



- **Future Solar Developments Inc.**

Acoustic Assessment Report

Type of Document
Final

Project Name
Acoustic Assessment Report LP#5

Project Location
8338 Scotchmere Drive, Strathroy-Caradoc, ON

Project Number
WSL-00002250-A0

Prepared By:

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Acoustic Assessment Report, LP# 5
8338 Scotchmere Drive, Strathroy-Caradoc, ON

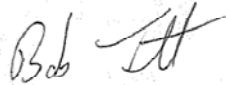
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Executive Summary

Exp services Inc. (**exp**) was retained by Future Solar Developments Inc. to conduct an acoustic assessment for a proposed solar facility that will be installed on the site located at 8338 Scotchmere Drive in the Township of Strathroy-Caradoc (herein referred to as the “Site”). The assessment was required for a Renewable Energy Approval for a Type 3 solar panel project under O.Reg. 359/09, Renewable Energy Approvals Under Part V.0.1 of the Act as amended by O.Reg. 521/10 and O.Reg. 231/11.

The proposed facility would comprise of a solar panel array, ground mounts for the array, twenty (20) Aurora PV Inverters (model PVI-5000-OUTD-US) to convert Direct Current (DC) energy harvested by the panels to Alternating Current (AC), and one (1) transformer to step-up the power to enable feed into the Hydro One distribution system.

The proposed facility is to be located at 8338 Scotchmere Drive in the Township of Strathroy-Caradoc in Ontario, on the northern side of Scotchmere Drive. The solar equipment is to be located to the west of the existing property buildings (see Site plans in Appendix A).

In addition to project LP#5, an identical operation (LP#6) is proposed for this address. It is the understanding of exp that LP#5 and LP#6 are intended to have separate feeds into the power distribution network and are to be considered as two separate projects. Due to the proximity of the proposed operations, the potential noise impact of both proposed facilities operating simultaneously has been assessed within this report.

The noise assessment conducted and reported below was based on MOE guidance documentation (“Basic Comprehensive Certificates of Approval (Air) – User Guide”, MOE, 2004). The following summary presents results, conclusions, and recommendations:

Equipment to be operated at the site that has the potential to give rise to environmental noise is limited to twenty (20) inverters and one (1) transformer. The operation of solar panels does not give rise to environmental noise.

The critical noise receptors have been identified as permanent residences. Point of Reception 1 (POR1) is located approximately 280 m south of the Site on the south side of Scotchmere Drive, POR2 is located approximately 310 m southwest of the Site on the north side of Scotchmere Drive and POR 3 is located approximately 370 m east of the Site south of Scotchmere Drive. Reported distances are between noise sources and the reception property boundary; this distance is less than the distance between the sources and any point 30 m from the POR dwelling as defined in Section 7 of NPC-232.

Potential noise impact from operation of the solar facility on the critical receptors was calculated and assessed versus criteria detailed in MOE NPC-232.

Solar facilities operate during daylight hours, the earliest sunrise at the Site is approximately 5:45 am and the latest sunset is approximately 9:10 pm. As such, it is appropriate to evaluate the project against MOE daytime (07:00 – 19:00), evening (19:00 – 23:00) and nighttime (23:00 – 07:00) hours.

Simultaneous operation of stationary sources, including stationary sources associated with the proposed adjacent solar facility LP#6, results in a calculated maximum noise impact of 23 dBA at the permanent residence receptors POR 1 and POR2; and 20 dBA at POR3 (residential receptor). As the calculated worst predictable case noise impacts are significantly lower than the applicable MOE exclusionary limits of 45 / 40 / 40 dBA for daytime / evening /nighttime periods respectively, it is concluded that the proposed facility would be in compliance with MOE noise criteria.

This executive summary is a brief summary of the report and should not be used as substitute for reading the report in its entirety.

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1 Introduction

Exp services Inc. (**exp**) was retained by Future Solar Developments Inc. to prepare an acoustic assessment report (AAR) for a proposed solar facility on the site located at 8338 Scotchmere Drive in the Township of Strathroy-Caradoc (herein referred to as the “Site”). The assessment was required for a Type 3 solar panel project under O.Reg. 359/09, Renewable Energy Approvals under Part V.0.1 of the Act as amended by O.Reg. 521/10 and O.Reg. 231/11.

The proposed facility would comprise of a solar panel array, ground mounts for the array, twenty (20) Aurora PV Inverters (model PVI-5000-OUTD-US) to convert DC energy harvested by the panels to AC, and one (1) transformer to step-up the power to enable feed into the Hydro One distribution system.

The proposed facility is to be located at 8338 Scotchmere Drive in the Township of Strathroy-Caradoc in Ontario, on the northern side of Scotchmere Drive. The solar equipment is to be located to the west of the existing property buildings (see Site plans in Appendix A).

In addition to project LP#5, an identical operation (LP#6) is proposed for this address. It is the understanding of exp that LP#5 and LP#6 are intended to have separate feeds into the power distribution network and are to be considered as two separate projects. Due to the proximity of the proposed operations, the potential noise impact of both proposed facilities operating simultaneously has been assessed within this report.

The proposed project is considered a Type 3 Renewable Energy Project as it would have a maximum name plate capacity greater than 12 kW. The electricity produced by the solar facility is intended to be fed into a local Hydro One distribution line. Equipment to be installed at the facility complies with the Ontario manufactured percentages as required by the Ontario Power Authority's Feed-in-Tariff Program.

This report assesses noise arising from identified sources, details the anticipated impact on the nearest receptors, and evaluates the calculated impact versus MOE criteria.

In accordance with legislative requirements, a copy of this report is to be made available to interested parties including the public and the local municipality at least 60 days prior to the final public consultation meeting.

2 Facility Description

The proposed facility consists of a ground-mounted solar array that will produce electricity from the sun's energy. The direct current generated by the solar array will be converted into alternating current and transformed to enable power to be fed into the Hydro One Network.

The proposed solar array will be attached to mounts on concrete blocks installed in the ground and will occupy an area of approximately 66 by 37 metres. As such the facility represents a fixed system and therefore the array will not produce any noise (c.f. sun tracking arrays). The associated inverters and transformer will be located to the west side of the solar array (south of the existing farm buildings).

The surrounding land use to the south, north and west is designated as General Agriculture (A1). Zoning maps have been included in Appendix A, as well as Site Plan Aerial maps which show details of the surrounding properties. Given the existing land use and land use in the surrounding area, the project is considered to be in a rural environment. Whilst background sound measurements have not been taken in support of this assessment, the acoustical environment is expected to be dominated by natural sounds as the closest significant roads are Adelaide Road approximately 2 km from the Site and Highway 402 approximately 3 km from the Site.

Solar facilities operate during daylight hours, the earliest sunrise at the Site is approximately 5:45 am and the latest sunset is approximately 9:10 pm. As such, it is appropriate to evaluate the project against MOE daytime (07:00 – 19:00), evening (19:00 – 23:00) and night-time (23:00 – 07:00) hours.

3 Noise Source Summary

The locations of all noise sources can be found in the Site Location Aerial Maps (Appendix A).

3.1 Noise Sources

The following noise sources were identified:

- Twenty (20) Aurora PV Inverters (model PVI-5000-OUTD-US) located west of the farm buildings; and,
- One (1) oil-filled step-up transformer (make and model to be confirmed) located adjacent to the inverter.

The proposed solar array is a fixed system and therefore does not include motors etc. as required with tracking systems.

3.2 Road Traffic

Other than construction traffic, the proposed renewable energy project will result in minimal increase in on-site road traffic associated with troubleshooting / maintenance visits as required. As such visits will be infrequent, road traffic noise associated with the proposed project is considered negligible.

3.3 Technical Information – Sources

Table 1 summarizes the specifications and locations of each significant stationary noise source of the proposed renewable solar energy project:

Table 3.1. Technical Information and Locations of Noise Source

| ID | Description | Location | Make | Model # | Rating |
|-----------------|-------------|--|-----------------|------------------|-----------------|
| I01 – I20 | Inverters | West of farm buildings, 8338 Strathroy Drive, Strathroy-Caradoc, ON. Detailed location indicated on map in Appendix A. | Aurora | PVI-5000-OUTD-US | 5000 W |
| T01 | Transformer | Adjacent to inverter | To Be Confirmed | To Be Confirmed | To Be Confirmed |

The planned locations of significant noise sources are provided in Figure 1 and approximate co-ordinates are provided in Table 5, Appendix B.

4 Points of Reception

Points of Reception for the approval of new sources, including verifying compliance with the Environmental Protection Act, are defined in Publication NPC-205¹ as premises in use, or zoned for future use, as:

- Permanent or seasonal residences;
- Hotels/motels
- Nursing/retirement homes;
- Rental residences;
- Hospitals;
- Camp grounds; and,
- Noise sensitive buildings such as schools and places of worship.

The closest points of reception to the project LP5 are located approximately 280 m, 310 m and 370 m from the project. Other receptors are located >500 m from the proposed project location. Below is a description of each point of reception. The points of reception have been taken as the property boundary for each receptor; this results in a distance lower than that between the sources and a point within 30 m of a dwelling or a camping area as stipulated in Section 7 of NPC-232.

POR1: Located approximately 280 metres south of the project noise sources. It is a residential and agricultural property, with a house and a barn located south of Scotchmere Drive. Source to receptor separation distances based on planned equipment locations are provided in Table 3, Appendix B.

POR2: Located approximately 310 metres south of the project noise sources. It is a residential property located north of Scotchmere Drive. Source to receptor separation distances based on planned equipment locations are provided in Table 3, Appendix B.

POR3: Located approximately 370 metres east of the project noise sources. The point of reception comprises of two adjacent residential properties located south of Scotchmere Drive. Source to receptor separation distances based on planned equipment locations are provided in Table 3, Appendix B.

5 Assessment Criteria (Performance Limits)

The subject property is located in the Township of Strathroy-Caradoc, a rural area (Class 3 Area). Criteria for assessing the impact of noise from stationary sources are provided in the MOE Publication NPC-232 (Sound Level Limits for Stationary Sources in Class 3 Areas (Rural), October 1995, Ministry of the Environment):

NPC-232 Table 232-1: Minimum Values of One Hour L_{eq} or L_{lm} by Time of Day

| | One Hour L_{eq} (dBA) or L_{LM} (dBA) |
|---------------|---|
| Time of Day | Class 3 Area |
| 07:00 – 19:00 | 45 |
| 19:00 – 23:00 | 40 |
| 23:00 – 07:00 | 40 |

Dependent on day of the year, the facility may generate electricity between 5:45 and 21:10. Both POR1 and POR2 are located in Class 3 areas where background noise is anticipated to be dominated by natural sounds. Therefore, the appropriate limits for total equipment operation are the MOE exclusionary limits of 45 dBA / 40 dBA (Class 3 Area, 07:00 – 19:00 (daytime operation) / 19:00 – 7:00 (evening and nighttime operation)).

6 Impact Assessment

Noise produced by the inverters was assessed by using the sound rating given in the manufacturer's specifications for the unit. The inverter manufacturer's specifications are provided in Appendix C.

In the absence of a selected make and model number, noise produced by the transformer was assessed based on data published in Table 0.3 of NEMA Standards Publication No. TR 1-1993 (R2000). The transformer size was conservatively assumed to be in the range 101 – 300 kVA (expected size is 100 kVA).

As the noise producing stationary sources at the facility are limited to twenty (20) identical inverters and one (1) transformer, a simple assessment considering only attenuation due to geometric divergence using procedures detailed in ISO 9613 Part 2 has been conducted. This method of assessment is expected to produce a conservative estimate of noise impact as no consideration is given to attenuation through ground absorption, atmospheric absorption or barrier effects.

The predicted sound levels at the selected PORs due to operation of each noise source are summarized in Table 3 (Appendix B). Distances between each source and POR are also provided in this table.

Sample calculations are provided in Appendix D and an Acoustic Assessment Summary Table is provided as Table 4 in Appendix B.

Consideration of additional solar facilities known to be planned within 500 m of POR1, POR2 and POR3 is provided in Section 7. The combined noise impact due to all of these known proposed solar facilities in simultaneous operation is summarized below.

7 Impact of Known Additional Planned Solar Facilities

Exp has been requested to conduct a noise assessment of an additional proposed solar facility, Project LP#6, to be located adjacent to LP#5. Implementation of both LP#5 and LP#6 would result in the operation of stationary noise sources in addition to those identified above with the potential to impact the points of reception discussed in this report. To determine the predictable worst case noise impact, the potential noise arising from simultaneous operation of all stationary sources associated with proposed solar facilities located in and around 8338 Scotchmere Drive in the Township of Strathroy-Caradoc has been calculated at critical points of reception:

Combined Impact Summary Table

| POR ID | POR Description | Time of Day | Sound Level at POR due to LP#5 (dBA) | Sound Level at POR due to LP#6 (dBA) | Total sound level at POR (dBA) | Performance Limit (dBA) Leq | Compliance with Performance Limit (Yes/No) |
|--------|---------------------|---------------|--------------------------------------|--------------------------------------|--------------------------------|-----------------------------|--|
| POR1 | Permanent residence | Day | 20 | 21 | 23 | 45 | Yes |
| | | Evening/night | 20 | 21 | 23 | 40 | Yes |
| POR2 | Permanent residence | Day | 19 | 20 | 23 | 45 | Yes |
| | | Evening/night | 19 | 20 | 23 | 40 | Yes |
| POR3 | Permanent residence | Day | 17 | 16 | 20 | 45 | Yes |
| | | Evening/night | 17 | 16 | 20 | 40 | Yes |

8 Proposed Noise Control Measures

Noise control measures are not necessary for this renewable energy project since the noise resulting from the operation of the solar panels results in a noise level below the MOE exclusionary limits for daytime, evening and nighttime operation.

9 Conclusions

It is concluded that operation of stationary sources associated with Project LP#5 at the Site located at 8338 Scotchmere Drive, in the Township of Strathroy-Caradoc, Ontario would result in noise levels at critical points of reception that are below MOE exclusionary limits for a Class 3 Area.

It is further concluded that, with respect to noise impact, operation of the proposed site would be compatible with existing land use planning guidance.

Simultaneous operation of the facility with the additional planned solar facility, LP#6, at 8338 Scotchmere Drive would result in noise levels at critical points of reception that are below MOE exclusionary limits for a Class 3 Area.

10References

1. International Organization for Standardization, ISO 9613-2: *Acoustics – Attenuation of Sound During Propagation Outdoors Part 2: General Method of Calculation*, Geneva, Switzerland, 1996.
2. Ontario Ministry of the Environment, *Publication NPC-232: Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)*, October 1995.
3. Ontario Ministry of the Environment, *Publication NPC-233: Information to be Submitted for Approval of Stationary Sources of Sound*, October 1995.
4. Ontario Ministry of the Environment, *Model Municipal Noise Control by-Law Publication NPC-103*, August 1978.
5. Ontario Ministry of the Environment, *Model Municipal Noise Control By-Law Publication NPC-104*, August 1978.
6. Ontario Ministry of the Environment, Environmental Assessment and Approvals Branch, *Basic Comprehensive Certificates of Approval (Air) User Guide Version 2.0*, April 2004.

11 Limitations

The objective of this report was to assess noise impact from operation of equipment and processes within the context of our contract with respect to existing Regulations and Guidelines within the applicable jurisdiction. Compliance of past and current owners with applicable local, provincial and federal government laws and regulations was not included in our contract for services.

The conclusions of this report are based, in part, on the information provided by others and any testing and analyses described in the report. The possibility remains that unexpected environmental conditions may be encountered. Should such an event occur, **exp** should be notified in order that we may determine if modifications to our conclusions are necessary.

This report has been prepared for the exclusive use of Future Solar Developers Inc. in accordance with accepted environmental study and/or engineering practices for a Noise Study. No other warranties, either expressed or implied, are made as to the professional services provided under the terms of the Survey and included in this report. Any use which a third party makes of this report, or any part hereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Appendix A – Figures



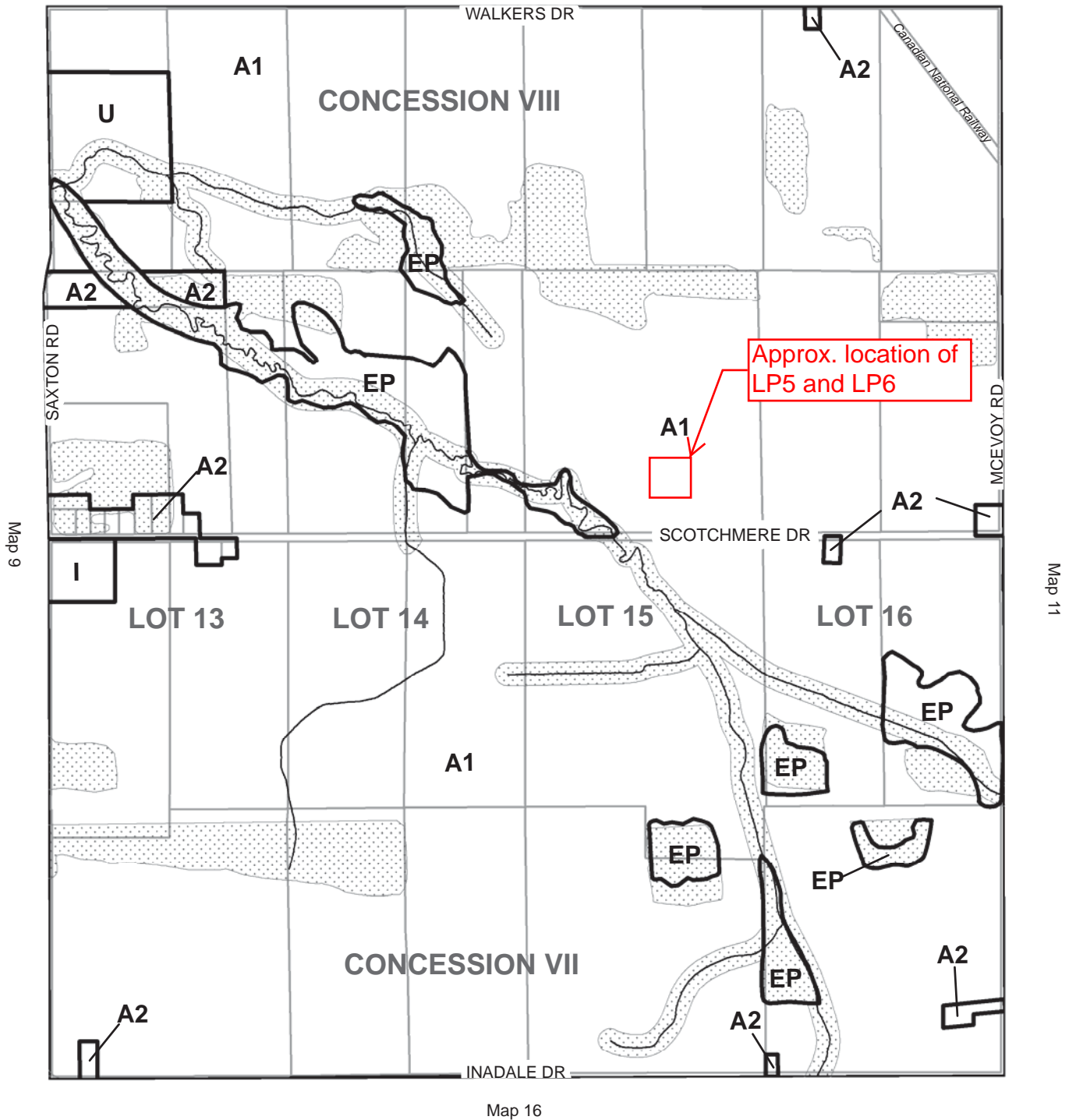
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Drawing Title: Site Plan Closest Receptors LP5
Prepared By: Rebecca Orth
Date: February 2012
Project No.: WSL-00002250-00

Acoustic Assessment, LP5
Future Solar Developments Inc.
8-3400 Pharmacy Ave.
Scarborough, Ontario M1W 3J8

Map 4




Map 16



MUNICIPALITY OF STRATHROY-CARADOC BY-LAW No. 43-08

LEGEND

 Natural Environment Overlay

1:15,000

0 150 300 600

Metres



SCHEDULE 'A'
MAP #10

KEY PLAN



NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F1
CONNECTION VOLTAGE: 4.8kv

NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F1
CONNECTION VOLTAGE: 4.8kV



PRELIMINARY
NOT FOR CONSTRUCTION





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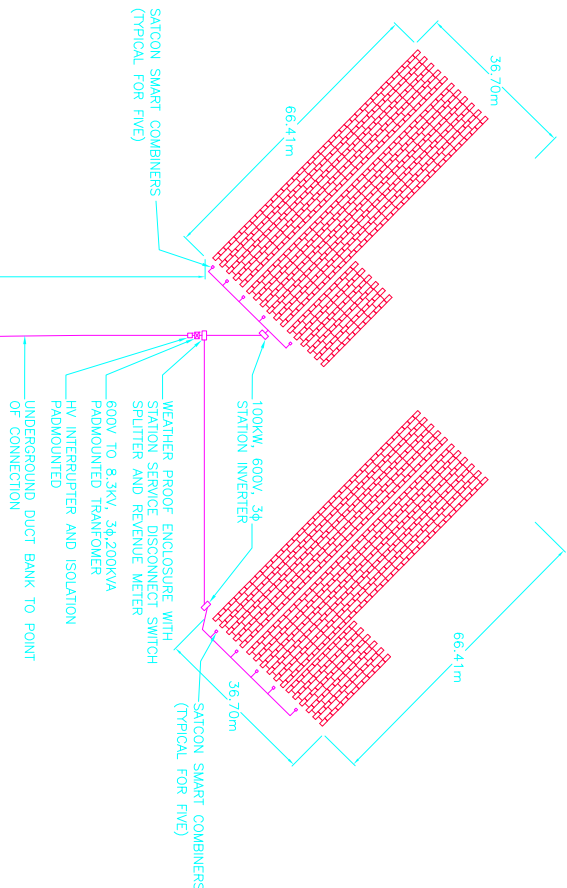
DRAFT



KEY PLAN

LEGEND

-  POINT OF CONNECTION
 PROPERTY LIMIT
 APPROX. SCSRA REGULATION BOUNDARY
 APPROX. PROVINCIAL WETLAND BOUNDARY



LP 5 STATISTICS:

NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F1
CONNECTION VOLTAGE: 4.8kV

LP 6 STATISTICS:

NUMBER OF MODULES: 507
NUMBER OF MODULES PER STRING: 13
NUMBER OF STRINGS: 39
PANEL TYPE: CANADIAN SOLAR CS6P-230
FEEDER NAME: F1
CONNECTION VOLTAGE: 4.8kV

SCOTCHMERE DRIVE

NOTE: AERIAL IMAGERY, TOPOGRAPHIC INFORMATION, AND PROPERTY LIMITS SHOWN AS SUPPLIED BY FIRST BASE SOLUTIONS.

NOTES

THE POSITION OF ALL POLE LINES, CONDUTTS, WATERMANS, MESSENGERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

PRELIMINARY
NOT FOR CONSTRUCTION

[illegible]

| | | | | | |
|-------------------|--------------------|--|-------------------------|---|----------------------------|
| DRAWING BY | APPROVED BY | CLIENT | MODIFY | PROJECT | PLOT NO. |
| | | FUTURE SOLAR DEVELOPMENTS INC. 3400 PHARMACY AVE., SCARBOROUGH, ON HAWERSCHELAG + JOFFE INC. 681 Second Street North, Toronto, Ontario M5B 2T9 Tel: (416) 444-1463 E: shawn@hjw.com | K/H S/SW J/W | 9274 UNION DR., STRATHROY, ON | 311-680 |
| | | | S/C POLY SWD B.B. | PRELIMINARY SITE PLAN LP5 & LP6 | |
| | | | DO REFR | | |
| | | | | | DATE OCT 7, 2011 |
| | | | | | DRAWING NO. ES-2 |

Appendix B – Tables

Table 1: Noise Summary Table

| Source | Sound Power Level (dBA) | Location | Sound Characteristics | Existing Noise Control Measures |
|-----------------------------|--------------------------------|-----------------|------------------------------|--|
| I01 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I02 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I03 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I04 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I05 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I06 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I07 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I08 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I09 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I10 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I11 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I12 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I13 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I14 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I15– Aurora PVI | 66.0 ^a | O | S, T | U |
| I16 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I17 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I18– Aurora PVI | 66.0 ^a | O | S, T | U |
| I19 – Aurora PVI | 66.0 ^a | O | S, T | U |
| I20 – Aurora PVI | 66.0 ^a | O | S, T | U |
| Transformer (liquid filled) | 71.0 ^a | O | S, T | U |

^a A 5 dB penalty has been applied to these sources as required by the MOE publication NPC 104, and included in the Sound Power Level provided in this table.

| Location | Sound Characteristics | Existing Noise Control Measures |
|---|---|---|
| O – Outside building I – Inside building | S – Steady QSI – quasi-steady impulsive I – Impulsive B – Buzzing T – Tonal C – Cyclic | S – Silencer A – Acoustic Lining B – Barrier L - Lagging E – Enclosure O – Other U – Uncontrolled |

Table 2: Performance Limits Summary Table

| Point of Reception ID | MOE Designation | Performance Limit (dBA) | |
|-----------------------|-----------------|-------------------------|----------------------|
| | | Day-time | Evening / Night-time |
| POR1 | Class 3 | 45 | 40 |
| POR2 | Class 3 | 45 | 40 |
| POR3 | Class 3 | 45 | 40 |

Table 3: Point of Reception Noise Impact Table

| Source ID | POR1 | | | POR2 | | | POR3 | | |
|------------------|------------------------------|----------------------|-------------------|------------------------------|----------------------|-------------------|------------------------------|----------------------|-------------------|
| | Distance ^a (m) | Sound Level (dBA) | | Distance ^a (m) | Sound Level (dBA) | | Distance ^a (m) | Sound Level (dBA) | |
| | | Day | Evening /Night | | Day | Evening /Night | | Day | Evening /Night |
| I01 – Aurora PVI | 275 | 6 | 6 | 305 | 5 | 5 | 376 | 4 | 4 |
| I02 – Aurora PVI | 275 | 6 | 6 | 305 | 5 | 5 | 375 | 4 | 4 |
| I03 – Aurora PVI | 275 | 6 | 6 | 305 | 5 | 5 | 374 | 4 | 4 |
| I04 – Aurora PVI | 275 | 6 | 6 | 305 | 5 | 5 | 373 | 4 | 4 |
| I05 – Aurora PVI | 275 | 6 | 6 | 306 | 5 | 5 | 372 | 4 | 4 |
| I06 – Aurora PVI | 276 | 6 | 6 | 306 | 5 | 5 | 376 | 4 | 4 |
| I07 – Aurora PVI | 276 | 6 | 6 | 306 | 5 | 5 | 375 | 4 | 4 |
| I08 – Aurora PVI | 276 | 6 | 6 | 306 | 5 | 5 | 374 | 4 | 4 |

| Source ID | POR1 | | | POR2 | | | POR3 | | |
|------------------|------------------------------|----------------------|-------------------|------------------------------|----------------------|-------------------|------------------------------|----------------------|-------------------|
| | Distance ^a (m) | Sound Level (dBA) | | Distance ^a (m) | Sound Level (dBA) | | Distance ^a (m) | Sound Level (dBA) | |
| | | Day | Evening /Night | | Day | Evening /Night | | Day | Evening /Night |
| I09 – Aurora PVI | 276 | 6 | 6 | 306 | 5 | 5 | 373 | 4 | 4 |
| I10 – Aurora PVI | 276 | 6 | 6 | 307 | 5 | 5 | 372 | 4 | 4 |
| I11 – Aurora PVI | 277 | 6 | 6 | 307 | 5 | 5 | 376 | 4 | 4 |
| I12 – Aurora PVI | 277 | 6 | 6 | 307 | 5 | 5 | 375 | 4 | 4 |
| I13 – Aurora PVI | 277 | 6 | 6 | 307 | 5 | 5 | 374 | 4 | 4 |
| I14 – Aurora PVI | 277 | 6 | 6 | 307 | 5 | 5 | 373 | 4 | 4 |
| I15 – Aurora PVI | 277 | 6 | 6 | 308 | 5 | 5 | 372 | 4 | 4 |
| I16 – Aurora PVI | 278 | 6 | 6 | 308 | 5 | 5 | 375 | 4 | 4 |
| I17 – Aurora PVI | 278 | 6 | 6 | 308 | 5 | 5 | 374 | 4 | 4 |
| I18 – Aurora PVI | 278 | 6 | 6 | 308 | 5 | 5 | 373 | 4 | 4 |
| I19 – Aurora PVI | 278 | 6 | 6 | 308 | 5 | 5 | 372 | 4 | 4 |
| I20 – Aurora PVI | 278 | 6 | 6 | 309 | 5 | 5 | 371 | 4 | 4 |
| T01 | 245 | 11 | 11 | 310 | 10 | 10 | 369 | 9 | 9 |

^a Calculated distances are based on best available data regarding source locations.

Table 4: Acoustic Assessment Summary Table

| POR ID | POR Description | Time of Day | Sound Level at POR (dBA) | Verified by Acoustic Audit? (Yes/No) | Performance Limit (dBA) Leq | Compliance with Performance Limit (Yes/No) |
|--------|---------------------|----------------|--------------------------|--------------------------------------|-----------------------------|--|
| POR1 | Permanent residence | Day | 20 | No | 45 | Yes |
| | | Evening/ night | 20 | No | 40 | Yes |
| POR2 | Permanent | Day | 19 | No | 45 | Yes |

| POR ID | POR Description | Time of Day | Sound Level at POR (dBA) | Verified by Acoustic Audit? (Yes/No) | Performance Limit (dBA) Leq | Compliance with Performance Limit (Yes/No) |
|--------|---------------------|----------------|--------------------------|--------------------------------------|-----------------------------|--|
| | residence | Evening/ night | 19 | No | 40 | Yes |
| POR3 | Permanent residence | Day | 17 | No | 45 | Yes |
| | | Evening/ night | 17 | No | 40 | Yes |

Table 5: Source and Receptor Co-ordinates

| Item | Identifier | UTM Easting ¹ | UTM Northing |
|----------|------------|--------------------------|--------------|
| Source | I01 | 453424 | 4754788 |
| | I02 | 453425 | 4754788 |
| | I03 | 453426 | 4754788 |
| | I04 | 453427 | 4754788 |
| | I05 | 453428 | 4754788 |
| | I06 | 453424 | 4754789 |
| | I07 | 453425 | 4754789 |
| | I08 | 453426 | 4754789 |
| | I09 | 453427 | 4754789 |
| | I10 | 453428 | 4754789 |
| | I11 | 453424 | 4754790 |
| | I12 | 453425 | 4754790 |
| | I13 | 453426 | 4754790 |
| | I14 | 453427 | 4754790 |
| | I15 | 453428 | 4754790 |
| | I16 | 453424 | 4754791 |
| | I17 | 453425 | 4754791 |
| | I18 | 453426 | 4754791 |
| | I19 | 453427 | 4754791 |
| | I20 | 453428 | 4754791 |
| | T01 | 453430 | 4754792 |
| Receptor | POR1 | 453466 | 4754516 |
| | POR2 | 453348 | 4754493 |
| | POR3 | 453797 | 4754834 |

¹ Zone 17

Appendix C – Manufacturer's Data

PVI-5000-OUTD-US PVI-6000-OUTD-US

GENERAL SPECIFICATIONS OUTDOOR MODELS

Designed for residential and small commercial PV installations, this inverter fills a specific niche in the Aurora product line to cater for those installations producing between 5kW and 20kW.

This inverter has all the usual Aurora benefits, including dual input section to process two strings with independent MPPT, high speed and precise MPPT algorithm for real-time power tracking and energy harvesting, as well as transformerless operation for high performance efficiencies of up to 97.1%.

The wide input voltage range makes the inverter suitable to low power installations with reduced string size. This outdoor inverter has been designed as a completely sealed unit to withstand the harshest environmental conditions.

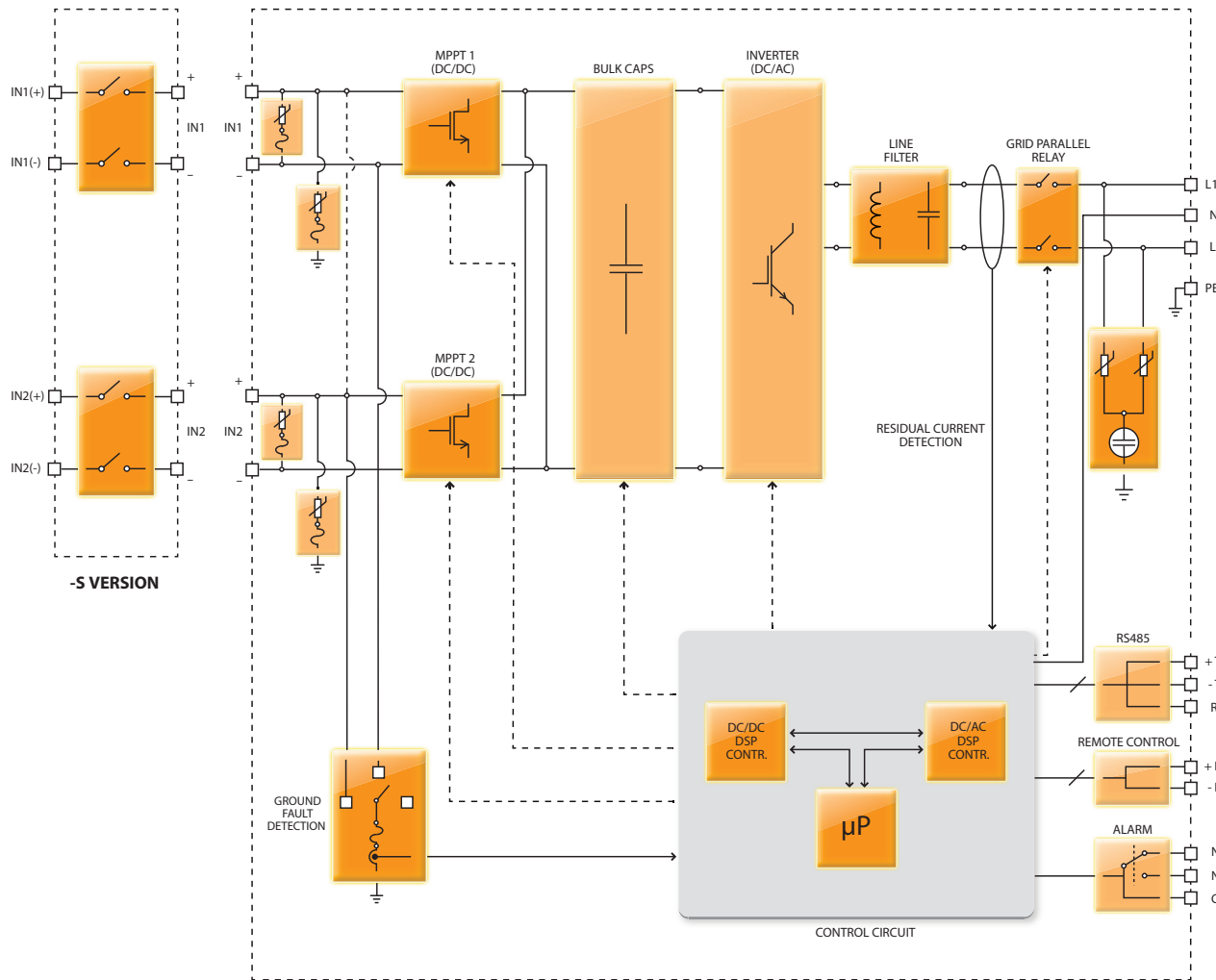


AURORA UNO

Features

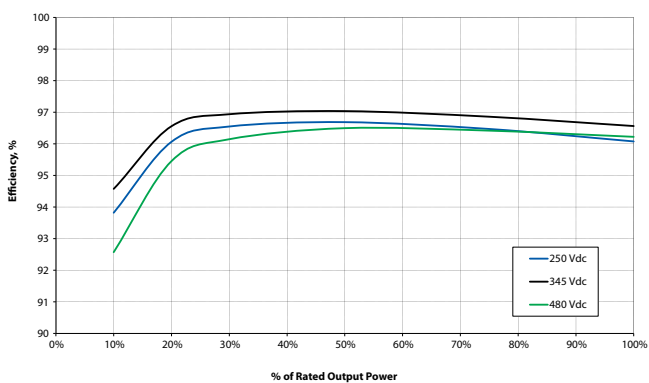
- Each inverter is set on specific grid codes which can be selected in the field
- Single phase output
- Dual input sections with independent MPP tracking, allows optimal energy harvesting from two sub-arrays oriented in different directions
- Wide input range
- High speed and precise MPPT algorithm for real time power tracking and improved energy harvesting
- Flat efficiency curves ensure high efficiency at all output levels ensuring consistent and stable performance across the entire input voltage and output power range
- Outdoor enclosure for unrestricted use under any environmental conditions
- RS-485 communication interface (for connection to laptop or datalogger)
- Compatible with PVI-RADIOMODULE for wireless communication with Aurora PVI-DESKTOP

BLOCK DIAGRAM OF PVI-5000-OUTD AND PVI-6000-OUTD FOR NORTH AMERICA

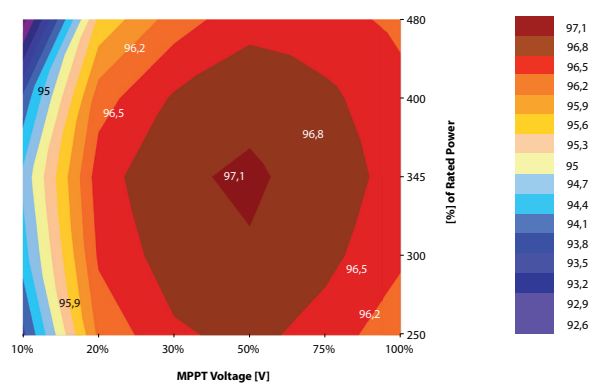


Block Diagram and Efficiency Curves

PVI-6000-OUTD-US



PVI-6000-OUTD-US



| PARAMETER | PVI-5000-OUTD-US | | | PVI-6000-OUTD-US | | |
|--|--|-------------|-------------|---|-------------|-------------|
| Input Side | | | | | | |
| Absolute Maximum DC Input Voltage (V _{max,abs}) | 600 V | | | | | |
| Start-up DC Input Voltage (V _{start}) | 200 V (adj. 120...350 V) | | | | | |
| Operating DC Input Voltage Range (V _{dcmín...V_{dcmax}}) | 0.7 x V _{start} ...580 V | | | | | |
| Rated DC Input Power (P _{dcr}) | 5150 W | | | 6180 W | | |
| Number of Independent MPPT | 2 | | | | | |
| Maximum DC Input Power for each MPPT (P _{MPPTmax}) | 4000 W | | | | | |
| DC Input Voltage Range with Parallel Configuration of MPPT at P _{acr} | 200...530 V | | | | | |
| DC Power Limitation with Parallel Configuration of MPPT | Linear Derating From MAX to Null [530V≤V _{MPPT} ≤580V] | | | | | |
| DC Power Limitation for each MPPT with Independent Configuration of MPPT at P _{acr} , max unbalance example | 4000 W [225V≤V _{MPPT} ≤530V] the other channel: P _{dcr} -4000W [90V≤V _{MPPT} ≤530V] | | | 4000 W [230V≤V _{MPPT} ≤530V] the other channel: P _{dcr} -4000W [120V≤V _{MPPT} ≤530V] | | |
| Maximum DC Input Current (I _{dcmáx}) / for each MPPT (I _{MPPTmax}) | 36.0 A / 18.0 A | | | | | |
| Maximum Input Short Circuit Current for each MPPT | 22.0 A | | | | | |
| Number of DC Inputs Pairs for each MPPT | 1 | | | | | |
| DC Connection Type | Screw Terminal Block, 3 Knock-Outs: 1 ½" or 1" (w/ Ring Reducer) | | | | | |
| Input Protection | | | | | | |
| Reverse Polarity protection | Yes, from limited current source | | | | | |
| Input Over Voltage Protection for each MPPT - Varistor | 2 | | | | | |
| Photovoltaic Array Isolation Control | GFDI (for use with either Positive or Negative Grounded Arrays) | | | | | |
| DC Switch Rating for each MPPT (-S Version) | 25 A / 600 V | | | | | |
| Output Side | | | | | | |
| AC Grid Connection Type | 208 V | 240 V | 277 V | 208 V | 240 V | 277 V |
| Rated AC Power (P _{acr}) | 5000 W | | | 6000 W | | |
| Maximum AC Output Power (P _{acmáx}) | 5000 W | | | 6000 W | | |
| Rated AC Grid Voltage (V _{acr}) | 208 V | 240 V | 277 V | 208 V | 240 V | 277 V |
| AC Voltage Range | 183...228 V | 211...264 V | 244...304 V | 183...228 V | 211...264 V | 244...304 V |
| Maximum AC Output Current (I _{ac,máx}) | 27.0 A | 23.0 A | 20.0 A | 30.0 A | 28.0 A | 24.0 A |
| Rated Output Frequency (f _r) | 60 Hz | | | | | |
| Output Frequency Range (f _{mín...f_{máx}}) | 59.3...60.5 Hz | | | | | |
| Nominal Power Factor (Cosphi _{acr}) | > 0.995 | | | | | |
| Total Current Harmonic Distortion | < 2% | | | | | |
| AC Connection Type | Screw terminal block | | | | | |
| Output Protection | | | | | | |
| Anti-Islanding Protection | 208 V | 240 V | 277 V | 208 V | 240 V | 277 V |
| Maximum AC Overcurrent Protection | 35.0 A | 30.0 A | 25.0 A | 40.0 A | 35.0 A | 30.0 A |
| Output Overvoltage Protection - Varistor | 2 (L1 - L2 / L1 - PE) | | | | | |
| Operating Performance | | | | | | |
| Maximum Efficiency (η _{máx}) | 208 V | 240 V | 277 V | 208 V | 240 V | 277 V |
| Weighted Efficiency (EURO/CEC) | 96.0% | 96.5% | 96.5% | 96.0% | 96.5% | 96.5% |
| Feed In Power Threshold | 20.0 W | | | | | |
| Stand-by Consumption | < 8.0 W | | | | | |
| Communication | | | | | | |
| Wired Local Monitoring | PVI-USB-RS485_232 (opt.), PVI-DESKTOP (opt.) | | | | | |
| Remote Monitoring | PVI-AEC-EVO (opt.), AURORA-UNIVERSAL (opt.) | | | | | |
| Wireless Local Monitoring | PVI-DESKTOP (opt.) with PVI-RADIOMODULE (opt.) | | | | | |
| User Interface | 16 characters x 2 lines LCD display | | | | | |
| Environmental | | | | | | |
| Ambient Temperature Range | -25...+60°C (-13...+ 140°F) with derating above 50°C (122°F) | | | | | |
| Relative Humidity | 0...100% condensing | | | | | |
| Noise Emission | <50 db(A) @ 1 m | | | | | |
| Maximum Operating Altitude without Derating | 2000 m / 6560 ft | | | | | |
| Physical | | | | | | |
| Environmental Protection Rating | IP 65 | | | | | |
| Cooling | Natural | | | | | |
| Dimension (H x W x D) | 1052mm x 325mm x222mmm / 41.4" x 12.8" x 8.7" | | | | | |
| Weight | < 27.0 kg / 59.5 lb | | | | | |
| Mounting System | Wall bracket | | | | | |
| Safety | | | | | | |
| Isolation Level | Transformerless | | | | | |
| Marking | cCSAus | | | | | |
| Safety and EMC Standard | UL 1741, CSA - C22.2 N. 107.1-01 | | | | | |
| Grid Standard | IEEE 1547 | | | | | |
| Available Products Variants | | | | | | |
| With DC Switch | PVI-5000-OUTD-US | | | PVI-6000-OUTD-US | | |



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Appendix D –Calculations

Calculation of Sound Power Levels

Inverter

Aurora PVI specifications indicate a sound pressure level of <50 dB(A) at a distance of 1 m. Sound power level for the inverter has been calculated using the following equation:

$$L_w = L_p - \log(d_r/d_t) + 11$$

Where:

L_w = sound power (dBA)

d_r = Reference distance (1 m)

d_t = Test distance

$$L_w = 51 - \log(1/1) + 11 = 61.0 \text{ dB(A)}$$

In the absence of frequency spectra for the inverter it has been assumed that noise from the inverter is tonal and a 5 dB penalty has therefore been applied as required by Section 4 of NPC-104.

Transformer

In the absence of a transformer make and model number, sound pressure has been calculated using data published in NEMA TR 1 – 1993 (R2000) Table 0.3. From Table 0.3, for an immersed transformer:

| Transformer Size | Average Sound Pressure (at ≤ 1 m) |
|------------------|--|
| 51 – 100 kVA | 51 dB |
| 101 – 300 kVA | 55 dB |

Anticipated transformer size is 100 kVA, as this size is at the limit of a size range the average sound pressure (at ≤ 1 m) for the next highest size range has been conservatively applied. The sound power level for the transformer has been calculated using the following equation:

$$L_w = L_p - \log(d_r/d_t) + 11$$

Where:

L_w = sound power (dBA)

d_r = Reference distance (1 m)

d_t = Test distance

$$L_w = 55 - \log(1/1) + 11 = 66.0 \text{ dB(A)}$$

In the absence of frequency spectra for the inverter it has been assumed that noise from the transformer is tonal and a 5 dB penalty has therefore been applied as required by Section 4 of NPC-104.

Sound Pressure Levels

Sound pressure levels have been calculated conservatively assuming that sound attenuation between the source and the PORs was due solely to geometric divergence (atmospheric absorption, barriers and absorptive ground were not taken into consideration).

The on-site road traffic associated to the renewable energy project will be restricted to occasional visits for maintenance or engineering purposes. As such traffic will be infrequent and so excluded as per Annex to Publication NPC-232 section A.3 (2).

The following equations were employed to calculate sound pressure at points of reception from source power levels including attenuation due to geometric divergence only (from ISO 9613 (Part 2)) and to calculate the total sound pressure level at points of reception due to operation of multiple stationary sources:

$$Lp2 = Lp1 - 20 \log \left(\frac{d}{do} \right)$$

Where:

do = reference distance (1 m)

d = distance between source and receptor

$Lp1$ = Sound pressure level at do

$Lp2$ = Sound pressure level at d

$$L_{tot} = 10 \log \left(\sum_{i=1}^n \text{antilog} \frac{Ln}{10} \right)$$

Where:

L_{tot} = total sound pressure at POR for all sources

Ln = sound pressure level at POR from source n

Example Calculations:

I01 – Inverter is located 275 m from POR1 and generates a sound pressure of <50 dBA at a distance of 1 m (manufacturer's specifications). In the absence of frequency data a penalty of 5 dBA has been applied for possible tonality.

Sound pressure at 1 m = 55 dBA

$$Lp2 = Lp1 - 20 \log \left(\frac{d}{do} \right)$$

$$Lp2 = 55 - 20 \log \left(\frac{275}{1} \right) = 6.2$$

As each inverter generates the same sound pressure level at 1 m and is approximately the same distance from POR1:

$$L_{tot} = 10 \log \left(\sum_{i=1}^n \text{antilog} \frac{Ln}{10} \right)$$

$$L_{tot} = 10 \log \left(20 \left(\text{antilog} \frac{6.2}{10} \right) + \text{antilog} \frac{11.1}{10} \right) = 20$$

Tables 3 and 4 in Appendix B summarize results obtained through application of the above equations.