Exporting to the Wires Owner may require additional operational/protection devices and coordination of operations with the Wires Owner.
6. Selection depends on grounding system, if required by Wires Owner.
7. Quantity shown in brackets below (e.g., (3)).
8. Both X and Y are required by this guideline X is IEEE Std 242 Protection Requirement.
9. Three-directional overcurrent relays may be substituted for reverse power relay.
10. Above to be in accordance with the Canadian Electrical Code.

Table 3:

Interconnection Protective Function Requirements
Generators Connected to Secondary or Primary System

For 6 cycles or less (Closed Transition Switching)

Generator Size	10 MW or less
Interconnect Disconnect Device	X
Generator Disconnect Device	X
Over-Voltage Trip	X
Under-Voltage Trip	X
Over/Under Frequency Trip	X
Overcurrent	X
Ground Over-Voltage Trip[1] Or Ground Over-Current Trip[1]	X
Synchronizing Check[2] Automatic	

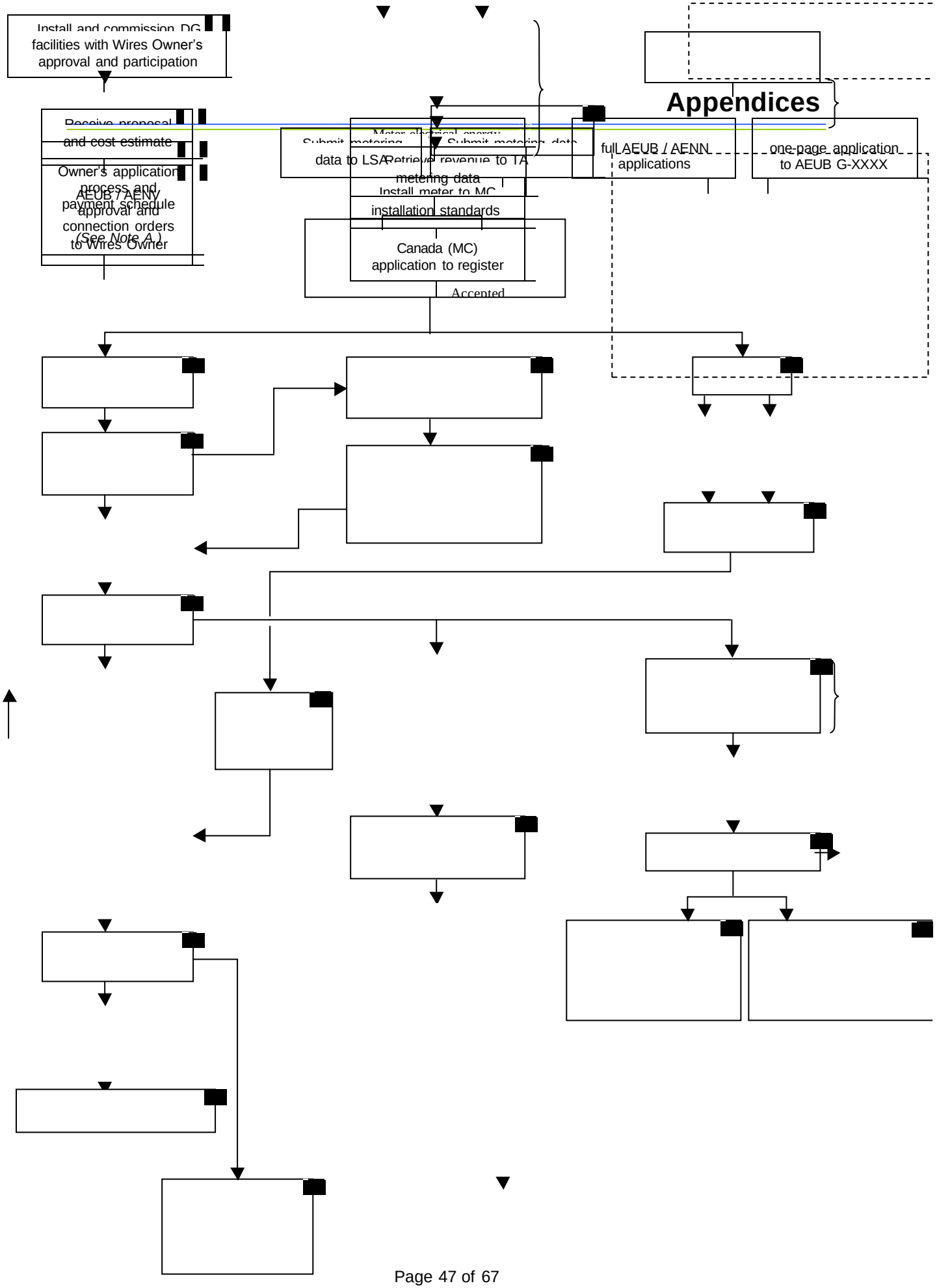
Notes:

1. Selection depends on grounding system, if required by the Wires Owner.
2. For synchronous and other types of generators with stand-alone capability.

Appendices

In this part…

Appendix A: Approval Process Block Diagram


Install and commission DG facilities with Wires Owner's approval and participation
Appendices
Receive proposal and cost estimate
Owner's application process and payment schedule
AEUB / AENV approval and connection orders
(See Note A)
to Wires Owner
Meter electrical energy
Submit metering data
data to LSA
Retrieve revenue to TA metering data
Install meter to MC installation standards
Canada (MC) application to register
Accepted
full AEUB / AENN applications
one-page application to AEUB G-XXXX

Appendices

Appendix B: Information Required From DG Owner

The DG Owner must submit detailed information for the Wires Owner to design, construct, operate and maintain their portion of the interconnection. The required information may include the following:

Information Requirements	Required at Application	Required During Design
1) DG OWNER'S CONTACT NAMES AND ADDRESSES		
a) Company name _____	X	
b) Contact for **commercial terms:** Name/Title _____ Address _____ Phone/Fax _____	X	
c) Contact for **engineering design:** Name/Title _____ Address _____ Phone/Fax _____	X	
d) Contact for **operating terms:** Name/Title _____ Address _____ Phone/Fax _____	X	
2) GENERAL INFORMATION		
a) Detailed map showing the proposed plan location ☐ Attached	X	
b) Site plan showing the arrangement of major equipment ☐ Attached	X	

c) Diagram showing the voltage and current rating of each component **X**

☐ Attached

3) OPERATING CHARACTERISTICS

a) Indicate how the facility will operate. **X**

☐ The facility is intended to sell electric energy to the wires owner.

☐ The facility will consume electric energy services from the electric system.

4) GENERATOR

a) Type **X**

☐ Synchronous ☐ Induction ☐ Inverter

b) Manufacturer_____ Model_____ **X**

c) Nominal rating **X**

_____ kW

_____ kVA

_____Volts

d) ☐ Single-Phase ☐ Three-Phase **X**

e) Governor droop _____% **X**

f) Generator connection configuration **X**

☐ Delta ☐ Wye

g) Generator grounding **X**

h) Impedances (positive, negative and zero sequence) **X**

Direct axis transient _____

Direct axis subtransient _____

Quadrature axis transient _____

Quadrature axis subtransient _____

5) PRIME MOVER

a) Type_____ **X**

b) Manufacturer_____ **X**

c) Model_____ **X**

d) Rating _____ X

e) Inertia constant _____ X

6) POWER FACTOR REGULATOR

a) Limits of range of reactive power X

Lagging (out) _____VAr

Leading (in) _____VAr

b) Accuracy tolerance of setting_____ X

7) VOLTAGE REGULATOR

a) Voltage regulator setting range _____to _____Volts X

b) Voltage regulator setting tolerance _____% X

8) COMPENSATOR (IF APPLICABLE)

a) Type of input(s)_____ X

b) Compensating resistance(s)_____ reactance(s)_____ X

☐ ☐ ☐ ☐ ☐ ☐ ☐

10) INTERCONNECTION PROTECTION

a) Complete and accurate protection diagrams X

☐ Attached

b) Description of the proposed protection schemes X

☐ Attached

c) Diagrams X

☐ Single line

☐ Schematic

☐ Wiring

d) Interconnection X

☐ Verify interconnection functionality

☐ Site test and settings

e) Maintenance plans for the: X

- ☐ Interconnection protection devices
- ☐ Interconnection interrupting devices

11) COMPLIANCE WITH ELECTRICAL INSPECTOR

☐ Permit or equivalent **X**

12) METERING

☐ 2 Element ☐ 3 Element **X**

Meter service provider _____ **X**

Meter data manager _____ **X**

Asset ID # _____ **X**

Modeling Information

In some cases, a generator (or the aggregate generation on a line) is large enough that adjacent customers or the dynamic stability of the Wires Owner's distribution system could be affected. The DG Owner is responsible for the cost of any required transient or dynamic stability studies, and the studies must be done in a manner suitable to, and approved by, the Wires Owner.

DG Owners are responsible for ensuring the data they submit provides an adequate mathematical representation of the facility's electric behavior. If the data is not available prior to purchasing equipment, it must be submitted as soon as it becomes available.

The studies must accurately determine:

1. The impact of the DG Owner's facility on adjacent customers of the Wires Owner.
2. The dynamic stability, in aggregate, of the Wires Owner's system.

Data may be supplied by the manufacturer or acquired directly by testing. It must include generator characteristics (i.e., speed, reactance, resistance, excitation system etc.) and governor characteristics (i.e., lead time/lag time constants, valve or gate opening data etc.).

The information requirements vary for induction generators and inverter generators, and for hydro or steam systems.

Appendix C: Joint Operating Agreement

Appendix D: Information Provided by Wires Owner

After receiving the application for interconnection, the Wires Owner must provide the following information to the DG Owner, on request:

1. Single Line Diagram or maps of the distribution system to the Point of Common Coupling (PCC).
2. Minimum and maximum 60 Hz source impedances (positive-sequence, negative-sequence and zero-sequence) at the PCC.
3. Maximum and minimum normal and emergency system operating voltage ranges at the PCC.
4. Harmonic impedance envelope at the PCC.
5. Planning, operating and reliability criteria, standards and policies.
6. The results of a planning study documenting the availability of the requested amount of system capacity.
7. Cost estimates and time schedule to build the upstream facilities.
8. Clearing and reclosing times for single-phase and multiple-phase faults occurring on the distribution system.
9. Characteristics and settings of protection on the distribution system.
10. Costs of studies and any required changes to the distribution system.

Some or all of this information will be required by the DG Owner to properly design the interconnection protection. The Wires Owner will identify when the costs of producing this information are to be assigned to the DG Owner.

Appendix E: Applicable Codes and Standards

The distributed generation (DG) and interconnection facilities must conform to this Guide and to the applicable sections of the codes and standards listed below. When the stated version of the code or standard is superseded by an approved revision, then that revision shall apply.

Specific types of interconnection schemes, DG technologies, and distribution systems may be subject to additional requirements, standards, recommended practices or guidelines external to this Guide. Determining the applicability and hierarchy of those requirements in relation to the requirements herein is beyond the scope of this Guide. Therefore, the following list of codes and standards is not to be regarded as all-inclusive, and users of this Guide must address related concerns.

Power Quality Standards

1. ANSI C84.1-1989 American National Standards for Electric Power Systems and Equipment Ratings (60 Hertz). Establishes nominal voltage ratings and operating tolerances for 60 Hz electric power systems from 100 V through 230 kV.
2. IEEE Std. 493-1900 IEEE Recommended Practice for Design of Reliable Industrial and Commercial Power Systems (IEEE Gold Book). Chapter 9 deals specifically with voltage sag analysis and methods of reporting sag characteristics graphically and statistically.
3. IEEE Std 519-1992 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.
4. IEEE Std. 1100-1992 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (IEEE Emerald Book).
5. IEEE Std 1159-1995 IEEE Recommended Practice for Monitoring Electric Power Quality.
6. IEEE Std 1250-1995 IEEE Guide for Service to Equipment Sensitive to Momentary Voltage Disturbances.

In addition to the power quality standards, the following standards are applicable to the interconnection of generation facilities to the Wires Owner's distribution system:

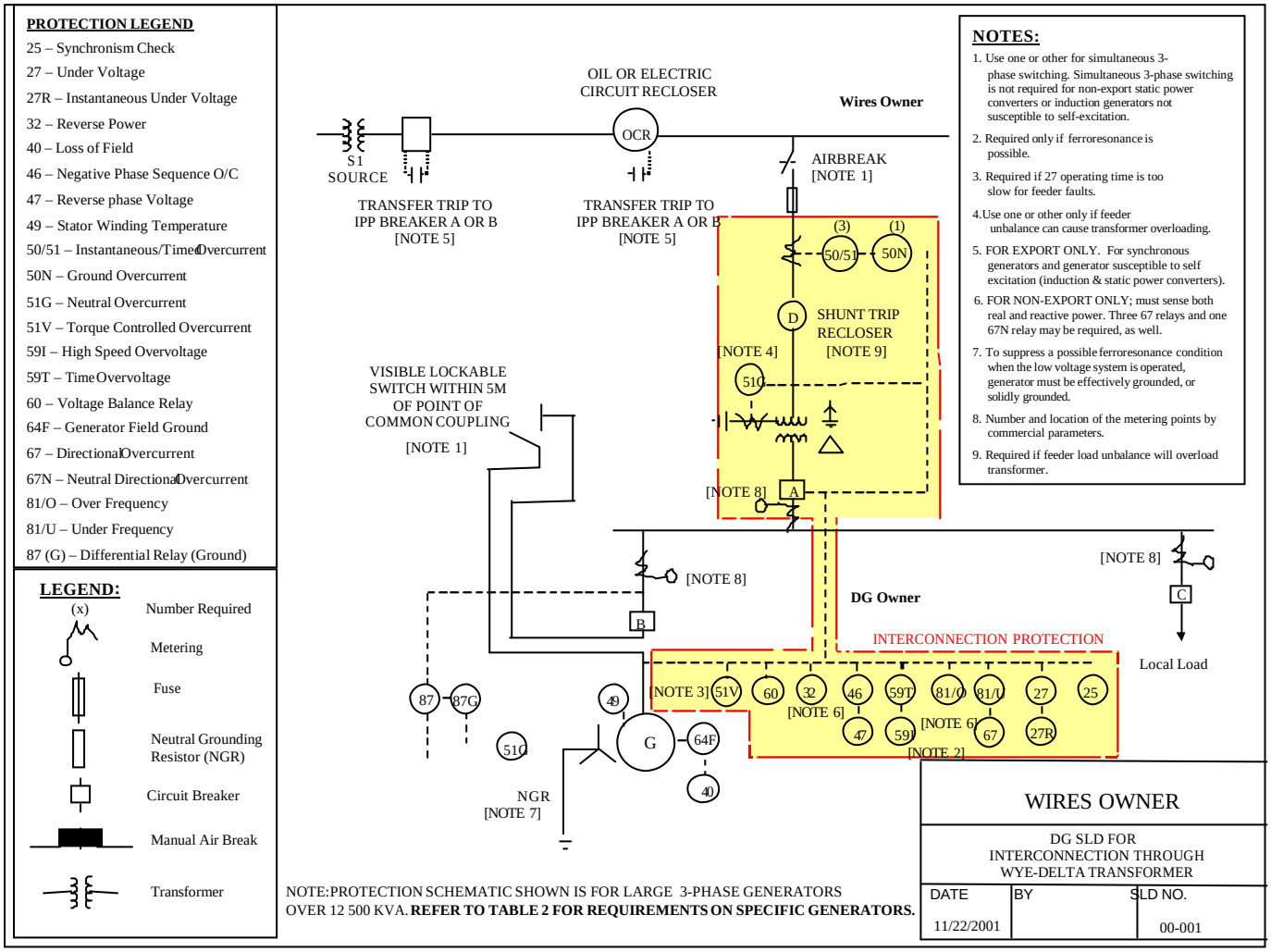
7. IEEE Std. 100 - 1997 IEEE Standard Dictionary of Electrical and Electronics Terms.
8. IEEE Std 315-1975 (Reaffirmed 1993) ANSI Y32.3-1975 (Reaffirmed 1989) CSA Z99-1975 Graphic Symbols for Electrical and Electronics Diagrams (including Reference Designation Letters).
9. IEEE Std 929-1988 IEEE Recommended Practice for Utility Interface of Residential and Intermediate Photovoltaic (PV) Systems.
10. C37.1 ANSI/IEEE Standard Definitions, Specifications and Analysis of Systems Used for Supervisory Control, Data Acquisition and Automatic Control.
11. C37.2 IEEE Standard Electrical Power System Device Function Numbers.
12. C37.18 ANSI/IEEE Standard Enclosed Field Discharge Circuit Breakers for Rotating Electric Machinery.
13. C37.20.1 ANSI/IEEE Standard for Metal-Enclosed Low-Voltage Power Circuit Breakers Switchgear.
14. C37.20.3 ANSI/IEEE Standard for Metal-Enclosed Interrupter Switchgear.
15. C37.24 ANSI/IEEE Standard for Radiation on Outdoor Metal-Enclosed Switchgear.
16. C37.27 ANSI/IEEE Standard Application Guide for Low-Voltage AC Non-integrally Fused Power Circuit Breakers (Using Separately Mounted Current-Limiting Fuses).

17. C37.29 ANSI/IEEE Standard for Low-Voltage AC Power Circuit Protectors Used in Enclosures.
18. C37.50 ANSI Standard Test Procedures for Low-Voltage AC Circuit Breakers Use In Enclosures.
19. C37.51 ANSI Standard Conformance Test Procedure for Metal Enclosed Low-Voltage AC Power Circuit-Breaker Switchgear Assemblies.
20. C37.52 ANSI Standard Test Procedures for Low-Voltage AC Power Circuit Protectors Used in Enclosures.
21. C57.12 IEEE Standard General Requirements for Liquid Immersed Distribution, Power and Regulating Transformers.
22. C57.12.13 Conformance Requirements for Liquid Filled Transformers Used in Unit Installations including Unit Substations.
23. C57.13.1 IEEE Guide for Field Testing of Relaying Current Transformers.
24. C57.13.2 IEEE Standard Conformance Test Procedures for Instrument Transformers.
25. C37.58 ANSI Standard Conformance Test Procedures for Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear.
26. C37.90 ANSI/IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
27. C37.90.1 ANSI/IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
28. C37.90.2 ANSI/IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
29. C37.95 IEEE Guide for Protective Relaying of Utility Consumer Interconnections.
30. C37.98 ANSI/IEEE Standard for Seismic Testing of Relays.
31. IEC 1000-3-3 Limitation of Voltage Fluctuations and Flicker in Low-Voltage Supply Systems for Equipment with Rated Current Less than 16A.
32. IEC1000-3-5 Limitation of Voltage Fluctuations and Flicker in Low-Voltage Supply Systems for Equipment with Rated Current Greater than 16A.
33. UL1008 Transfer Switch Equipment.
34. IEEE P1547, DRAFT Standard for Distributed Resources Interconnected with Electric Power Systems. Canadian Electrical Code, CSA no. C22-1, latest version.C22.2 No. 31- M89 (R1995) Switchgear Assemblies.
35. Can/CSA - C22.2 No. 107.1-95 Commercial and Industrial Power Supplies.
36. Can/CSA - C22.2 No. 1010.1-92 Safety Requirements For Electrical Equipment for Measurement, Control and Laboratory Use.
37. Can/CSA - C22.2 No. 144-M91 (R1997) Ground Fault Circuit Interrupters.
38. C22.2 No. 193-M1983 (R1992) High-Voltage Full-Load Interrupter Switches.
39. C22.2 No. 201-M1984 (R1992) Metal Enclosed High-Voltage Busways.
40. C22.2 No. 229-M1988 (R1994) Switching and Metering Centres.
41. CSA Standard CAN3 C235 83 Preferred Voltage Levels for AC Systems 0 to 50,000V.
42. Alberta Electrical and Communication Utility Code (formerly the Alberta Electrical and Communication Utility System Regulation 44/1976 or future amendments).
43. Measurement System Standard / Transmission Administrator Metering Standard GC301 Practices for Management and Transfer of Metered Data.
44. C37.04-1999 IEEE Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).

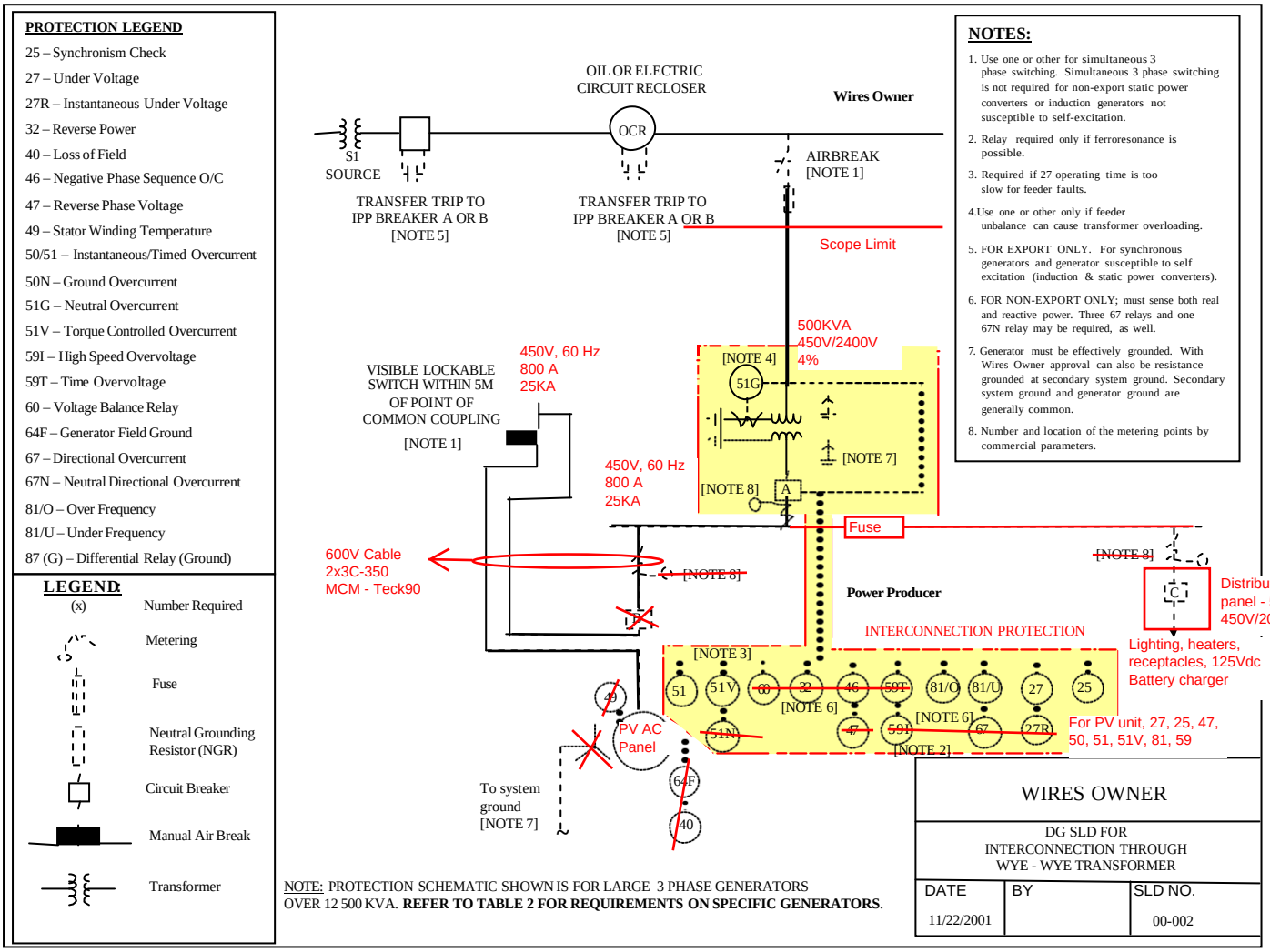
45. C37.06-1997 American National Standard for Switchgear--AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis--Preferred Ratings and Related Required Capabilities.
46. C37.09-1999 IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI/DoD).
47. C37.010-1999 IEEE Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
48. C37.011-1994 IEEE Application Guide for Transient Recovery Voltage for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
49. C37.012-1979 (R1988) IEEE Application Guide for Capacitance Current Switching for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
50. C37.013-1997 IEEE Standard for AC High-Voltage Generator Circuit Breaker Rated on a Symmetrical Current Basis.
51. C37.015-1993 IEEE Application Guide for Shunt Reactor Switching.
52. C37.081-1981 (Reaff 1988) Guide for Synthetic Fault Testing of AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
53. C37.11-1997 IEEE Standard Requirements for Electrical Control for High-Voltage Circuit Breakers Rated on A Symmetrical Current Basis.
54. C37.13-1990 (R1995) IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
55. C37.14-1992 IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures.
56. C37.16-1997 American National Standard for Switchgear - Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors-- Preferred Ratings, Related Requirements, and Application Recommendations.
57. C37.20.2-1999 IEEE Standard for Metal-Clad and Station-Type Cubicle Switchgear.
58. C37.23-1987 (R1991) IEEE Standard for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus.
59. C37.30-1997 IEEE Standard Requirements for High-Voltage Switches.
60. C37.32-1996 American National Standard for Switchgear--High-Voltage Air Switches, Bus Supports, and Switch Accessories--Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide.
61. C37.34-1994 IEEE Standard Test Code for High-Voltage Air Switches.
62. C37.35-1995 IEEE Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Air Disconnecting and Load Interrupter Switches.
63. C37.36b-1990 IEEE Guide to Current Interruption with Horn-Gap Air Switches.
64. C37.37-1996 IEEE Standard for Loading Guide for AC High-Voltage Air Switches (in Excess of 1000 V).
65. C37.38-1989 IEEE Standard for Gas-Insulated, Metal-Enclosed Disconnecting, Interrupter, and Grounding Switches.
66. C37.42-1996 American National Standard for Switchgear--Distribution Cutouts and Fuse Links—Specifications.
67. C37.44-1981 (R1987) American National Standard Specifications for Distribution Oil Cutouts and Fuse Links.
68. C37.54-1996 American National Standard for Switchgear--Indoor Alternating-Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear Assemblies--Conformance Test Procedures.
69. C37.55-1989 American National Standard for Switchgear--Metal-Clad Switchgear Assemblies--Conformance Test Procedures.

70. C37.57-1990 American National for Switchgear--Metal-Enclosed Interrupter Switchgear Assemblies--Conformance Testing.
71. C37.66-1969 (Reaff 1988) American National Standard for Requirements for Oil-Filled Capacitor Switches for Alternating-Current Systems.
72. C37.81-1989 (R1992) IEEE Guide for Seismic Qualification of Class 1E Metal-Enclosed Power Switchgear Assemblies.
73. C37.85-1989 (R1998) American National Standard for Switchgear--Alternating-Current High-Voltage Power Vacuum Interrupters-Safety Requirements for X-Radiation Limits.
74. ANSI/IEEE C37.90-1989 Surge Withstand And Fast Transient Tests.
75. 120-1989 (Reaff-1997) IEEE Master Test Guide for Electrical Measurements in Power Circuits.
76. 1291-1993 IEEE Guide for Partial Discharge Measurement in Power Switchgear.
77. IEEE Std C62.23-1995 Application Guide for Surge Protection of Electric Generating Plants.
78. ANSI /IEEE C62.41-1991 Recommended Practices on Surge Voltages in Low-Voltage AC Power Circuits.
79. C57.13-1993 IEEE Standard Requirements for Instrument Transformers.
80. C57.13.3-1983 (R1991) IEEE Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases.
81. C57.98-1993 IEEE Guide for Transformer Impulse Tests.
82. C57.19.100-1995 (R1997) IEEE Guide for Application of Power Apparatus Bushings.
83. C57.110-1986 (R1992) IEEE Recommended Practice for Establishing Transformer Capability When Supplying Nonsinusoidal Load Currents.
84. C62.92.4-1991 IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part IV – Distribution.
85. IEEE Std 242-1986 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
86. ANSI C12.20 Electricity Meters 0.2 And 0.5 Accuracy Classes.
87. ANSI C62.1 Surge Arresters for AC Power Circuits.
88. ANSI C62.11 Metal-Oxide Surge Arresters for AC Power Circuits.
89. NEMA CC-1 Electric Power Connectors for Substations.
90. NEMA LA-1 Surge Arresters.
91. NEMA MG-1 Motors.

Appendix F: Single Line Diagram for Wye-Delta Interconnection



Appendix G: Single Line Diagram For Wye-Wye Interconnection



Appendix H: Protective Settings Commissioning Document

PROTECTIVE SETTINGS COMMISSIONING DOCUMENT

(Set applicable protection to the most conservative values or as agreed to by the Wires Owner)

OVER VOLTAGE PROTECTION PARAMETERS

	Phase Voltage to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip [redacted] - N	106% to 120% 1% Increments						30 Cycles					
Fast Trip [redacted] - N	144% to 120% 1% Increments						100 ms					

UNDER VOLTAGE PROTECTION PARAMETERS

	Phase Voltage to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip [redacted] - N	50% to 90% 1% Increments						120 Cycles					
Fast Trip [redacted] - N	Less than 50% 1% Increments						100 ms					

NON ISLANDING FUNCTION TEST

Loss of Utility Voltage	100 ms		
Generator Restart Delay after Utility Voltage Failure	5 min Minimum		
Dead Bus Test	Fail to Start Successful (Y or N)		

OVER FREQUENCY PROTECTION PARAMETERS

	Frequency to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip	60.5 to 61.5 Hz 1% Increments						3 minutes					
Fast Trip	61.5 to 61.7 Hz 1% Increments						30 seconds					

UNDER FREQUENCY PROTECTION PARAMETERS

	Frequency to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip	59.5 to 58.5 Hz 1% Increments						3 minutes					
Second Trip	58.5 to 57.9 Hz 1% Increments						30 seconds					
Third Trip	57.9 to 57.4 Hz 1% Increments						7.5 seconds					
Fourth Trip	57.4 to 56.9 Hz 1% Increments						45 cycles					
Fifth Trip	56.9 to 56.5 Hz 1% Increments						7.2 cycles					
Fast Trip	Less than 56.4 Hz						100 ms					

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Appendix H: Protective Settings Commissioning Document (continued)

REVERSE AC CURRENT PROTECTION FUNCTION

	Current to Trip						Duration to Trip					
	DESIGN LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	DESIGN VALUE	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Primary Trip												

SYNCHRONIZATION LIMITS FOR SYNCHRONOUS GENERATORS

	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET
Frequency Difference	+ 0.2 Hz		
Voltage Difference	5%		
Phase difference	10 Deg		

WIRES PHASE & GROUND FAULT PROTECTION FUNCTION

	Maximum Current or Volts to Trip						Duration to Trip					
	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET	TESTED A	TESTED B	TESTED C
Phase Current							200 ms					
Neutral Current							200 ms					

TRANSFER TRIP PROTECTION

	GUIDELINE LIMIT	ADJUSTABLE RANGE	AS SET
Generator Lockout	0.6 seconds		
Fail Safe Lockout	6 seconds		

TEST CERTIFICATION AND HISTORICAL DATA

TYPE OF TEST

ORIGINAL COMMISSIONING TEST		PROTECTION SYSTEM RE-TEST	

DATE OF TEST

WIRES OWNER REPRESENTATIVE

DG OWNER REPRESENTATIVE

TITLE

TITLE

DATE

GENERATOR LOCATION & IDENTIFICATION NUMBER

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Appendix H: Protective Settings Commissioning Document (continued)

Note 1:

- ☒ Refer to Chapter 11, “Connecting Small Geerators to Utility Distribution Systems,” by A. B. Sturton.
- ☒ Refer to “Transformer Concepts and Application Course Notes,” by Power Technologies Inc., Schenectady, New York.
- ☒ Refer to “Electrical Transients in Power Systems,” by Allan Greenwood.
- ☒ Refer to “Electrical Transmission & Distribution Reference Book,” by Westinghouse.

Note 2:

- ☒ Refer to “Protective Relaying, Principles and Applications,” by J. Lewis Blackburn for details on sub-synchronous resonance.
- ☒ Refer to “Electrical Transmission & Distribution Reference Book,” by Westinghouse.

Note 3:

- ☒ Refer to Chapter 8, “Harmonic and Resonant Effects on Application of Capacitors, Distribution Systems, Electric Utility Reference Book,” by Westinghouse.
- ☒ Refer to Chapters 11 & 12, “Connecting Small Generators to Utility Distribution Systems,” by A. B. Sturton.
- ☒ Refer to Chapter 10, “Electric Power Systems: Switching Surges -Interruption of Capacitive Circuits,” by B. M. Weedy.

Note 4:

- ☒ Refer to Chapter 4, “Connecting Small Generators to Utility Distribution Systems,” by A. B. Sturton.

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Appendix I: Accuracy Schedules for Metering Equipment

Schedule 1: Non-Dispensated Metering Equipment

Schedule Of Accuracies For Metering Equipment Approved Under Section 9(1) Of The Electricity and Gas Inspection Act

Metering Point Capacity (MVA)	Watthour Meter Accuracy Class	Varhour Meter Accuracy Class	Measurement Transformers Accuracy Class
10 and Above	0.2%	0.5%	0.3%
Below 10	0.5%	1.0%	0.3%

Notes:

1. This schedule applies to requirements set out in Part 2, Section 5.0 of this Guide.
2. If an alternate measurement is used to determine reactive energy, the accuracy class of the alternate measurement must be equal to or better than the accuracy class set out for reactive energy.

Schedule 2: Dispensated Metering Equipment

Schedule Of Accuracies For Meters Approved Under Section 9(2) Or 9(3) Of The Electricity And Gas Inspection Act

Meter Accuracy		
Metering Point (MVA)	Points of Delivery	Points of Supply
10 and Above	1.0 %	1.0 %
Below 10	1.0 %	1.0 %

Notes:

1. This schedule applies to requirements set out in Part 2, Section 5.0 of this Guide.
2. If an alternate measurement is used to determine reactive energy, the accuracy class of the alternate measurement must be equal to or better than the accuracy class set out for reactive energy.

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Appendix D: Forms of Proposal

FORMS OF PROPOSAL

Proponents are requested to provide comprehensive information as outlined in the RFP Documents to enable complete and accurate evaluation of their Proposal. Omission of any information that the VGFN deems as pertinent to the Proposal may cause the Proposal to receive a lower rating through evaluations, or may cause the Proposal to be disqualified at the VGFN's absolute discretion.

1. Addenda and Questions and Answer Acknowledgement
2. Proposal Submission
3. Fixed Cost for Scope of Work
4. Proposed Alterations / Optimizations
5. Proposed Project Work Schedule
6. Technical Documents / Information
7. Rate Sheet-Ongoing Work I Change Orders I Additional Work
8. Proposed Personnel
9. Experience in Similar Work
10. Form of Contract

1. ADDENDA AND QUESTIONS AND ANSWER ACKNOWLEDGEMENT

The Proponent acknowledge receipt of, and has taken into consideration, the following Addenda and Questions and Answers series through the RFP process:

Addenda #		Received	
Addenda #		Received	
Addenda #		Received	
Addenda #		Received	
Addenda #		Received	
Addenda #		Received	

Q&A #		Received	
Q&A #		Received	
Q&A #		Received	
Q&A #		Received	
Q&A #		Received	
Q&A #		Received	

2. PROPOSAL SUBMISSION

Proponent's Legal Business Name:			
Address:			
City:			
Province / State			
Postal Code / ZIP			
Phone:			
Fax:			
Email:			
Business Status: (check box)	☐ Incorporated	☐ Sole Partnership	☐ Partnership
If Incorporated - Location and Date			
Contact Name for this proposal:			
Contact Name Title:			
Contact Phone Number:			
Contact Email:			
Contract Signature & Title:			

In witness whereof, Proponent has executed at ……. this …….. day of ……., 2018.

Authorized Signatory(s)

(print name)	(signature)
(print name)	(signature)

3. FIXED COST FOR THE SCOPE OF WORK

Provide a detailed fixed cost for the Scope of Work (Appendix C). Consider the following information when detailing the fixed costs. Section 4 of Appendix C details the full scope of work.

3.1 Costs to include

Accommodation, meals and local labour and machine and equipment rental costs (local only) will be provided by VGFN. Proponents should not include these costs but provide sufficient information for VGFN to calculate cost adders.

3.2 Material Shipping

Shipping options are limited in Old Crow. For small shipment, Air North (http://www.flyairnorth.com/Cargo/CargoInfo.aspx#) or Alkan Air (http://alkanair.com/) can be hired.

For large shipment, we recommend Proponents to consider Lynden Transport to ship material by truck to Fairbanks Alaska, and use their sister company, Lynden Air Cargo and their Hercules to air freight to Old Crow. Lynden Transport can manage the paperwork for crossing the border and re-entry to Canada. The Owner verified with Lynden Air Cargo that recent US tariff on PV panels will not be imposed on this Project, since the panels are only in transit in the US.

Contact information:

Sandra Darke
Lynden Transport
sdarke@lynden.com
780-960-9444

Adam Murray
Director of Business Development & Marketing
Lynden Air Cargo
amurray@lynden.com
907-227-0494
http://www.lynden.com/lac/hercules-cargo-load-planner.html

3.3 Temporary Storage in Old Crow

Temporary storage will be available (free of charge) for material shipped to Old Crow before installation. Depending on shipment size, Proponent will be responsible for organizing the logistics of receiving the shipment.

3.4 Pricing

Costs paid by contractor and billable to VGFN (expand as necessary):

Design Costs		$
Procurement Costs		$
Materials Breakdown		
PV Panels	Unit Cost ($)	$
	Cost ($)	$
PV Panels shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Panel frames	Unit Cost ($)	$
	Cost ($)	$
Panel frames shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Combiner	Unit Cost ($)	$
	Cost ($)	$
Combiner shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$

Wiring	Unit Cost ($)	$
	Cost ($)	$
Wiring shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
EC Combiner Panel	Unit Cost ($)	$
	Cost ($)	$
EC Combiner Panel shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Grounding equipment	Unit Cost ($)	$
	Cost ($)	$
Grounding equipment shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Fencing	Unit Cost ($)	$
	Cost ($)	$
Fencing shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Bird management equipment	Unit Cost ($)	$
	Cost ($)	$
Bird management equipment shipping	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
(Other – add lines as necessary)	Unit Cost ($)	$
	Cost ($)	$
(Other – add lines as necessary)	Total weight (kg)	
	Total volume (m^3)	
	Cost ($)	$
Installation and testing cost		$
Flights for contractors		$
Total Cost		**$**

Cost paid direct by VGFN:

- To determine food and accommodation costs:

Number of contractors personnel on site	
Number of days on site	

- To determine local labour requirements (excluding machinery operator). Note day and evening shifts can be negotiated later.

Number of local labourers required per day	
Number of work days	

- To determine machinery and equipment rental cost (see Appendix F for machinery list available)

	Billable Resource	Unit	Number of day/hours
Example	*e.g. CAT 988 Loader*	*Hourly*	*10*
1			
2			
3			
4			
5			

4. PROPOSED ALTERATIONS / OPTIMIZATION

Proponent should provide proposed alterations or optimization (if applicable).

Proponents may attach supporting documents as required.

5. PROPOSED PROJECT WORK SCHEDULE

Supply schedule for procurement and install components. Reference the overall project schedule included in Section 4. This will be used as a project baseline and to confirm proposers understanding of the work involved.

6. TECHNICAL DOCUMENTS / INFORMATION

Include all technical documents / information requested in the Scope of Work Document (Appendix C - Section 7):

1. Equipment Data sheets (inverter, PV modules, communication, combiner boxes, cables, etc)
2. Single line diagram
3. Communication diagram
4. Bill of material with ratings and makes of components
5. Outline drawing of the equipment (PV modules, Invertors, combiner boxes) with its certified maximum dimensions and weight.
6. PV system simulation
7. Typical schematic or diagram circuits showing as a minimum:
    a. How many modules per string
    b. How many strings per container box
    c. How many trunks per inverter
    d. How many inverters
8. Type test certificates for similar equipment
9. Guarantee / Warranty details for equipment

7. RATE SHEET - ONGOING WORK / CHANGE ORDERS / ADDITIONAL WORK

Proponent is requested to provide personnel rates. VGFN with the agreement of the Proponent may request additional work on a time and materials basis.

Personnel rates shall be in Canadian Dollars and include all costs of performing the Work and all applicable duties and taxes except the Canadian Federal Goods and Services Tax (GST). GST should be identified as a separate item to all or any requested pricing items.

Personnel Rates:

Personnel rates are to be all inclusive including benefits, overhead, mark-up and all other employee and/or subcontractor related costs.

Personnel by Occupation	Hourly Rate	Overtime	Double Time

Proponent is to identify and quantify any additional costs not identified in the rates above.

8. PROPOSED PERSONNEL

Proponent is requested to provide information on the personnel that Proponent is proposing to perform the Work, including but not limited, to the key personnel indicated below.

Proponent should attach a resume or curriculum vitae (CV) detailing the experience, education, training, and certificates held by the Project Manager and key personnel assigned to the project.

1. The name of the proposed Project Manager and his/her pervious related work experience. If there will be more than one Project Manager, Proponent should provide details.

_____

_____

2. The names and qualifications of the proposed key personnel including previous related work experience, training, certifications, affiliations, etc.

_____

_____

_____

_____

3. The average number of workers the Proponent proposes to employ and maintain for the Work.

_____

_____

Proponent may attach additional pages, as required to provide complete information. Resumes and/or CV's should be attached, referencing this Proposal Form.

Note: Substitution of personnel, including but not limited to the named Project Manager(s) and key personnel, will only be with the express written consent of VGFN.

9. EXPERIENCE IN SIMILAR WORK

Proponent is to provide a list of at least (3) references for projects in similar scope and size to the Work contemplated in this RFP including when the work was completed, a description of the work, the client for whom the work was performed and a budgeted value for the work.

The proponent is to advise if any projects were delayed or ran over budget, the reasoning for the overrun(s), and the mitigation strategy that was employed to bring the project back on track. Additional information should be attached, referencing this Proposal Form.

External References:

Reference #1

Client Organization:			
Contact Person:			
Street Address:			
Telephone Number:			
Email Address:			
Description of Services:			
Year Completed:		**Work Value:**	

Reference #2

Client Organization:			
Contact Person:			
Street Address:			
Telephone Number:			
Email Address:			
Description of Services:			
Year Completed:		**Work Value:**	

Reference #3

Client Organization:			
Contact Person:			
Street Address:			
Telephone Number:			
Email Address:			
Description of Services:			
Year Completed:		**Work Value:**	

10. FORM OF CONTRACT

Please supply Proponent preferred form of contract.

Appendix E: Porcupine Equipment / Machinery List

PORCUPINE ENTERPRISES LTD.

	BILLABLE RESOURCES	Unit	2016 Operating
LABOUR	FOREMAN (incl. pickup)	Hourly	$ 150.00
	LABOUR	Hourly	$ 90.00
	MECHANIC	Hourly	$ 230.00
	WELDER	Hourly	$ 230.00
LOADING	CAT 988 LOADER	Hourly	$ 425.00
	CAT 950 LOADER	Hourly	$ 260.00
	KOMATSU 320 LOADER	Hourly	$ 285.00
	CAT SKIDSTEER	Hourly	$ 235.00
	CAT 235 EXCAVATOR	Hourly	$ 390.00
	CAT 315 EXCAVATOR	Hourly	$ 360.00
	KABOTA MINI-EXCAVATOR	Hourly	$ 260.00
HAULING	CAT769 RT#6	Hourly	$ 390.00
	CAT769 RT#7	Hourly	$ 390.00
	KENWORTH T800 DT#4	Hourly	$ 270.00
	KENWORTH T800 DT#5	Hourly	$ 270.00
RIP/GRADE	CHAMPION GRADER	Hourly	$ 255.00
	CAT D7 DOZER	Hourly	$ 375.00
	CAT D9 DOZER	Hourly	$ 500.00
PACK	WATER TRUCK	Hourly	$ 265.00
	DRUM PACKER	Hourly	$ 230.00
SUPPORT	FUEL TRUCK	Hourly	$ 260.00
	PICKUP TRUCK 1	Daily	$ 250.00
	PICKUP TRUCK 2	Daily	$ 250.00
	SERVICE TRUCK	Daily	$ 250.00
	5KW GENERATOR	Daily	$ 230.00
	FROST FIGHTER HEATER (w/o fuel)	Daily	$ 175.00
	LIGHTING PLANT	Daily	$ 230.00
	COMPRESSOR	Daily	$ 230.00
	FLAT DECK TRAILER	Daily ($25/hr min 4hr)	$ 200.00
	PLATE TAMPER	Daily	$ 175.00
	PUMPS & HOSES	Daily	$ 175.00

PRICING CONDITIONS:

*Rates listed are inclusive of all room and board costs, fuel and lubricants, fueling and mechanical support, transportation and freight FOB Old Crow Yukon, operator (where applicable), overhead and profit.

*During off season operations, October through May, rates are subject to idling charges for maintaining machinery in ready condition with safe operating temperatures and pressures for machine oils. The need for idling machinery shall be discussed with the clients representative on site, but will ultimately be at the Foreman's discretion. The hourly idling charge shall be calculated at 65% of the operated rate.

*In the event of a community invoked standby, such as a funeral, an 8 hour standby charge shall apply for all employees where point-of-hire/primary residence is not Old Crow.

*Materials will be billed at cost FOB Old Crow +15%.

*These rates are in effect July 1, 2016.

Appendix F: Drawings

NOTES:

1. ALL MEASUREMENTS IN METRES UNLESS NOTED OTHERWISE.
2. THE SPACING BETWEEN THE SOLAR PANEL ROWS IS 20.0m (BETWEEN THE CENTRES OF THE ROWS).
3. ALL SOLAR PANELS ARE AT 45 DEGREES.
4. THERE MUST BE A MINIMUM OF 3.0m SPACE ALLOWED AROUND EQUIPMENT FOR SNOW CLEARANCE NEAR ROADS.
5. THE PANELS ARE MOUNTED BACK TO BACK IN AN EAST–WEST FACING ARRANGEMENT.
6. REFER TO ALL OTHER DRAWINGS IN THE 3905 SERIES FOR FOUNDATION DETAILS AND PANEL ARRANGEMENT.
7. EACH PV PANEL IS 1.011m WIDE BY 2.02m LONG.
8. EACH PANEL 350 W
9. TOTAL LENGTH = 650m
10. TOTAL CAPACITY = 900 KW

FOR INFORMATION ONLY

SCALE A 12.5 0 25 50 75 m

DWG. NO.	DESCRIPTION	Rev.	REVISION DESCRIPTION	Date	Design	Drawn	Chk'd	App'd
REFERENCE DRAWINGS		A	ISSUED FOR INFORMATION	MAR 01, 18	SW	SC	NH	NH

DRAWN BY: S. CHEUNG
DESIGN BY: S. WATERS
CHK'D BY: N. HAWLEY
APP'D BY: N. HAWLEY
DATE: MAR 01, 18
SCALE: AS SHOWN

CLIENT: Vuntut Gwitchin Government

SEAL BY

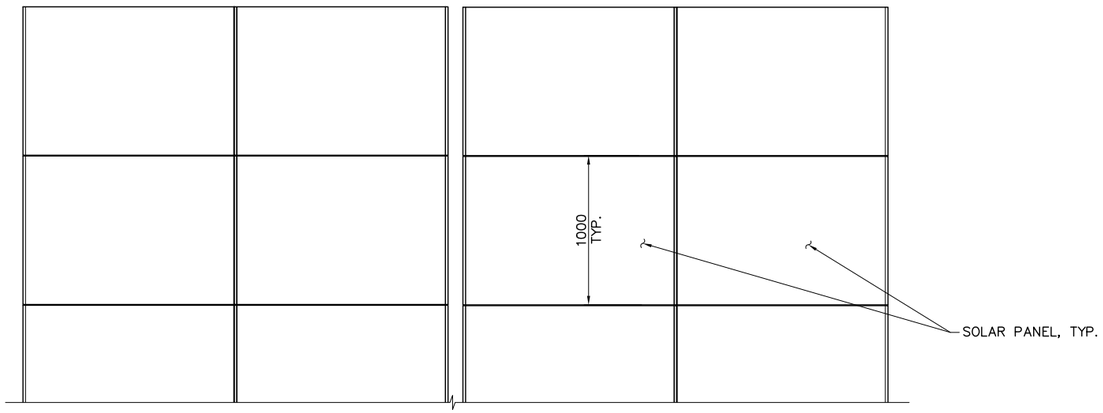
OLD CROW SOLAR PV PROJECT

GENERAL ARRANGMENT
PANEL LAYOUT

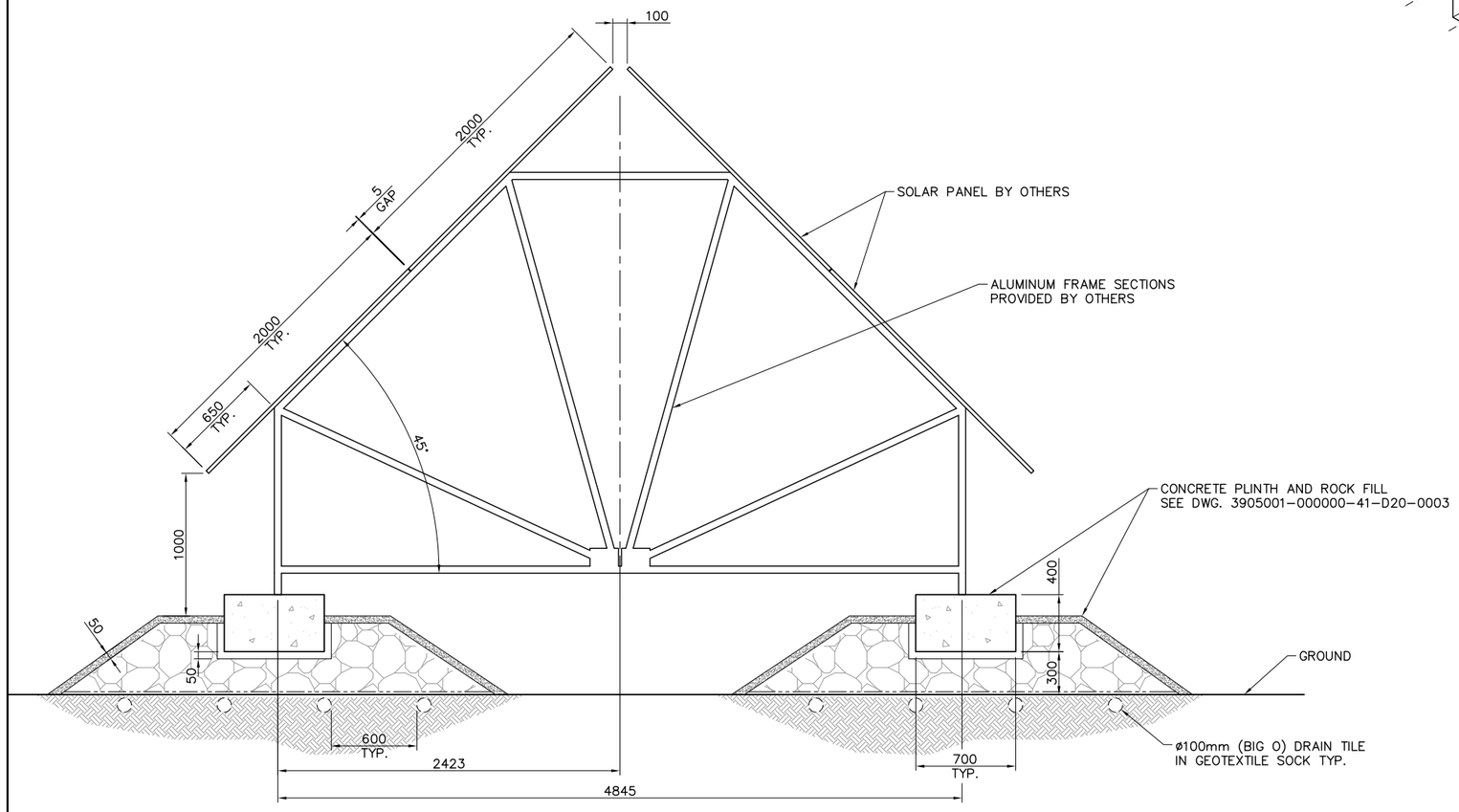
DRAWING NO. 3905001–000000–41–D20–0001

REVISION AA

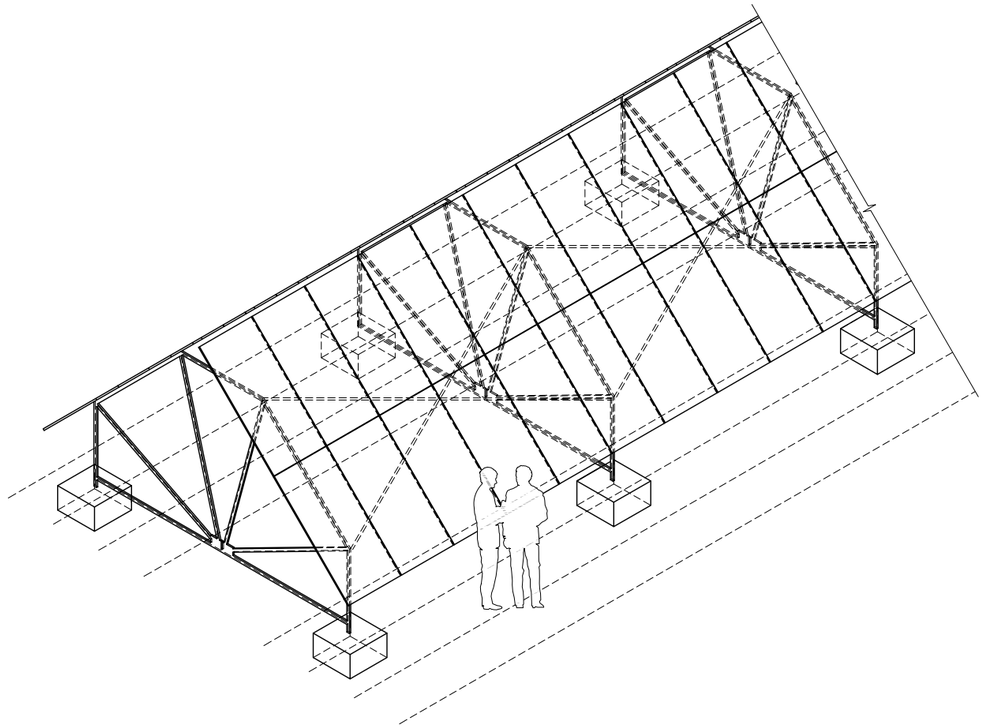
File: Z:\03 projects\3905\3905001-000000-41-D20-0001_opt1; Plotted: 3/1/2018 12:23 PM by CHEUNG, SIMON; Saved: 12/21/2017 5:01 PM by LUU4652



PLAN VIEW
SCALE A



ELEVATION
SCALE A



ISOMETRIC VIEW

NOTES

1. ALL MEASUREMENTS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL SOLAR PANELS ARE AT 45 DEGREES.
3. HOURLY WIND PRESSURE IS 0.48 kPa AT 1/50 PROBABILITIES OF EXCEEDANCE.
4. CONCRETE COMPRESSIVE STRENGTH TO BE 35 MPa.
5. ASCE 7-10 CODE (MINIMUM DESIGN LOADS FOR BUILDINGS & OTHER STRUCTURES) IS USED FOR DESIGN CALCULATIONS.
6. BRACING BETWEEN MOUNTING FRAMES TO BE SPECIFIED BY OTHERS.
7. SITE DRAINAGE TO BE FINALIZED.
8. ALL DIMENSIONS TO BE CONFIRMED.

FOR INFORMATION ONLY

SCALE A 0.4 0.2 0 0.4 0.8 1.2 1.6 2.0 m

DWG. NO.	DESCRIPTION								
REFERENCE DRAWINGS		Rev.	REVISION DESCRIPTION	Date	Design	Drawn	Chk'd	App'd
		A	ISSUED FOR INFORMATION	MAR 01, 18	SW/BS	SC	CC	BS

DRAWN BY: S. CHEUNG
DESIGN BY: S. WATERS/B. SONG
CHK'D BY: C. CHUNG
APP'D BY: B. SONG
DATE: MAR 01, 18
SCALE: AS SHOWN

CLIENT
Vuntut Gwitchin Government

BBA

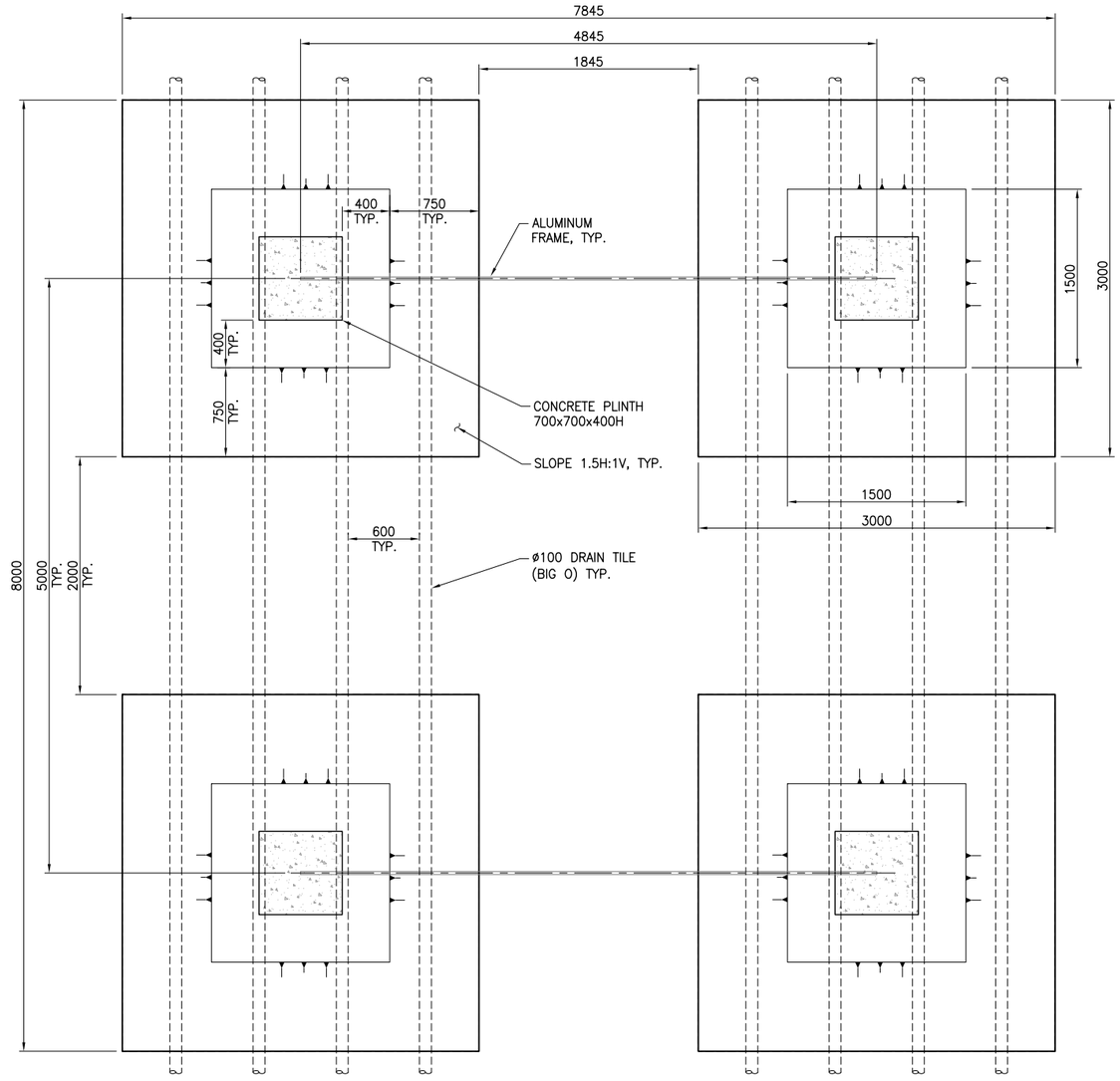
SEAL BY

OLD CROW SOLAR PV PROJECT

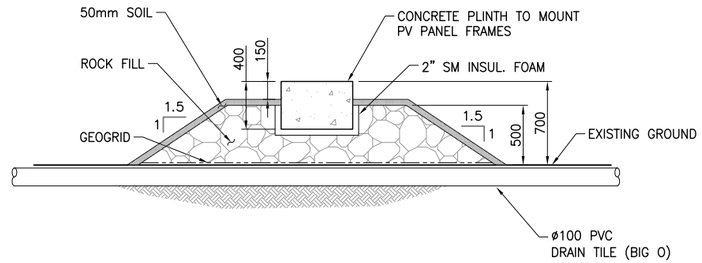
SOLAR PANEL ASSEMBLY
GENERAL LAYOUT

DRAWING NO. 3905001-000000-41-D20-0002
REVISION AA

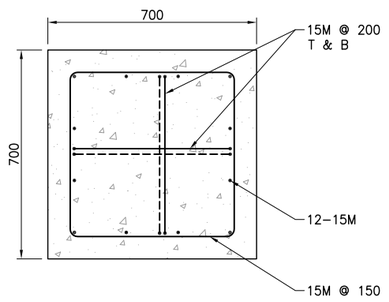
File: Z:\03 projects\3905\3905001-000000-41-D20-0002; Plotted: 3/1/2018 12:07 PM by CHEUNG, SIMON; Saved: 3/1/2018 11:58 AM by CHES4643



PLAN
SCALE A



TYPICAL TRENCH AND ROCK FILL ELEVATION
SCALE A



CONCRETE PLINTH DETAIL
SCALE B

NOTES

1. ALL MEASUREMENTS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. THE TYPICAL PLAN VIEW OF A 5.0 m SECTION SHOWN IS TO BE REPEATED TO MAKE UP A PANEL ROW OF 40.0m OR 30.0m. SEE OTHER DRAWINGS IN THE SERIES FOR GENERAL SITE ARRANGEMENT.
3. ANCHOR BOLTS, BASE PLATE AND GROUT TO BE SPECIFIED WHEN PV FRAME MOUNTING FRAME MEMBERS ARE FINALIZED.
4. GEOTECHNICAL INFORMATION IS FROM TETRA TECH "DESKTOP GEOTECHNICAL EVALUATION FOR SOLAR PANEL ARRAY OLD CROW, YT" REPORT. THE DESIGN IS SUBJECT TO CHANGE BASED ON SITE CONDITIONS.
5. FOUNDATION SETTLEMENT TO BE MONITORED AND FOUNDATION ELEVATION TO BE ADJUSTED AS REQUIRED.
6. SITE DRAINAGE TO BE FINALIZED.
7. GRADATION OF ROCK FILL FROM QUARRY TO BE PROVIDED FOR REVIEW BY ENGINEER. COMPACTION SPECIFICATION TO BE FINALIZED.
8. CONCRETE COMPRESSIVE STRENGTH TO BE 35 MPa.
9. ALL DIMENSIONS TO BE CONFIRMED.

DWG. NO.	DESCRIPTION	A	ISSUED FOR INFORMATION	MAR 01, 18	SW/BS	SC	CC	BS
REFERENCE DRAWINGS		Rev.	REVISION DESCRIPTION	Date	Design	Drawn	Chk'd	App'd

DRAWN BY: S. CHEUNG
DESIGN BY: S. WATERS/B. SONG
CHK'D BY: C. CHUNG
APP'D BY: B. SONG
DATE: MAR 01, 18
SCALE: AS SHOWN

CLIENT
Vuntut Gwitchin Government

BBA

GEOTECHNICAL ASPECT ONLY

SEAL BY

FOR INFORMATION ONLY

SCALE B 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m

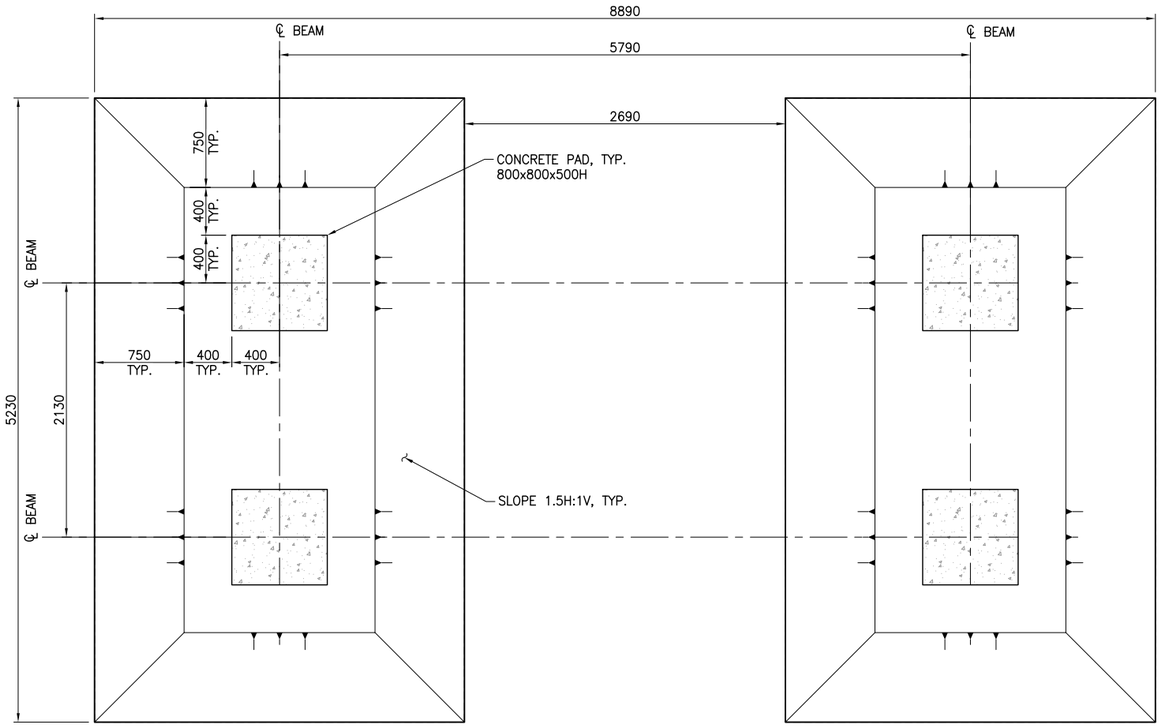
SCALE A 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

OLD CROW SOLAR PV PROJECT

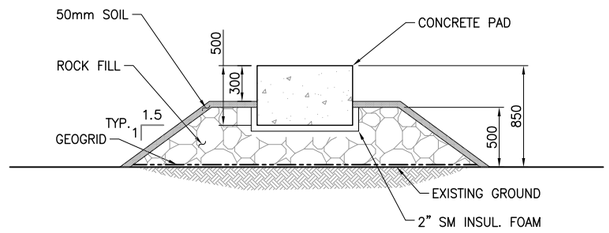
PANEL MOUNTING FOUNDATIONS
TYPICAL PLAN AND SECTIONS

DRAWING NO. 3905001-000000-41-D20-0003
REVISION AA

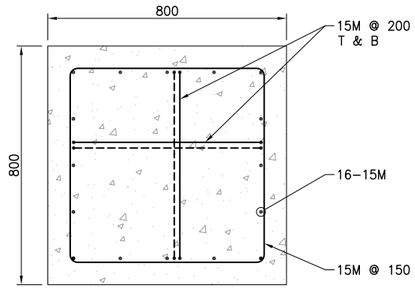
File: Z:\03 Projects\3905\3905001-000000-41-D20-0003; Plotted: 3/1/2018 12:07 PM by CHEUNG, SIMON; Saved: 3/1/2018 12:03 PM by CHES4643



PLAN
SCALE A



TYPICAL TRENCH AND ROCK FILL ELEVATION
SCALE A



CONCRETE PAD DETAIL
SCALE B

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REFERENCE DRAWINGS	

Rev.	REVISION DESCRIPTION	Date	Design	Drawn	Chk'd	App'd
A	ISSUED FOR INFORMATION	MAR 01, 18	BS	SC	CC	BS

DRAWN BY: S. CHEUNG
DESIGN BY: B. SONG
CHK'D BY: C. CHUNG
APP'D BY: B. SONG
DATE: MAR 01, 18
SCALE: AS SHOWN

CLIENT
Vuntut Gwitchin Government

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GEOTECHNICAL ASPECT ONLY

SEAL BY

FOR INFORMATION ONLY

SCALE B 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m

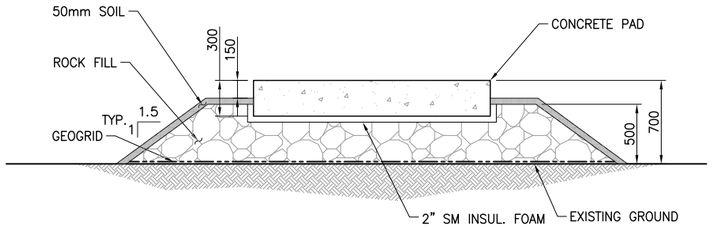
SCALE A 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

OLD CROW SOLAR PV PROJECT

E-HOUSE FOUNDATIONS
TYPICAL PLAN AND SECTIONS

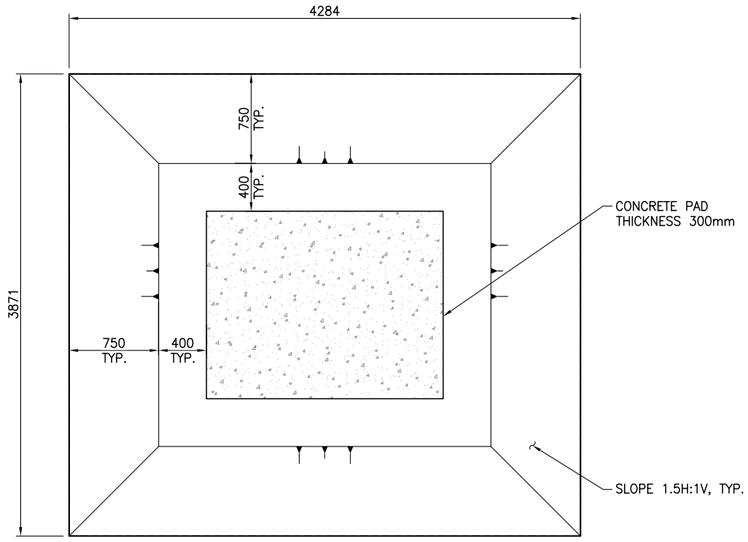
DRAWING NO. 3905001-000000-41-D20-0005
REVISION AA

File: Z:\03 projects\3905\3905001-000000-41-D20-0005; Plotted: 3/1/2018 12:10 PM by CHEUNG, SIMON; Saved: 3/1/2018 12:04 PM by CHES4643



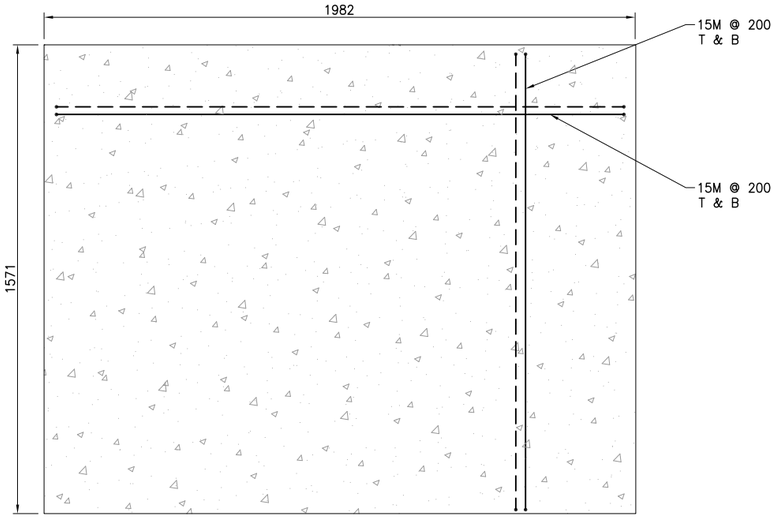
TYPICAL TRENCH AND ROCK FILL ELEVATION

SCALE A



PLAN

SCALE A



CONCRETE PAD DETAIL

SCALE B

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DRAWN BY: S. CHEUNG
DESIGN BY: B. SONG
CHK'D BY: C. CHUNG
APP'D BY: B. SONG
DATE: MAR 01, 18
SCALE: AS SHOWN

CLIENT

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SCALE B 0.2 0.1 0 0.2 0.4 0.6 0.8 1 m

SCALE A 0.5 0.25 0 0.5 1.0 1.5 2.0 2.5 m

OLD CROW SOLAR PV PROJECT

TRANSFORMER FOUNDATION TYPICAL PLAN AND SECTIONS

DRAWING NO. 3905001-000000-41-D20-0006

REVISION AA

File: Z:\03 projects\3905\3905001-000000-41-D20-0006; Plotted: 3/1/2018 12:10 PM by CHEUNG, SIMON; Saved: 3/1/2018 10:18 AM by CHES4643