GRAND RENEWABLE ENERGY PARK

SOLAR PARK — NOISE ASSESSMENT REPORT

Revision 3

For

Grand Renewable Solar LP

David Oxtoby

Zephyr North Ltd.

850 LEGION ROAD UNIT 20
BURLINGTON ON L7S 1T5
CANADA

Phone: 905-335-9670
Fax: 905-335-0119
Internet: Info@ZephyrNorth.com

By

J.R. Salmon
S.J. Corby

2013 September 5

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

This Report was prepared by Zephyr North Ltd. of Burlington Ontario Canada as an account of work sponsored by Grand Renewable Solar LP. Neither Zephyr North Ltd. nor any person acting on its behalf:

(a) Makes any warranty or representation whatsoever, express or implied, (i) with respect to the use of any information, apparatus, method, process, or similar item disclosed in this report, including merchantability and fitness for a particular purpose, or (ii) that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or (iii) that this report is suitable to any particular user's circumstance, or

(b) Assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Zephyr North Ltd. or its representatives have been advised of the possibility of such damages) resulting from your selection or use of this report or any information, apparatus, method, process or similar item disclosed in this report.

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

1.1 Purpose

This Noise Assessment Report (NAR) describes the results of an amended noise impact study for the Solar Park component of Grand Renewable Solar LP's proposed Grand Renewable Energy Park (GREP-Solar). Amongst other changes, it documents updates to the size and number of inverter/transformer clusters enabled by employment of an inverter technology more efficient than that described in the original project design. The original Noise Assessment for the combined Solar and Wind Park components of the project are documented in Zephyr North (2012a, 2012b).

It is important to note that for the purposes of this report the solar portion (GREP-Solar) is considered to be a completely independent project from the wind portion (GREP-Wind) of the full Grand Renewable Energy Park (GREP).

1.2 Revision 0

Revision 0 was the original GREP-Solar Noise Assessment Report in which the Solar Park was treated as an independent project and the size and number of inverter/transformer clusters was updated. It applied to the Solar Park portion of the project and assumed that the Wind Park portion of the project (GREP-Wind) remained unchanged from that assessed previously and described in the documents cited above. However, it should be noted that updated turbine noise emission specifications for both the GREP-Wind and Summerhaven Wind Energy Centre were used for Revision 0.

Figure 1-1 Project location map.

1.3 Revision 1

Revision 1 included the following as requested by the Ontario Ministry of Environment (MoE) via email (2013-08-13).

Three sound pressure level columns (GREP (Wind and Solar), SWEC, Overall) were added to the concordance table (GREP (Wind and Solar) *v.* SWEC; Table 3-1, Section 3.5). Note that an updated description of the columns in Table 3-1 (including the additional columns) was included in Section 3.5 .

A request was made by Ontario MoE to "Please confirm these participating points of receptors (PORs) are for Grand Renewable Energy Park-Wind Park". This could not be confirmed as stated. The participating points of reception in the Revision 1 Noise Assessment Report and the previous revision (R0) were participants only in the GREP-Solar project, and not in the GREP-Wind project, unless a specific dwelling was a participant in *both* the GREP-Solar and GREP-Wind projects. Many of the GREP-Wind points of reception were too distant to be of relevance to this analysis.

A request was made by Ontario MoE to "Please confirm the most updated noise report of Summerhaven Wind Energy Centre Project (SWEC) was used in the [R0] assessment." Upon investigation, it was discovered that there was an updated Noise Assessment Report (Golder, 2012) for the SWEC. At the time of the Revision 0 analysis, Zephyr North was not aware of this latter report. The R1 report was updated to reflect the updated SWEC Noise Assessment Report. Note, though, that none of the turbine or transformer locations, types, *etc.*, nor receptor locations, types, *etc.*, that impact the GREP-Solar project appeared to have changed from the original parameters used in Revision 0 and based on the older Golder (2011) Noise Assessment Report.

As requested, an A0 size map of the project area and its details was provided to the Ontario MoE.

As requested, "Comparison Table[s]" showing "comparison between the previous sound power level (REA), and current sound power level (Amendment) of the Grand Renewable Energy Park – Solar Park (GREP)" was included in Section 7 . Tables 7-2, 7-4, and 7-6 of the R1 report summarized these comparisons for project receptors, VLSRs and participants respectively. Note that these tables listed comparisons between sound pressure levels and not sound power levels.

In some sections, minor editorial changes were made in order to improve the clarity of the report. Where appropriate, clarifications were added.

1.4 Revision 2

Revision 2 included the following changes.

The inclusion distance for receptors and VLSRs (from project eHouses and transformer) was changed from 1,500 to 1,000 m. (Note, though, that for the concordance table (Section 3.5), the distance from turbines remained at 1,500 m).

Additional description and updates (Section 5.1.1) and documentation (Section 13) for the inverter, inverter transformer, and eHouse was included.

Based on further assessment of the eHouse construction and geometry, octave band source sound power levels for the eHouse noise sources were updated (Sections 5.1.1.3 and 13). These updated values were used in the R2 noise assessment.

Entries in some of the tables were re-ordered to ensure that the receptor/ VLSR/ participant identifiers were sequential.

Some of the maps were updated for improved clarity.

In some sections, minor editorial changes were made in order to improve the clarity of the report. Where appropriate, clarifications were added.

1.5 Revision 3

This Revision (3) includes the following changes.

Based on further assessment of the eHouse construction and geometry, octave band source sound power levels for the eHouse noise sources have been updated (Sections 5.1.1.3 and 13). These updated values have been used in the present noise assessment.

Minor editorial changes have been made in order to improve the clarity of the report. Where appropriate, clarifications have been added.

1.6 Brief Project Description

As shown in Figure 1-1, the GREP (Solar and Wind) is located in Ontario in Haldimand County. It is about 6 km north of the Lake Erie shore and about 7.5 km south-southeast of the town of Cayuga.

The full GREP project features one solar array (the Solar Park) with a nominal capacity of 100 MW and one cluster of 67 wind turbines (the Wind Park) with a nominal capacity of 148.6 MW. The GREP will also include one substation (serving both the Solar and Wind Park portions of the project) and a 20 km transmission line that will connect the project substation to the provincial electrical grid.

For information, Figure 1-2 shows the full GREP details. Note that only turbines within 5 km of GREP-Solar are shown. Figure 1-3 shows further details of the Solar Park portion of the project.

1.7 Reporting Details

This report has been prepared to meet all reporting requirements related to renewable energy project noise for a *Renewable Energy Approval* (REA) under the *Green Energy and Economy Act* (Government of Ontario, 2009).

This noise impact assessment was carried out for the GREP-Solar under Section 55.(3) of O. Reg 359/09 (Government of Ontario, 2009b) and amendments (Government of Ontario, 2010, 2011, 2012). The assessment methodology and calculations conform to the ISO 9613-2 Standard (ISO, 1996). Where appropriate, results of the analysis have been interpreted using the Ontario Ministry of Environment's Noise Guidelines for Wind Farms (MoE, 2008). This latter document generally provides guidelines and clarifications for the application of MoE regulations document NPC-232 (MoE, 1995b) and NPC-104 (MoE) to wind farm projects.

It is important to note that both the Solar Park and Wind Park portions of the project have been designed to be compliant with the MoE Noise Guidelines (MoE, 2008). This is a more stringent specification for the Solar Park, as it stipulates a *de facto* maximum receptor sound pressure level of 40.0 dBA at receptors for both daytime and nighttime periods.

The MoE (2008) document prescribes receptor noise level limits based on an analysis of typical wind-induced background noise levels, and tabulates these limits as functions of the ambient 6, 7, 8, 9, and 10 ms^{-1} wind speeds measured at 10 m above ground level (a.g.l.). Note that the receptor noise level limits must be met for noise produced by other project hardware such as inverters, substation transformers and other noise sources in addition to noise produced by wind turbines. Obviously, these wind-speed-dependent noise level limits do not apply to the Solar Park portion of the project. For the purposes of this report, they are fixed at 40.0 dBA.

This report will show that the estimated noise levels generated by the project inverters, transformers, wind turbines and other hardware meet the MoE (2008) prescribed limits at all qualified receptors.

1.8 Sound Level Limits for Wind Farms

MoE (2008) lists the sound level limits for wind farms (based on the NPC-205 (MoE, 1995a) and NPC-232 (MoE, 1995b) publications and a consideration of the background ambient wind-induced sound level) as follows. Note that noise contributions from other project hardware, such as switching stations, transformer substations, *etc*., must be included in the cumulative noise assessment.

Summary of Sound Level Limits for Wind Turbines							
Wind speed (ms^{-1}) at 10 m height	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Wind turbine sound level limits Class 3 Area, dBA	40.0	40.0	40.0	43.0	45.0	49.0	51.0
Wind turbine sound level limits Class 1 Area, dBA	45.0	45.0	45.0	45.0	45.0	49.0	51.0
Reference wind induced background sound level L_{90}, dBA	30.0	31.0	33.0	36	38.0	42.0	44.0

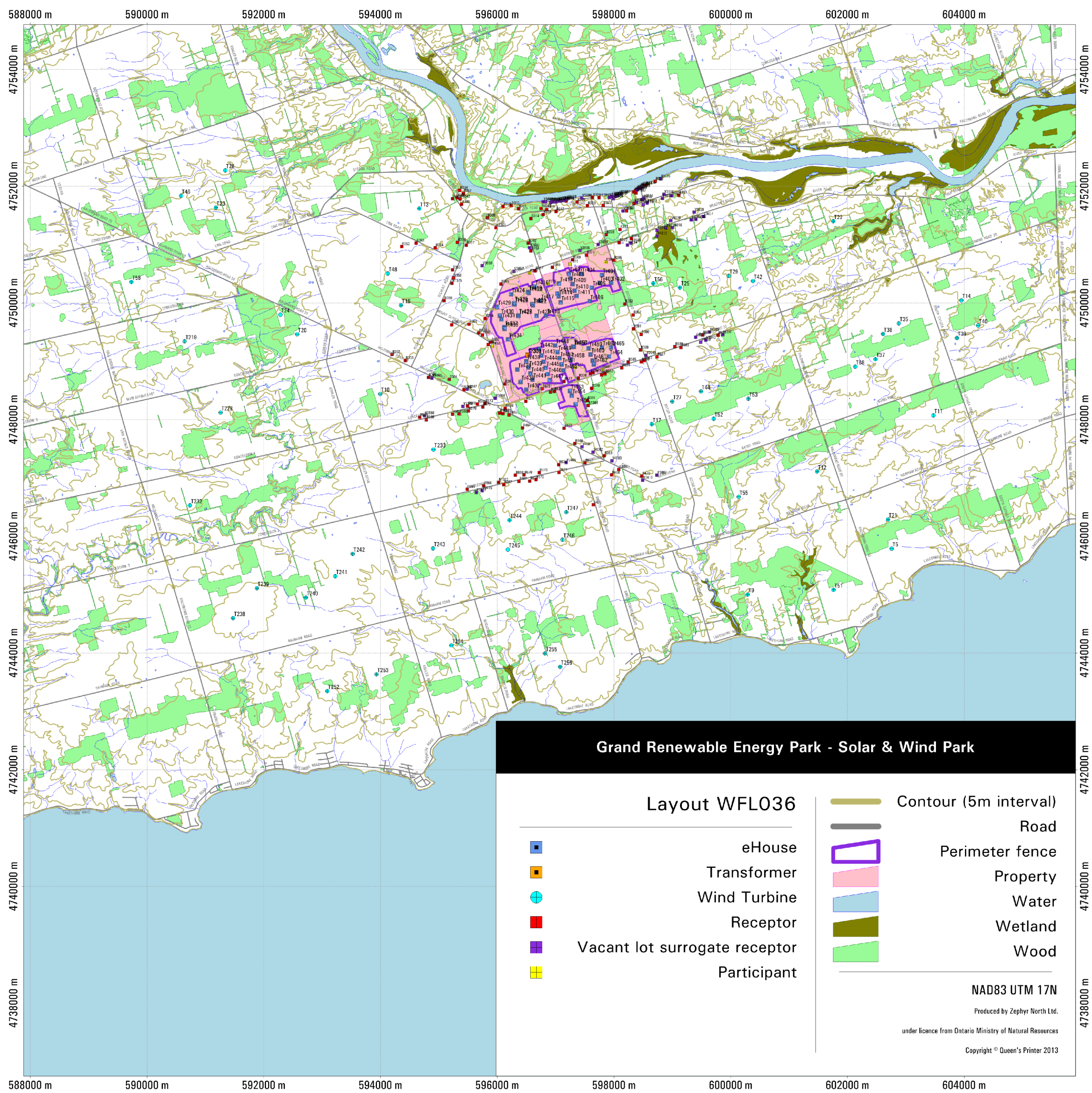


Figure 1-2 Solar and Wind Park map.

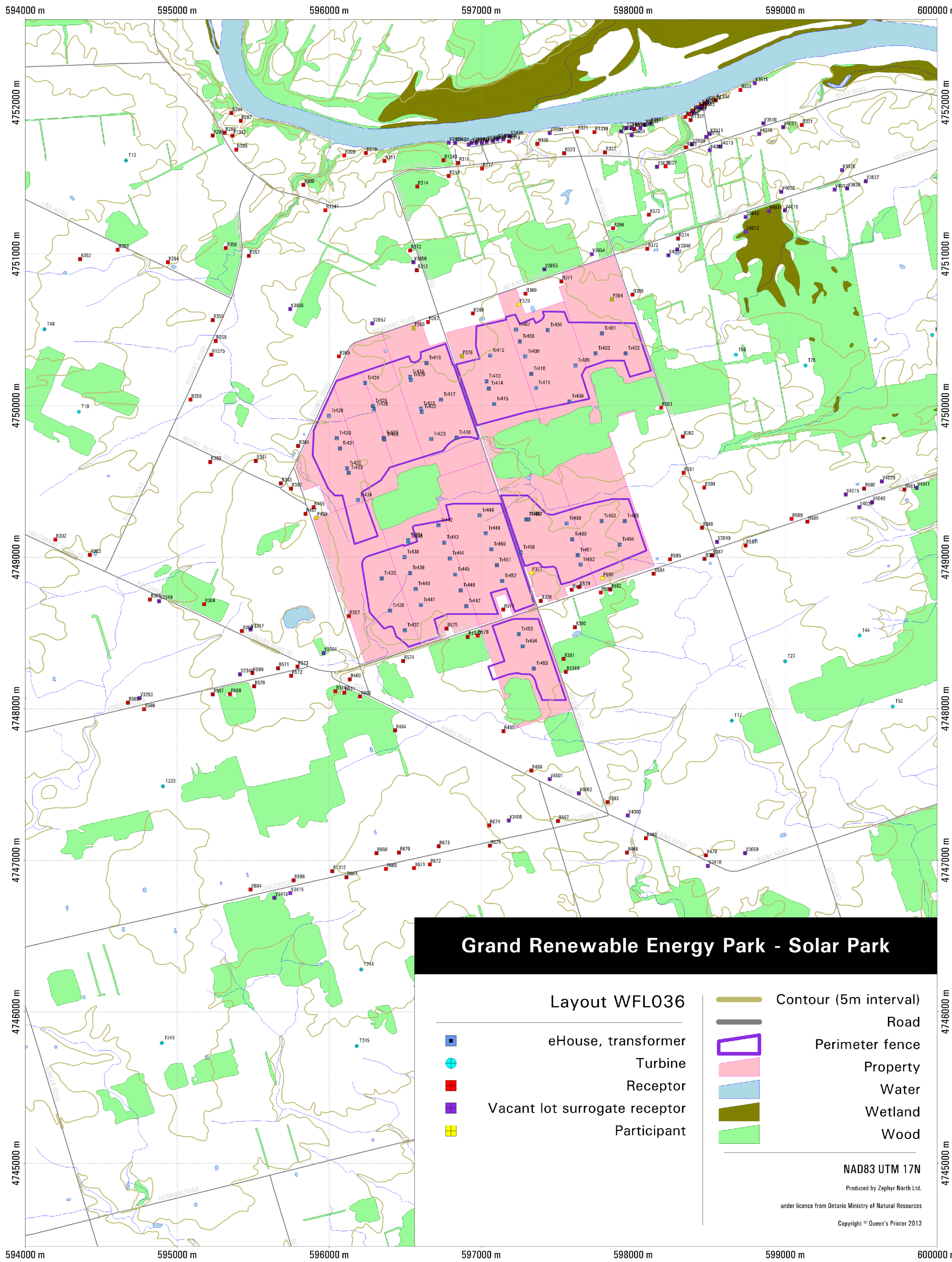


Figure 1-3 Solar Park Details.

2 PROJECT LAYOUT

2.1 Project Site

The Grand Renewable Energy Park is located in Haldimand County, Ontario as shown in Figure 1-1. Full GREP project (solar and wind) details, along with typical topographic map features, are shown in Figure 1-2, and in Figure 1-3 which expands the view of the Solar Park portion of the project (GREP-Solar).

Within the project domain, the topography can be characterized as very gently rolling to the point of being almost flat. On the land portion of Figure 1-2, the 5 m interval contour lines confirm this. Note that the general terrain elevation in the land portion of the project area is about 200 m above sea level (a.s.l). To the south of the project domain lies (the obviously very flat) Lake Erie with its surface located at 175 m a.s.l.

The surface roughness of the project domain is typical of Ontario rural terrain with a heterogeneous mixture of agricultural fields, woodlots, farm buildings, dwellings, rural settlements, and small villages and towns.

The GREP site features a population density typical of southern Ontario rural communities — a relatively sparse population in the countryside except for a small number of settlement clusters (villages and towns).

The primary activity in this area is agriculture.

2.2 Project Details

Figure 1-2 shows both solar and wind properties that have been optioned for lease to the project proponent — Grand Renewable Solar LP in the case of the Solar Park. Also shown are prospective turbine, point of reception (receptor), vacant lot, vacant lot surrogate receptor (VLSR), and participating point of reception (participant) locations. Turbine numbers are designated with the prefix 'T', receptors are designated with 'R', VLSRs with 'V', and participants with 'P'. Transformers (*i.e.*, substation transformers) are designated with 'Tr'.

Figure 1-3 also shows the prospective locations of the GREP-Solar solar array clusters and their associated eHouses (enclosures containing two inverters, plus an associated transformer). eHouses are also designated with 'Tr'.

As specified by O.Reg.359/09, the Solar Park portion of the Grand Renewable Energy Park is a Class 3 Solar Facility.

The Solar Park portion of the project is made up of approximately 445,000 fixed-orientation solar panels mounted on racks above the ground covering 325 ha. The panels will face south, and will repose at angles between 26 and 30º from the horizontal. They are organized into 65 2.0-MW clusters (or units), each consisting of solar panels and an 'eHouse' consisting of two 800 kW SMA SC800CP-CA inverters housed in a single custom-designed acoustic enclosure plus one 1.6-MVA 34.5 kV transformer mounted on the same base. The eHouse rests on a steel frame located at ground level and supported by helical ground screws. The eHouse transformer has been specified by the project proponent to be the ABB 1600 kVA Proprietary Class III model. Note that the eHouse will be evaluated as a single unit for source noise purposes. In Figure 1-3, the eHouses are numbered Tr401 to Tr465.

Where appropriate, a 2 m berm will be constructed on the exterior of the Solar Park to provide a landscaping barrier for landowners of proximate adjacent residences. It should be noted that any potential noise attenuation impacts of the berm have *not* been taken into consideration in this report.

The GREP-Solar project is located approximately in the area bounded by Mount Olivet Road to the west-southwest, Meadows Road to the northwest and north-northwest, Sutor Road to the east-northeast, and Haldimand Road 20 to the south-southeast. Note that a small portion of the farm lies to the south-southeast of Haldimand Road 20 as well. There are GREP-Wind turbines to the east and west of the Solar Park. There are also turbines from the adjacent Summerhaven Wind Energy Centre (SWEC) to the south and southwest. A listing of all GREP-Solar eHouses is available in Section 12 of this report.

The Ontario NPC designation for the project properties would generally be Class 3 — Rural. Typical background noise for the project area would be generated by residential, agricultural, and small commercial activities, ambient wind, vehicles on the regional roads, and waves at the shoreline of Lake Erie. For the purposes of this report, all areas have been considered to be NPC Class 3.

All project eHouses and substation power transformers (Solar and Wind) and neighbouring project wind turbines and transformers have been included in the present noise assessment. The individual turbine GSU transformers have not been included because their output operating voltage is below 50 kV. In addition and as noted above, no acoustical attenuation properties of the solar project's landscaping berm have been included.

2.3 Municipal Zoning

Typically, the project area is zoned as Agricultural.

2.4 Adjacent Projects

2.4.1 GREP-Wind

The Wind Park portion of the GREP will consist of 67 power (and noise) derated Siemens Wind Power A/S turbines. There will be 65 SWT-2.3-101 (Max Power 2,221 kW) and two SWT-2.3-101 (Max Power 2,126 kW) turbines resulting in a project nameplate capacity of 148.6 MW. (Note, for clarity, that these turbines are generally referred to as model SWT-2.3-101 — their nominal designation.) In Figure 1-2, project turbines are numbered T1 to T69. There are no turbines numbered T31 nor T32 in the layout. A generator step-up transformer (GSU) will be located next to each of the turbines.

The GREP-Wind project stretches for a distance of about 14 km roughly parallel to the shoreline of Lake Erie. Turbines are located from approximately 0.8 km to 14.3 km from the shoreline. A listing of all GREP-Wind turbine locations can be found in Section 12 of this report.

2.4.2 Summerhaven Wind Energy Centre

Figure 1-2 shows locations of turbines located within 5 km in the nearby NextEra Energy Canada ULC Summerhaven Wind Energy Centre (SWEC). These locations have been taken from Golder (2012). The turbines are located roughly to the south-southwest of the GREP-Solar. In Figure 1-2 Summerhaven project turbines are numbered T201 to T261. (Note that T202, T219, and T260 do not exist and other turbines are not shown due to their remoteness.)

The Golder (2012) Noise Study Report states that the SWEC will be comprised of 58 power derated Siemens SWT-2.3-101 (Max Power 2,221 kW) turbines for a project capacity of approximately 128.8 MW.

Further details of these turbines are provided further below. All turbines in the SWEC within 5 km of any receptor of the GREP-Solar have been included in the present noise assessment.

2.4.3 Byng Wind Project

While the Byng Wind Project was included in the previous assessment of the full GREP project, it has been omitted here due to its substantial distance (16 km to the east) from any of the GREP-Solar hardware. It will not be considered further.

2.5 Substations

2.5.1 Grand Renewable Energy Park

Within the confines of the Solar Park, the GREP will include a 274 MW substation servicing both the Solar and Wind Parks. This substation will consist of a 108 MVA power transformer for the Solar Park, and a 166 MVA power transformer for the Wind Park portion of the project. The transformers are shown as Tr301 and Tr300 respectively in Figure 1-3. The nearest wind turbine (GREP-Wind T56) is located about 2.4 km to the east-northeast of the substation.

Noise from the two transformers has been included in all of the reported noise calculations.

2.5.2 Summerhaven Wind Energy Centre

Golder ((2012)) states that the SWEC transformer station will be located at 582,616E, 4,747,537N (NAD83 UTM17N). This is approximately 15.3 km west of the nearest GREP-Solar hardware. Therefore, due to its remoteness from the GREP-Solar and the number of intervening SWEC and GREP-Wind turbines, noise from the SWEC transformer has not been included in any of the reported noise calculations.

3 DESCRIPTION OF RECEPTORS

3.1 Definition

Receptors (non-participating points of reception), vacant lot surrogate receptors (VLSRs), and participants (participating points of reception) are defined in Ontario MoE NPC-232 (MoE, 1995b) and Noise Guidelines publication (MoE, 2008), and in Ontario O.Reg. 359-09 and proposed amendments (Government of Ontario; 2009b, 2010).

For information: 129 receptors, 68 VLSRs, 7 participants (total 204), and 88 vacant lots have been identified within 2 km of any project hardware; 59 receptors, 12 VLSRs, 7 participants (total 78), and 28 vacant lots have been identified within 1 km of any project hardware.

3.2 Determination of Receptors and Participants

Receptors and participants were identified through mapping, aerial photographs, and on-site surveys of the area. Typically, for this area, receptors are residential dwellings of individuals and families not associated with the project. Section 12 lists limited details for all known receptors and participants situated within 2 km of any GREP-Solar hardware in the project area. Their locations are shown in Figures 1-2 and 1-3. All receptors within 1.0 km of any eHouse or power transformer have been included and reported in this noise impact analysis. All receptors have been considered to be designated as rural (NPC Class 3).

For the purposes of noise assessment, participants have been defined as dwellings occupied by landowners who receive financial compensation for the placement of project hardware (solar panels, eHouses, transformers, cables, roads, *etc*.) on their properties.

3.3 Vacant Lots

The MoE (2008) Guidelines also requires prediction of the noise levels on "...vacant lots that have been zoned by the local municipality to permit residential or similar noise-sensitive uses...". Therefore, all vacant lots within 1.0 km of any GREP-Solar hardware were identified as those lots defined by the complete set of cadastral map parcel fabric which did not contain a receptor nor a participant dwelling (and were obviously not road rights-of-way, *etc*.). A one-hectare "building envelope within the vacant lot property that would reasonably be expected to contain the use, and that conforms with the municipal zoning by-laws in effect" was also identified for each of the vacant lots by determining a location within the vacant lot where the predicted noise level would be below the allowed maxima. A 'vacant lot surrogate receptor' (VLSR) centred in the one-hectare building envelope and designated with a height of 4.5 m was created for the purpose of noise estimation. The VLSRs are listed in Section 12 .

3.4 Methodology

ISO 9613-2 modelling was carried out for all receptors, VLSRs, and participants.

A calculated receptor sound pressure level for each receptor was determined as stipulated in Section 6.3.2 of MoE (2008). The heights of dwellings designated as 1-, 2-, and 3-storeys were set to be 1.5, 4.5, and 7.5 m respectively.

As noted above, participating receptors (referred to herein as participants) have also been surveyed and are shown in Figures 1-2 and 1-3, and listed in Section 12 . Estimates of sound pressure levels were made for the participant locations.

It should be noted that the receptors, VLSRs, and participants listed in Section 12 include only those that are closer than or equal to 1,000 m from any GREP-Solar eHouse or substation noise source.

3.5 Concordance Table

Following the 2013-08-13 email request from the Ontario MoE, a concordance table that rationalizes the identification of receptors and VLSRs between, in this case, the GREP (Solar and Wind) and any adjacent projects. For this case, the latter would be the Summerhaven Wind Energy Centre (SWEC) as it is the only neighbouring project that meets the 1.5 km distance criterion for consideration.

Table 3-1 lists receptors and VLSRs which are located within 1.0 km of any eHouse, substation transformer or turbine in the GREP (Solar and Wind) and within 1.5 km of any turbine in the Summerhaven Wind Energy Centre. All relevant noise sources from the GREP (Solar and Wind) and the SWEC have been included in the analysis in this report.

The next paragraphs describe the columns in Table 3-1.

The first pair of columns in the table list the UTM coordinates (NAD83 UTM17N) of the receptor or VLSR as determined for the GREP (Solar and Wind). The second pair of columns list the coordinates as provided in a spreadsheet via a private communication (Bird, 2012) for the SWEC. Note that for receptors these pairs of columns are generally slightly different. This difference can be attributed to the choice of the exact location of the dwelling in questions and the precision of the GIS data including base mapping and air or satellite photography. However, in the case of VLSRs, the locations can be significantly different since the VLSR need only be located on the vacant property in question, although it must be surrounded by at least 1 ha of available land, zoned to permit residential or similar uses, conform with local building codes, and be consistent with the typical building pattern in the area. In some instances, it is possible for the two project designers to reasonably choose two VLSRs on the same vacant lot property which are hundreds of metres apart. Note that there are some receptors and VLSRs in each of the projects that do not appear to have matches in the other project. These have been indicated by "n/a".

The fifth column in the table lists the distance between the two locations (GREP (Solar and Wind)-designated or SWEC-designated) determined for the receptor or VLSR. Where there is no receptor/VLSR associated with one of the projects, "n/a" has been inserted.

The next pair of columns list the receptor or VLSR identifier — first as used for the GREP (Solar and Wind), and second as used for the SWEC. Naturally, these would not be expected to be the same. As noted above, there are some receptors/VLSRs that are found in one project and not in the other. This is indicated by "n/a".

The next pair of columns lists the distances from the receptor or VLSR to the nearest noise source (transformer or turbine) — first in the GREP (Solar and Wind), and second in the SWEC. Note that the GREP (Solar and Wind) receptor/VLSR coordinates are used for this calculation. Again, "n/a" indicates that there is no receptor/VLSR designated in the specific project.

The next pair of columns identifies the nearest noise source as determined in the previous columns — first as specified in the GREP (Solar and Wind), and second as specified in the SWEC. As before, "n/a" indicates that there is no receptor/VLSR designated in the specific project.

The next three columns list the receptor/VLSR sound pressure levels — the first for the case where only GREP (Solar and Wind) noise sources are included, the second where only SWEC noise sources are included, and the third where noise sources from both projects are included. Note that the sound pressure levels are listed for the GREP (Solar and Wind) receptor/VLSR locations. They have not been determined for the SWEC receptor/VLSR locations. Note that the "Total Level" has been determined from a full analysis including both the GREP (Solar and Wind) and the SWEC noise sources at GREP (Solar and Wind) receptors/VLSRs.

Table 3-1 GREP (Solar and Wind)—SWEC receptor/VLSR concordance table.

UTM coordinates GREP		UTM coordinates SWEC			Noise receptor ID		Distance to nearest source (m)		Nearest source ID		Level of farm (dBA)		Level (dBA)
Easting (m)	Northing (m)	Easting (m)	Northing (m)	Difference (m)	GREP	SWEC	GREP	SWEC	GREP	SWEC	GREP	SWEC	Total
595426	4748513	595426	4748517	4	R306	POR0143	982	1148	Tr435	WTG-033	31.3	32.1	34.7
596136	4748195	n/a	n/a	n/a	R460	n/a	484	n/a	Tr437	n/a	30.2	n/a	n/a
596099	4748107	596103	4748104	5	R461	POR0146	571	1344	Tr437	WTG-033	28.4	30.8	32.7
596203	4748080	596201	4748082	3	R462	POR0144	527	1425	Tr437	WTG-033	30	32.2	34.2
597146	4747852	597144	4747856	4	R465	POR2336	459	1436	Tr455	WTG-047	31.9	31.9	34.9
597329	4747592	597329	4747592	0	R466	POR0141	674	1185	Tr455	WTG-047	32.3	33.2	35.8
595494	4748236	595489	4748243	9	R569	POR0018	994	951	Tr436	WTG-033	30.6	33.8	35.5
595663	4748268	595665	4748269	2	R571	POR0019	828	1086	Tr436	WTG-033	28.8	31.5	33.4
595750	4748218	595749	4748220	2	R572	POR2330	778	1115	Tr436	WTG-033	30.2	32.9	34.7
595790	4748278	595788	4748282	4	R573	POR0129	712	1185	Tr436	WTG-033	30.3	32.4	34.4
596041	4748115	n/a	n/a	n/a	R1362	n/a	608	n/a	Tr437	n/a	28.4	n/a	n/a
595482	4748523	n/a	n/a	n/a	V3347	n/a	926	n/a	Tr429	n/a	31.2	n/a	n/a
595963	4748368	n/a	n/a	n/a	V3664	n/a	518	n/a	Tr435	n/a	30.5	n/a	n/a
597451	4747536	n/a	n/a	n/a	V4001	n/a	738	n/a	Tr401	n/a	32.9	n/a	n/a
597642	4747443	597699	4747402	70	V4002	VPOR0005	875	1126	Tr465	WTG-047	33.7	33.3	36.5
n/a	n/a	597748	4747540	n/a	n/a	VPOR0125	n/a	1260	n/a	WTG-047	n/a	n/a	n/a
n/a	n/a	595699	4748271	n/a	n/a	POR0128	n/a	1113	n/a	WTG-033	n/a	n/a	n/a
n/a	n/a	596204	4748164	n/a	n/a	POR0148	n/a	1463	n/a	WTG-033	n/a	n/a	n/a

4 DESCRIPTION OF SOURCES

4.1 eHouses

4.1.1 Grand Renewable Energy Park

As described previously, there will be 65 solar units in the Solar Park portion of the GREP. Each unit will consist of 2.0 MWDC of solar panels (which are slightly oversized with respect to the inverter capacity), two 800-kW inverters, one 1.6-MWAC transformer, and ancillary equipment consisting of racking, cabling, site buildings, *etc*. Note that the inverters will be limited electronically to operate at less than their 800 kW maximum.

For each of the solar units, the two inverters will be housed in a single environmental/acoustic enclosure which will contain ventilation air openings. (Ventilation of the enclosed portion of the solar unit will be performed by fans included in the inverters.) Each inverter enclosure and associated transformer will be collocated (with approximately 2 m separation) on a steel chassis at ground level supported by helical screw anchors. For convenience, in this report the units consisting of two inverters in an enclosure and one power transformer have been termed 'eHouses'. The 65 1.6-MW transformers will feed power to the 108 MVA Solar Park substation power transformer located on the GREP-Solar site. (The other substation transformer provides for the Wind Park portion of the GREP.) These latter transformers are described below in Section 4.3 .

For purposes of analysis, each eHouse (65 in all) will be treated as a single point noise source. All 65 of these have been included in the present noise assessment.

4.1.1.1 Inverter

The inverter model to be used for this project is the SMA Sunny Central 800-kW SC800CP-CA. It will be controlled by built-in software that, in this case, limits its output to 769.2 kW. It is briefly described in the following table. For clarity in the following, note that the SMA 800-kW SC800CP-CA, the SMA 800-kW SC800CP-US, and the SMA 800-kW SC800CP-XT are all identical devices. The suffixes only indicate the country of manufacture. A descriptive brochure for this inverter is found in Section 13 (Appendix B).

Each eHouse contains two of these inverters housed in a steel acoustic enclosure.

Noise from all inverters has been included in the present noise assessment (via assessment of the eHouses).

	SMA SC800CP-CA
Type	DC to 60 Hz AC power inverter
Inverters per eHouse enclosure	2
Operating voltages	620 VDC input (rated); 360 VAC output (rated)
Rating	800 kW max (each inverter) but software limited to 769 2 kW
Height	2.27 m (located in larger eHouse enclosure)
Core tank size	n/a
Source location	within enclosure on eHouse (see below)
Sound characteristics	steady, tonal
Noise control measures	enclosure

4.1.1.2 Inverter Transformer

Each eHouse will include a 1.6 MVA transformer to step up the 360 VAC voltage from the inverters to the 34.5 kVAC voltage of the site collection system. The transformer model has been specified as ABB 1600 kVA Proprietary Class III. Note that it will not be located within the acoustical enclosure that houses the inverters, but will be on the common eHouse platform. A description of this transformer is found in Section 13 (Appendix B).

Each eHouse includes one of these transformers.

Noise from all these transformers has been included in the present analysis (via assessment of the eHouses).

	Inverter Transformer
Type	AC power transformer; ABB 1600 kVA Proprietary Class III
Operating voltages	360 VAC input; 34.5 kVAC output
Rating	1.6 MVA
Height	to be determined
Core tank size	to be determined
Source location	outside
Sound characteristics	steady, tonal
Noise control measures	uncontrolled

4.1.1.3 eHouse

Each eHouse contains two of the SMA SC800CP-CA inverters contained in a single acoustic enclosure with air intake and outlet vents, and an associated 1.6 MW transformer. These are all collocated on a steel pad at ground level. As noted above, the transformer is not located within the acoustical enclosure but, nevertheless, is considered to be included in the eHouse unit. The eHouse's acoustical enclosure will contain four silencers in total, two for the air intake and two for the air outlet.

A source noise specification for the eHouse has been provided by HGC Engineering (2013) via Grand Renewable Solar LP, and is included in Section 13 (Appendix B) for reference. The eHouse is briefly described in the following table.

For noise assessment purposes each eHouse is considered to be a single point source (65 total eHouses).

Noise from all these eHouses has been included in the present analysis.

	eHouse
Type	ground-mounted steel base supporting steel enclosure (containing two inverters) and transformer (outside the enclosure) (details to be finalized)
Inverters per eHouse	2x SMA SC800CP-CA (in steel enclosure)
Transformers per eHouse	1x 1.6 MVA transformer (not enclosed)
Operating voltages	as for inverters and transformer
Rating	as for inverters and transformer
Height	3.2 m
Core tank size	not applicable
Source location	outside
Sound characteristics	steady, tonal (the inverters contain fans; the steel inverter enclosure does not contain fans)
Noise control measures	a steel enclosure with four silencers (2x air intake, 2x air outlet) for the two inverters; none for the transformer

4.2 Wind Turbines

4.2.1 Grand Renewable Energy Park — Wind

Th e turbines proposed for the GREP-Wind are manufactured by Siemens Wind Power A/S (www.siemens.com/wind) of Germany. The proposed models are the SWT-2.3-101 (Max Power 2,221 kW) and the SWT-2.3-101 (Max Power 2,126 kW).

All GREP-Wind turbines have been included in the present assessment.

4.2.1.1 Siemens SWT-2.3-101 (Max Power 2,221 kW) Turbine

The following table summarizes this turbine's general characteristics.

	Siemens SWT-2.3-101 (Max Power 2,221 kW)
Type, number of blades, rotor orientation	horizontal-axis, 3-bladed, upwind wind turbine
Rated power	2,221 kW
Rotor diameter; swept area	101.0 m; 8,000 m^2
Operational rotation rate	6.0 to 16.0 rpm; variable speed
Hub height; tower type	99.5 m; steel tubular tower
Power regulation	pitch regulation with variable speed
Cut-in wind speed	4 ms^{-1}
Cut-out wind speed	25 ms^{-1}
Rated wind speed	12-13 ms^{-1}
Gearbox	yes; 3 stage planetary/helical
Generator; speed	asynchronous with squirrel-cage rotor, without slip rings; variable speed
Turbine step-up transformer	external to tower; 690 VAC to 34.5 kVAC
Braking system	aerodynamic primary brake by full-span feathering of individual blades; mechanical disk brake on high-speed shaft which has two hydraulic calipers
Yaw system	active electric externally geared slewring; passive friction brake

4.2.1.2 Siemens SWT-2.3-101 (Max Power 2,126 kW) Turbine

The following table summarizes this turbine's general characteristics.

	Siemens SWT-2.3-101 (Max Power 2,126 kW)
Type, number of blades, rotor orientation	horizontal-axis, 3-bladed, upwind wind turbine
Rated power	2,126 kW
Rotor diameter; swept area	101.0 m; 8,000 m^2
Operational rotation rate	6.0 to 16.0 rpm; variable speed
Hub height; tower type	99.5 m; steel tubular tower
Power regulation	pitch regulation with variable speed
Cut-in wind speed	4 ms^{-1}
Cut-out wind speed	25 ms^{-1}
Rated wind speed	12-13 ms^{-1}
Gearbox	yes; 3 stage planetary/helical

	Siemens SWT-2.3-101 (Max Power 2,126 kW)
Generator; speed	asynchronous with squirrel-cage rotor, without slip rings; variable speed
Turbine step-up transformer	external to tower; 690 VAC to 34.5 kVAC
Braking system	aerodynamic primary brake by full-span feathering of individual blades; mechanical disk brake on high-speed shaft which has two hydraulic calipers
Yaw system	active electric externally geared slewring; passive friction brake

4.2.2 SWEC Wind Turbines

In addition to the GREP turbines, there are 58 Siemens SWT-2.3-101 (Max Power 2,221 kW) turbines in the Summerhaven Wind Energy Centre.

All of SWEC wind turbines have been included in the present assessment.

4.2.2.1 Siemens SWT-2.3-101 (Max Power 2,221 kW) Turbine

A description of the SWT-2.3-101 (Max Power 2,221 kW) turbine has been given above in Section 4.2.1.1 . NextEra has not provided any information to Grand Renewable Solar LP nor to Zephyr North to suggest that the SWT-2.3-101 (Max Power 2,221 kW) turbines used in the Summerhaven project will be any different from the description in the table above. Note, though, that the proposed hub height for the turbines in the Summerhaven project is 80 m.

Turbine locations and any additionally required information have been taken from the Golder ((2012)) noise assessment report.

4.3 Substations

4.3.1 Grand Renewable Energy Project — Solar and Wind

There will be a substation shared between the GREP-Solar and the GREP-Wind located as shown in Figures 1-2 and 1-3. Two collocated power transformers to step up the voltage from the 100 MW Solar Park and the 148.6 MW Wind Park along with ancillary equipment will comprise the substation.

4.3.1.1 Solar Park Transformer

The Solar Park transformer will be rated at 108 MVA. Technical specifications for the GREP-Solar substation power transformer have been published but a number of details of the transformer model have not yet been released. As soon as this information is available, it will be provided to the MoE.

Noise from this transformer has been included in the present analysis.

The following table describes the Solar Park sub-station transformer.

	Substation Solar Park Transformer
Type	AC power transformer; details to be finalized
Operating voltages	34.5 kVAC input; 230 kVAC output
Rating	108 MVA
Height	to be determined
Core tank size	to be determined
Source location	outside
Sound characteristics	steady, tonal
Noise control measures	uncontrolled

4.3.1.2 Wind Park Transformer

The Wind Park transformer will be rated at 166 MVA. Technical specifications for the GREP-Wind substation power transformer have been published but a number of details of the transformer model have not yet been released. As soon as this information is available, it will be provided to the MoE.

Noise from this transformer has been included in the present analysis.

The following table describes the Wind Park sub-station transformer.

	Substation Wind Park Transformer
Type	AC power transformer; details to be finalized
Operating voltages	34.5 kVAC input; 230 kVAC output
Rating	166 MVA
Height	to be determined
Core tank size	to be determined
Source location	outside
Sound characteristics	steady, tonal
Noise control measures	uncontrolled

4.4 Summerhaven Wind Energy Centre

The SWEC substation and its transformer is located about 8 km west of the nearest GREP-Solar eHouse. There are several SWEC turbines significantly closer to this transformer station than the nearest GREP-Solar eHouse.

Due to its remoteness from the GREP-Solar, noise from the SWEC transformer has not been included in any of the reported noise calculations.

4.5 Summary

Table 4-1 is modelled on Table A1, *Noise Source Summary Table*, taken from the *Basic Comprehensive Certificates of Approval (Air) User Guide* (MoE, 2011). An additional column has been added that enumerates the quantity of each type of noise source.

Table 4-1 summarizes the number and type of each noise source as described above and in Section 5 . Additional information is also available in Section 12 .

Table 4-1 Noise source summary table.

Source ID	Quantity	Source Description	Broadband Source Sound Power Level (dBA)	Source Location	Sound Characteristics	Noise Control Measures
T1 to T9	9	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=99.5m Noise=(NRO,-1)105dBA(Mxmm) – GREP-Wind	105.0	Outside	Steady	Uncontrolled
T10	1	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,126kW HH=99.5m Noise=(NRO -2)104dBA(Mxmm) – GREP-Wind	104.0	Outside	Steady	Uncontrolled
T11 to T30	20	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=99.5m Noise=(NRO,-1)105dBA(Mxmm) – GREP-Wind	105.0	Outside	Steady	Uncontrolled
T33 to T57	25	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=99.5m Noise=(NRO,-1)105dBA(Mxmm) – GREP-Wind	105.0	Outside	Steady	Uncontrolled
T58	1	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,126kW HH=99.5m Noise=(NRO -2)104dBA(Mxmm) – GREP-Wind	104.0	Outside	Steady	Uncontrolled
T59 to T69	11	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=99.5m Noise=(NRO,-1)105dBA(Mxmm) – GREP-Wind	105.0	Outside	Steady	Uncontrolled
T201	1	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=80.0m Noise=(NRO,-1)105dBA(Mxmm) – SWEC	105.0	Outside	Steady	Uncontrolled
T203 to T228	26	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=80.0m Noise=(NRO,-1)105dBA(Mxmm) – SWEC	105.0	Outside	Steady	Uncontrolled
T230 to T259	30	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=80.0m Noise=(NRO,-1)105dBA(Mxmm) – SWEC	105.0	Outside	Steady	Uncontrolled
T261	1	Turbine: Siemens SWT-2.3-101 RD=101m RP=2,221kW HH=80.0m Noise=(NRO,-1)105dBA(Mxmm) – SWEC	105.0	Outside	Steady	Uncontrolled
Tr300	1	Transformer: Wind Farm: 85dBA + 5dB tonal penalty 4.0 m a.g.l. – GREP-Wind	90.0	Outside	Steady, Tonal	Uncontrolled
Tr301	1	Transformer: Solar Farm: 85dBA + 5dB tonal penalty (all octaves) 4.0 m a.g.l. – GREP-Solar	90.0	Outside	Steady, Tonal	Uncontrolled
Tr401 to Tr465	65	eHouse: Solar Farm: 71dBA + 5dB tonal penalty – GREP-Solar	76.0	Outside	Steady, Tonal	Uncontrolled

5 NOISE EMISSION RATINGS

5.1 Solar Inverters, Enclosures, Transformers

5.1.1 Grand Renewable Energy Park

As noted above, there are 65 eHouses in the Solar Park portion of the Grand Renewable Energy Park. Each eHouse serves approximately 6,845 solar modules, and consists of two inverters within an acoustical enclosure with four ventilation openings (two air intake and two air exhaust) and separate inverter transformer, all mounted on a steel platform.

Each eHouse will be treated as a single point noise source and emission data for the complete eHouse (2 inverters in an enclosure, 1 transformer outside the enclosure but mounted on the same platform) will be provided below.

5.1.1.1 Inverter

The 130 SMA Sunny Central SC800CP-CA inverters only occur in pairs within each of the project's 65 eHouses. The total electrical output of the 65 eHouses is 100 MW AC, equal to the contractual limit of the project's FIT contract. For clarity, this total is controlled through the use of standard software included in each of the 130 inverters that can be set to limit the output to any level required. For the present project, it will be set to a limit of 769.2 kW.

The two inverters are the only source of noise within each eHouse enclosure. An SMA inverter data sheet is provided in Section 13 . Please note that this data sheet covers inverters of several sizes and it is the SC800CP-CA information that is relevant.

The calculation of the contribution by the two inverters to the total eHouse noise has been based on the SMA Inspection Report for the Acoustical Environmental Test, included in Section 13 . This detailed report is based on testing conducted on 2013-03-06, and indicates a sound power level of 93.3 dBA for an inverter excluding the eHouse enclosure or any air intake or exhaust silencers. Please note that SMA inverter model SC800CP-XP is identical to model SC800CP-CA, with the CA designation merely indicating that final assembly of the unit has taken place in Canada.

It is important to note that source noise from the inverters is included in the eHouse source noise (Section 5.1.1.3 below).

For reference, a summary inverter data sheet is provided in Section 13 .

5.1.1.2 Inverter Transformer

The ABB 1600 kVA Proprietary Class III inverter transformers will be supplied as an integral component of each eHouse, and their noise emissions are included as part of the total. The contribution of the transformers toward the total eHouse noise emission has been determined based on the NEMA rating of 43.4 dBA in the ABB Sound Test Report [Ref: 13Q1833961] for product 12J037182, which is the same unit. A copy of this Sound Test Report is included in Section 13 , along with a summary data sheet for the inverter transformer. Please note that the potentially ambiguous figure of “50” (no units given) for sound level listed in the ABB price quote dated 2013-04-01 and provided in Section 13 has been not been used, as has ABB subsequently provided the much more detailed and specific Sound Test Report.

It is important to note that source noise from the inverter transformers is included in the eHouse source noise (Section 5.1.1.3 below).

For reference, a summary data sheet for the inverter transformer is provided in Section 13 .

5.1.1.3 eHouse

HGC Engineering (2013) via Grand Renewable Solar LP has undertaken considerable analysis of the eHouse design to determine unmitigated and mitigated noise emission data.

The unmitigated eHouse emission data is based on the above-mentioned acoustic reports from SMA for the inverters and ABB for the transformers, combined with the eHouse design (available on request) and data on the acoustic properties of the materials used for the eHouse walls and roof. These materials are supplied by a company called Vicwest and include DM40 wall panels and HR 4 roof panels. Representative specification sheets for both products are

Table 5-1 eHouse acoustic emissions summary.

Inverters per eHouse: 2			
Transformers per eHouse: 1			
Operating voltage: as per inverters, transformer			
Rating: n/a			
Core tank size: n/a			
Source height (m): 3.2 m			
Source location: outside			
Sound characteristics: steady, tonal			
Noise control measures: enclosure for inverters; un-controlled for transformer			
Frequency (Hz)	**Source sound power level (dBLin)**	**Tonal penalty (dB)**	**Net source sound power level (dBLin)**
63	89	5	94
125	78	5	83
250	71	5	76
500	64	5	69
1000	54	5	59
2000	53	5	58
4000	65	5	70
8000	63	5	68
Broadband (dBA)	71*		76**

* Guaranteed to be no more than 71.0 dBA as per Page 1 of HGC (2013)

** Guaranteed to be no more than 76.0 dBA

Zephyr North

included in Section 13 , although the actual thickness of the steel layer to be used in the final design may differ.

The mitigated eHouse emission data are based on the unmitigated calculations plus the inclusion of four silencers (two for the air intake and two for the air exhaust) to be supplied by a company called Vibro-Acoustics. A Silencer Schedule prepared by Vibro-Acoustics showing physical dimensions and the Dynamic Insertion Loss for the air intake and exhaust silencers is included in Section 13 , along with a letter confirming that the eHouses will have a maximum broadband noise emission (source sound power level) of 71 dBA.

As this device houses two inverters, its noise has been designated as tonal and, as required by MoE (2008), a 5 dB penalty has been applied as per MoE NPC-104.

The noise emission data for the mitigated eHouse (including two inverters, the inverter transformer, and silencers) have also been validated by HGC Engineering, which has calculated the octave-band source sound power levels for the eHouse. This distribution is shown in Table 5-1 above.

5.2 Wind Turbines

5.2.1 Grand Renewable Energy Park — Wind

5.2.1.1 Siemens SWT-2.3-101 (Max Power 2,221 kW)

Siemens SWT-2.3-101 (Max Power 2,221 kW) turbine broadband source sound power level data for 10 m (a.g.l) wind speeds of 3 to 11 to cut-out (25) ms^{-1} and octave band source sound power level data for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} were provided in Siemens A/S documentation (Siemens, 2012a) supplied by Grand Renewable Solar LP. This document is included in Section 13 and is referenced to IEC 61400-11. This turbine's maximum broadband source sound power level is 105.0 dBA while its rated power is 2.221 MW.

With respect to tonality, the Siemens (2012a) document referenced above states, "The sound level test reports for the Siemens Wind Turbine

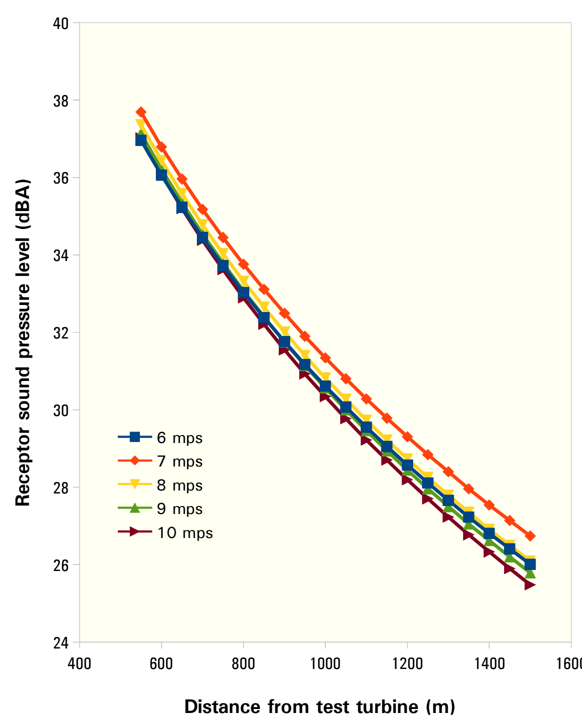


Figure 5-1 SWT-2.3-101 (MP 2221 kW) wind speed sensitivity test.

Generators have shown that the SWT-2.3-101 wind turbine generators produce no tonal audibility above 3 dB determined in accordance with IEC 61400-11:2002." No tonal penalty has been applied to these turbines.

The broadband and octave band noise information was used with the site-specific power law wind shear exponent of 0.45 (see Section 5.3 below for derivation) to synthesize/interpolate/extrapolate octave band source sound power levels for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} for use in the ISO 9613-2 estimates of receptor noise levels.

In addition, sensitivity tests were performed with the 'raw' (*i.e.*, unadjusted) 'Manufacturer's emission levels'. Figure 5-1 shows the results of these tests for a series of 4.5 m height receptors placed at 50 m intervals between 550 and 1500 m from a single SWT-2.3-101 (Max Power 2,221 kW) turbine. The graph shows the receptor sound pressure level as a function of distance from the turbine using each of the raw octave band source sound power level sets corresponding to the 10 m a.g.l. 6, 7, 8, 9, and 10 ms^{-1} wind speeds. The "predictable worst case" for all distances occurs for the10 m a.g.l. 7 ms^{-1} wind speed. As a consequence of these tests, for this turbine the 10 m a.g.l. 7 ms^{-1} wind speed set of octave band source sound power levels has been used for all noise assessment calculations in the ISO 9613-2 modelling.

The 10 m broadband and octave band source sound power levels for the Siemens SWT-2.3-101 (Max Power 2,221 kW) turbine for a hub height of 99.5 m are shown in Table 5-2. Note that the 'Adjusted emission levels' for *all* wind speeds have all been set to those corresponding to the 'Manufacturer's emission levels' 10 m a.g.l.

Table 5-2 Siemens SWT-2.3-101 (Max Power 2,221 kW) — Wind turbine acoustic emissions summary.

Make and Model: Siemens SWT-2.3-101 (Max Power 2,221 kW)										
Rating: 2,221 kW										
Hub height (m): 99.5										
Wind profile adjustment: summer night-time power-law wind shear coefficient = 0.45										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (10 m a.g.l)					Adjusted emission levels (10 m a.g.l.)				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz) 63	112.5	112.2	111.0	111.1	110.7	112.2	112.2	112.2	112.2	112.2
125	106.4	107.7	107.2	106.6	105.7	107.7	107.7	107.7	107.7	107.7
250	105.1	106.1	105.0	104.3	103.5	106.1	106.1	106.1	106.1	106.1
500	100.9	101.5	100.4	100.2	99.8	101.5	101.5	101.5	101.5	101.5
1000	99.2	99.9	100.1	100.0	100.2	99.9	99.9	99.9	99.9	99.9
2000	95.3	96.0	97.7	97.8	98.2	96.0	96.0	96.0	96.0	96.0
4000	91.2	92.5	92.6	94.4	94.5	92.5	92.5	92.5	92.5	92.5
8000	78.2	79.0	81.9	81.8	81.6	79.0	79.0	79.0	79.0	79.0
A-weighted	**104.2**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**	**105.0**

7 ms^{-1} wind speed set of octave band source sound power levels since these correspond to the MoE-defined "predictable worst case".

5.2.1.1 Siemens SWT-2.3-101 (Max Power 2,126 kW)

Siemens SWT-2.3-101 (Max Power 2,126 kW) turbine broadband source sound power level data for 10 m (a.g.l) wind speeds of 3 to 11 to cut-out (25) ms^{-1} and octave band source sound power level data for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} were provided in Siemens A/S documentation (Siemens, 2012b) supplied by Grand Renewable Solar LP. This document is included in Section 13 and is referenced to IEC 61400-11. This turbine's maximum broadband source sound power level is 104.0 dBA while its rated power is 2.126 MW.

With respect to tonality, the Siemens (2012b) document referenced above states, "The sound level test reports for the Siemens Wind Turbine Generators have shown that the SWT-2.3-101 wind turbine generators produce no tonal audibility above 3 dB determined in accordance with IEC 61400-11:2002." No tonal penalty has been applied to these turbines.

The broadband and octave band noise information was used with the site-specific power law wind shear exponent of 0.45 (see Section 5.3 below for derivation) to synthesize/interpolate/extrapolate octave band source sound power levels for 10 m a.g.l. wind speeds of 6, 7, 8, 9, and 10 ms^{-1} for use in the ISO 9613-2 estimates of receptor noise levels.

In addition, sensitivity tests were performed with the 'raw' (*i.e.*, unadjusted) 'Manufacturer's emission levels'. Figure 5-2 shows the results of these tests for a series of 4.5 m height receptors placed at 50 m intervals between 550 and 1500 m from a single SWT-2.3-101 (Max Power 2,126 kW) turbine. The graph shows the receptor sound pressure level as a function of distance from the turbine using each of the raw octave band source sound power level sets corresponding to the 10 m a.g.l. 6, 7, 8, 9, and 10 ms^{-1} wind speeds. The "predictable worst case" for all distances occurs for the10 m a.g.l. 7 ms^{-1} wind speed. As a consequence of these tests, for this turbine the 10 m a.g.l. 7 ms^{-1} wind

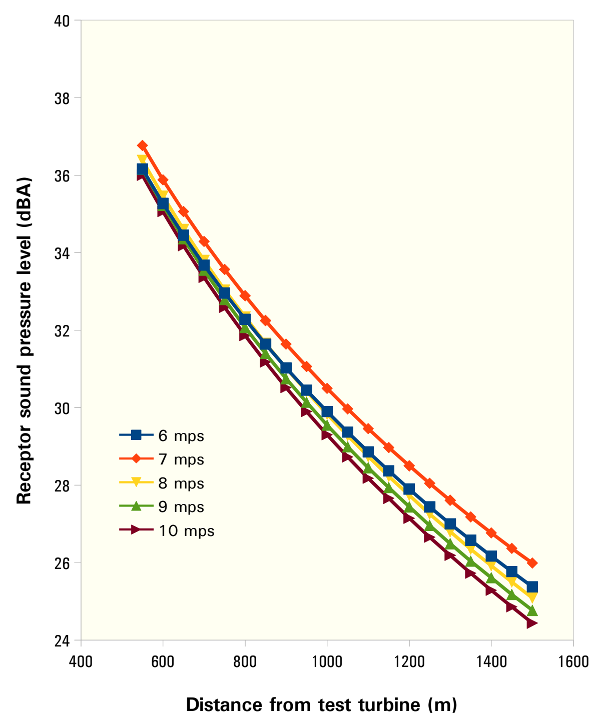


Figure 5-2 SWT-2.3-101 (MP 2126 kW) wind speed sensitivity test.

Zephyr North

speed set of octave band source sound power levels has been used for all noise assessment calculations in the ISO 9613-2 modelling.

The 10 m broadband and octave band source sound power levels for the Siemens SWT-2.3-101 (Max Power 2,221 kW) turbine for a hub height of 99.5 m are shown in Table 5-3. Note that the 'Adjusted emission levels' for *all* wind speeds have all been set to those corresponding to the 'Manufacturer's emission levels' 10 m a.g.l. 7 ms^{-1} wind speed set of octave band source sound power levels since these correspond to the MoE-defined "predictable worst case".

Table 5-3 Siemens SWT-2.3-101 (Max Power 2,126 kW) — Wind turbine acoustic emissions summary.

Make and Model: Siemens SWT-2.3-101 (Max Power 2,126 kW)										
Rating: 2,126 kW										
Hub height (m): 99.5										
Wind profile adjustment: summer night-time power-law wind shear coefficient = 0.45										
	Octave band sound power level (dB)									
	Manufacturer's emission levels (10 m a.g.l)					Adjusted emission levels (10 m a.g.l.)				
Wind speed (ms^{-1})	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**
Frequency (Hz) 63	112.2	111.8	110.8	110.8	110.4	111.8	111.8	111.8	111.8	111.8
125	105.9	107.1	106.8	106.2	105.3	107.1	107.1	107.1	107.1	107.1
250	105.0	105.8	103.3	102.6	101.7	105.8	105.8	105.8	105.8	105.8
500	100.3	100.8	99.5	99.2	98.8	100.8	100.8	100.8	100.8	100.8
1000	97.7	98.3	99.3	99.2	99.3	98.3	98.3	98.3	98.3	98.3
2000	93.9	94.5	96.6	96.7	97.2	94.5	94.5	94.5	94.5	94.5
4000	90.6	91.8	91.5	93.3	93.4	91.8	91.8	91.8	91.8	91.8
8000	78.1	78.8	80.4	80.3	80.1	78.8	78.8	78.8	78.8	78.8
A-weighted	**103.3**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**	**104.0**

5.2.2 Summerhaven Wind Energy Centre

5.2.2.1 Siemens SWT-2.3-101 (Max Power 2,221 kW)

As far as the project proponent and Zephyr North are aware, this turbine is identical to the Siemens SWT-2.3-101 (Max Power 2,221 kW) described above in Section 5.2.1.1 with the exception of the hub height which is specified to be 80.0 m for the SWEC in contrast to 99.5 m for the GREP-Wind project.

All noise emission information for this turbine can be obtained from Section 5.2.1.1

5.3 Site-Specific Vertical Wind Shear Exponent

The site-specific vertical wind shear exponent was calculated from two GREP-Wind *in situ* project wind monitoring stations installed on the GREP (Wind) site. Both these wind monitoring stations have wind measurements at nominal levels of 30, 45 and 60 m.

The vertical wind shear exponent was calculated by Zephyr North from a least-squares fit of a power law profile to period-averaged data at the three available levels of wind speed. The averaged data were filtered to include only the summer months of April through September inclusive, and the diurnal hours between 23:00 and 07:00 the following day. That is, the power law wind shear exponent for the 'average summer night time wind speed profile' is reported here — specifically, 0.44 for the Mast1 60 m WM station, and 0.45 for the Mast2 60 m WM station. One full summer of data was used for each station.

To be conservative, a value of 0.45 was used for the vertical wind shear exponent for all turbines (GREP-Wind and SWEC) for the purposes of this report.

It should be noted, however, that due to the determination of the 'Manufacturer's emission levels' 10 m a.g.l. 7 ms^{-1} wind speed set of octave band source sound power levels as the MoE-defined "predictable worst case", the summer night-time vertical wind shear does not play a part in the results of this noise assessment.

5.4 Substations

5.4.1 Grand Renewable Energy Park

As noted previously, there will be a 108 MVA transformer for the Solar Park portion of the GREP project and a 166 MVA transformer for the Wind Park portion. These will be collocated within the confines of a single substation located on the property of the Solar Park as shown in Figures 1-2 and 1-3.

5.4.1.1 Solar Park Transformer Noise Emission Rating

Technical specifications for the GREP-Solar substation power transformer have been published but a number of details of the transformer model have not yet been released. As soon as this information is available, it will be provided to the MoE.

In keeping with a previous REA application for the full project (GREP-Solar and GREP-Wind; Zephyr North, 2012a, 2012b), the broadband source sound power level for the GREP-Solar transformer has been specified to be less than or equal to 85 dBA. For the purposes of this noise assessment, octave band source sound power levels characteristic of a typical power transformer were adjusted to reflect the maximum 85 dBA broadband sound power level. These adjusted levels were used as input to the present analysis. Note that these octave band source sound power levels are identical to those used in the previous (full GREP project) noise assessment (Zephyr North, 2012a).

As this device is a transformer, its noise has been designated as tonal and, as required by MoE (2008), a 5 dB penalty has been supplied as per MoE NPC-104.

Broadband and octave band source sound power levels are listed in Table 5-4 below along with the 5 dB tone penalty assessed to every octave band and the net levels. The penalized octave band source sound power levels have been used for noise assessment for this project.

Note that for the purposes of this report, a transformer noise source height of 4.0 m has been assumed. This will be updated as soon as further information becomes available.

Note, for information, that the nearest receptor to either of the collocated (solar or wind) project transformers is approximately 610 m away.

5.4.1.2 Wind Park Transformer Noise Emission Rating

Technical specifications for the GREP-Wind substation power transformer have been published but a number of details of the transformer model have not yet been released. As soon as this information is available, it will be provided to the MoE.

In keeping with a previous REA application for the full project (GREP-Solar and GREP-Wind; Zephyr North, 2012a, 2012b), the broadband source sound power level for the GREP-Wind transformer has been specified to be less than or equal to 85 dBA. For the purposes of this noise assessment, octave band source sound power levels characteristic of a typical power transformer were adjusted to reflect the maximum 85 dBA broadband sound power level. These adjusted levels were used as input to the present analysis. Note that these octave band source sound power levels are identical to those used in the previous (full GREP project) noise assessment report (Zephyr North, 2012a).

As this device is a transformer, its noise has been designated as tonal and, as required by MoE (2008), a 5 dB penalty has been supplied as per MoE NPC-104.

Note that there will be a solid fence surrounding at least portions of the transformer substation. However, this fence has been designed for fire containment purposes only, and has not been considered in this report to provide any noise attenuation.

Broadband and octave band source sound power levels are listed in Table 5-5 below along with the 5 dB tone penalty assessed to every octave band and the net levels. The penalized octave band source sound power levels have been used for noise assessment for this project.

Note that for the purposes of this report, a transformer noise source height of 4.0 m has been assumed. This will be updated as soon as further information becomes available.

Note, for information, that the nearest receptor to either of the collocated (solar or wind) project transformers is approximately 610 m away.

Table 5-4 Solar Park transformer acoustic emissions summary.

Make and Model: Model to be determined			
Operating voltage: 34.5 kVAC / 230 kVAC			
Rating: 108 MVA			
Core tank size: to be determined			
Source height (m): 4.0 m (to be finalized)			
Source location: outside			
Sound characteristics: steady, tonal			
Noise control measures: uncontrolled			
Frequency (Hz)	**Source sound power level (dBLin)**	**Tonal penalty (dB)**	**Net source sound power level (dBLin)**
63	63.5	5.0	68.5
125	75.6	5.0	80.6
250	78.1	5.0	83.1
500	83.5	5.0	88.5
1000	80.7	5.0	85.7
2000	76.9	5.0	81.9
4000	71.7	5.0	76.7
8000	62.6	5.0	67.6
Broadband (dBA)	85.0		90.0

Table 5-5 Wind Park transformer acoustic emissions summary.

Make and Model: Model to be determined			
Operating voltage: 34.5 kVAC / 230 kVAC			
Rating: 166 MVA			
Core tank size: to be determined			
Source height (m): 4.0 m (to be finalized)			
Source location: outside			
Sound characteristics: steady, tonal			
Noise control measures: uncontrolled			
Frequency (Hz)	**Source sound power level (dBLin)**	**Tonal penalty (dB)**	**Net source sound power level (dBLin)**
63	63.5	5.0	68.5
125	75.6	5.0	80.6
250	78.1	5.0	83.1
500	83.5	5.0	88.5
1000	80.7	5.0	85.7
2000	76.9	5.0	81.9
4000	71.7	5.0	76.7
8000	62.6	5.0	67.6
Broadband (dBA)	85.0		90.0

6 IMPACT ASSESSMENT

6.1 Methodology

Cumulative eHouse, transformer, and turbine sound levels were estimated at each of the receptors using the ISO 9613-2 Standard model. eHouse, transformer and wind turbine octave band and A-weighted sound power values, standardized meteorological conditions, eHouse/transformer/turbine locations, receptor/ VLSR/ participant locations, and characteristics were used to determine the A-weighted sound pressure levels at all receptors.

6.2 Specific Parameters

a)

Analysis was carried out for inverter enclosure, transformer and turbine source sound power levels in eight octave bands (63 to 8,000 Hz) corresponding to 10 m (a.g.l.) ambient wind speeds of 6, 7, 8, 9, and 10 ms^{-1}.

b)

ISO 9613-2 parameters, as prescribed in the MoE (2008) Noise Guidelines were set as follows:

Ambient air temperature: 10 C
Ambient humidity: 70 %

The required atmospheric attenuation coefficients to be used in the ISO 9613-2 modelling of noise propagation are prescribed in MoE (2008). These have been used in the present assessment, and are shown in the following table.

Atmospheric Absorption Coefficients								
Centre Octave Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Atmospheric Absorption Coefficient (dB/km) from MoE Oct 2008 document	0.1	0.4	1.0	1.9	3.7	9.7	32.8	117.0

c)

The ISO 9613-2 Standard term for Ground Attenuation was calculated using the "General" Method (Section 7.3.1 of the Standard). Ground factors were assigned the following maximum values as requested in the MoE (2008) publication.

Source ground factor: 1.0 (soft ground)
Middle ground factor: 0.8 (soft ground)
Receptor ground factor: 0.5 (hard/soft ground)

6.3 Additional parameters and conditions

Sound pressure levels were not calculated for any receptor for which there was no GREP-Solar noise source (eHouse, transformer) closer than 1,000 m.

For any receptor, noise sources further than 5,000 m away were not included in the calculations.

No additional adjustments were made for wind speed or direction since ISO 9613-2 assumes worst-case conditions for these parameters with respect to noise impact.

6.4 Results

Results are reported in Tables 7-1, 7-3 and 7-5 found in Section 7 and the noise level isopleth map of Section 8 .

Tables 7-2, 7-4, and 7-6 provide comparison receptor, VLSR, and participant sound pressure levels from the original GREP (Solar and Wind) noise assessment report (Zephyr North, 2012a) and the present assessment. Note that in Table 7-2 receptor 587 is labelled as a receptor (R587). In the original GREP (Solar and Wind) noise assessment receptor 587 is listed as a participant (P587). Also, in Table 7-4 the entry for VLSR V4014 for the original GREP (Solar and Wind) noise assessment is marked "n/a". This VLSR was not included in the earlier noise assessment report.

Table 6-1 briefly summarizes the results of the present noise assessment. It is a sorted list of the highest sound pressure levels (SPrL) determined in the analysis for receptors and VLSRs.

Table 6-1 Highest sound pressure levels (SPrL) at receptors.

Receptor ID	SPrL (dBA)	Height (m)	Nearest Noise Source	Project or Other	Distance (m)
R587	39.2	4.5	T27	O	808
R393	39.0	4.5	Tr402	P	428
V3649	38.3	4.5	Tr465	P	623
R390	37.9	4.5	Tr465	P	567
R392	37.9	1.5	T56	O	642
R389	37.7	4.5	Tr465	P	511
R391	37.7	4.5	Tr465	P	502
R585	37.3	4.5	Tr464	P	345
R387	37.2	1.5	Tr464	P	611
R388	37.1	1.5	Tr464	P	567
R584	37.1	4.5	Tr464	P	296
V4002	36.5	4.5	Tr455	P	875
V3646	36.5	4.5	Tr401	P	744
V4014	36.5	4.5	Tr401	P	676
R395	36.5	4.5	Tr401	P	326
R359	36.1	1.5	T16	O	740
V4001	36.1	4.5	Tr455	P	738
R374	36.0	4.5	Tr401	P	802
R466	35.8	4.5	Tr455	P	674
R355	35.7	4.5	Tr429	P	992
R358	35.7	4.5	Tr429	P	895
R1369	35.6	4.5	Tr455	P	213
R569	35.5	4.5	T233	O	951
R465	34.9	4.5	Tr455	P	459
R572	34.7	4.5	Tr436	P	778
R306	34.7	4.5	Tr435	P	982

7 NOISE LEVEL SUMMARY TABLES

Table 7-1 Receptor noise level summary.

Point of Reception ID	Description	Height (m)	Distance to Nearest Noise Source (m)	Nearest Noise Source	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R306	Residence	4.5	982	Tr435	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R307	Residence	1.5	273	Tr436	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
R312	Residence	1.5	752	Tr416	29.1	29.1	29.1	29.1	29.1	40.0	43.0	45.0	49.0	51.0
R313	Residence	4.5	617	Tr416	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R355	Residence	4.5	992	Tr429	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R358	Residence	4.5	895	Tr429	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R359	Residence	1.5	740	T16	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
R360	Residence	1.5	839	Tr429	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R361	Residence	1.5	552	Tr430	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R362	Residence	1.5	391	Tr432	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R363	Church	1.5	445	Tr432	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
R364	Residence	7.5	258	Tr430	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
R365	Residence	1.5	245	Tr424	31.0	31.0	31.0	31.0	31.0	40.0	43.0	45.0	49.0	51.0
R367	Residence	4.5	271	Tr416	31.6	31.6	31.6	31.6	31.6	40.0	43.0	45.0	49.0	51.0
R368	Residence	4.5	300	Tr412	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R369	Residence	4.5	246	Tr407	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R371	Residence	4.5	334	Tr404	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R372	Residence	1.5	633	Tr401	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R373	Residence	1.5	843	Tr401	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R374	Residence	4.5	802	Tr401	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R378	Residence	1.5	265	Tr453	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R380	Residence	1.5	366	Tr454	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R381	Residence	1.5	207	Tr455	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R387	Residence	1.5	611	Tr464	37.2	37.2	37.2	37.2	37.2	40.0	43.0	45.0	49.0	51.0
R388	Residence	1.5	567	Tr464	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R389	Residence	4.5	511	Tr465	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R390	Residence	4.5	567	Tr465	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R391	Residence	4.5	502	Tr465	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R392	Residence	1.5	642	T56	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R393	Residence	4.5	428	Tr402	39.0	39.0	39.0	39.0	39.0	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height (m)	Distance to Nearest Noise Source (m)	Nearest Noise Source	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
R395	Residence	4.5	326	Tr401	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R396	Residence	1.5	699	Tr401	31.9	31.9	31.9	31.9	31.9	40.0	43.0	45.0	49.0	51.0
R455	Residence	4.5	293	Tr434	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R457	Residence	4.5	354	Tr434	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R460	Residence	4.5	484	Tr437	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R461	Residence	1.5	571	Tr437	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R462	Residence	4.5	527	Tr437	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R464	Residence	1.5	662	Tr437	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
R465	Residence	4.5	459	Tr455	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R466	Residence	4.5	674	Tr455	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R569	Residence	4.5	951	T233	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R571	Residence	1.5	828	Tr436	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R572	Residence	4.5	778	Tr436	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R573	Residence	4.5	712	Tr436	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R574	Residence	4.5	202	Tr437	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R575	Residence	4.5	196	Tr447	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R576	Residence	4.5	207	Tr447	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R577	Residence	4.5	187	Tr452	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R578	Residence	1.5	174	Tr462	33.7	33.7	33.7	33.7	33.7	40.0	43.0	45.0	49.0	51.0
R579	Residence	1.5	148	Tr462	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R581	Residence	1.5	226	Tr462	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0
R582	Residence	1.5	256	Tr462	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R584	Residence	4.5	296	Tr464	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R585	Residence	4.5	345	Tr464	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R587	Residence	4.5	808	T27	39.2	39.2	39.2	39.2	39.2	40.0	43.0	45.0	49.0	51.0
R1317	Residence	4.5	202	Tr447	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R1362	Residence	1.5	608	Tr437	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R1369	Residence	4.5	213	Tr455	35.6	35.6	35.6	35.6	35.6	40.0	43.0	45.0	49.0	51.0
R1375	Residence	1.5	873	Tr429	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0

Table 7-2 Receptor noise level comparison.

Point of Reception ID	Description	Height (m)	GREP-Solar NAR-R3 (dBA)	GREP (Wind & Solar) REA (dBA)
R306	Residence	4.5	34.7	35.2
R307	Residence	1.5	32.3	35.2
R312	Residence	1.5	29.1	32.2
R313	Residence	4.5	30.9	32.7
R355	Residence	4.5	35.7	36.2
R358	Residence	4.5	35.7	36.1
R359	Residence	1.5	36.1	37.6
R360	Residence	1.5	34.3	36.1
R361	Residence	1.5	32.6	35.1
R362	Residence	1.5	31.9	35.0
R363	Church	1.5	32.0	34.9
R364	Residence	7.5	33.6	35.6
R365	Residence	1.5	31.0	35.0

Point of Reception ID	Description	Height (m)	GREP-Solar NAR-R3 (dBA)	GREP (Wind & Solar) REA (dBA)
R367	Residence	4.5	31.6	34.3
R368	Residence	4.5	31.9	34.5
R369	Residence	4.5	32.5	34.5
R371	Residence	4.5	33.1	34.6
R372	Residence	1.5	34.1	35.9
R373	Residence	1.5	32.6	34.5
R374	Residence	4.5	36.0	36.4
R378	Residence	1.5	33.2	37.0
R380	Residence	1.5	34.0	36.6
R381	Residence	1.5	34.0	36.5
R387	Residence	1.5	37.2	38.9
R388	Residence	1.5	37.1	38.8
R389	Residence	4.5	37.7	38.2
R390	Residence	4.5	37.9	38.3
R391	Residence	4.5	37.7	38.2
R392	Residence	1.5	37.9	39.4
R393	Residence	4.5	39.0	39.4
R395	Residence	4.5	36.5	37.2
R396	Residence	1.5	31.9	34.1
R455	Residence	4.5	33.4	35.3
R457	Residence	4.5	33.3	35.0
R460	Residence	4.5	34.0	34.8
R461	Residence	1.5	32.7	34.9
R462	Residence	4.5	34.2	34.9
R464	Residence	1.5	33.0	35.1
R465	Residence	4.5	34.9	35.5
R466	Residence	4.5	35.8	36.2
R569	Residence	4.5	35.5	35.9
R571	Residence	1.5	33.4	35.3
R572	Residence	4.5	34.7	35.2
R573	Residence	4.5	34.4	35.0
R574	Residence	4.5	33.8	35.4
R575	Residence	4.5	34.2	36.4
R576	Residence	4.5	34.1	36.2
R577	Residence	4.5	34.4	38.4
R578	Residence	1.5	33.7	36.9
R579	Residence	1.5	34.0	36.9
R581	Residence	1.5	34.4	37.0
R582	Residence	1.5	34.6	37.1
R584	Residence	4.5	37.1	37.7
R585	Residence	4.5	37.3	37.9
R587	Residence	4.5	39.2	39.5
R1317	Residence	4.5	34.1	36.1
R1362	Residence	1.5	32.8	35.0
R1369	Residence	4.5	35.6	36.6
R1375	Residence	1.5	34.7	36.4

Table 7-3 Vacant lot surrogate receptor noise level summary.

Point of Reception ID	Description	Height (m)	Distance to Nearest Noise Source (m)	Nearest Noise Source	Calculated Sound Level at Selected Wind Speeds (dBA)					Sound Level Limit (dBA)				
					6.0	7.0	8.0	9.0	10.0	6.0	7.0	8.0	9.0	10.0
V3347	VLSR	4.5	926	Tr435	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V3646	VLSR	4.5	744	Tr401	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
V3649	VLSR	4.5	623	Tr465	38.3	38.3	38.3	38.3	38.3	40.0	43.0	45.0	49.0	51.0
V3654	VLSR	4.5	529	Tr401	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
V3655	VLSR	4.5	402	Tr404	32.3	32.3	32.3	32.3	32.3	40.0	43.0	45.0	49.0	51.0
V3656	VLSR	4.5	672	Tr416	30.8	30.8	30.8	30.8	30.8	40.0	43.0	45.0	49.0	51.0
V3657	VLSR	4.5	397	Tr424	31.7	31.7	31.7	31.7	31.7	40.0	43.0	45.0	49.0	51.0
V3658	VLSR	4.5	693	Tr424	33.0	33.0	33.0	33.0	33.0	40.0	43.0	45.0	49.0	51.0
V3664	VLSR	4.5	518	Tr436	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
V4001	VLSR	4.5	738	Tr455	36.1	36.1	36.1	36.1	36.1	40.0	43.0	45.0	49.0	51.0
V4002	VLSR	4.5	875	Tr455	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
V4014	VLSR	4.5	676	Tr401	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0

Table 7-4 Vacant lot surrogate receptor noise level comparison.

Point of Reception ID	Description	Height (m)	GREP-Solar NAR-R3 (dBA)	GREP (Wind & Solar) REA (dBA)
V3347	VLSR	4.5	34.6	35.0
V3646	VLSR	4.5	36.5	36.9
V3649	VLSR	4.5	38.3	38.7
V3654	VLSR	4.5	33.4	34.4
V3655	VLSR	4.5	32.3	33.9
V3656	VLSR	4.5	30.8	32.5
V3657	VLSR	4.5	31.7	34.2
V3658	VLSR	4.5	33.0	34.0
V3664	VLSR	4.5	34.0	34.8
V4001	VLSR	4.5	36.1	36.4
V4002	VLSR	4.5	36.5	36.8
V4014	VLSR	4.5	36.5	n/a

Table 7-5 Participant noise level summary.

Participating Receptor ID	Description	Height (m)	Distance to Nearest Noise Source (m)	Nearest Noise Source ID	Calculated Sound Level at Selected Wind Speeds (dBA)				
					6.0	7.0	8.0	9.0	10.0
P366	Residence	1.5	246	Tr416	30.4	30.4	30.4	30.4	30.4
P370	Residence	4.5	168	Tr407	32.6	32.6	32.6	32.6	32.6
P376	Residence	4.5	185	Tr412	32.6	32.6	32.6	32.6	32.6
P377	Residence	4.5	151	Tr458	34.5	34.5	34.5	34.5	34.5

Participating Receptor ID	Description	Height (m)	Distance to Nearest Noise Source (m)	Nearest Noise Source ID	Calculated Sound Level at Selected Wind Speeds (dBA)				
					6.0	7.0	8.0	9.0	10.0
P394	Residence	4.5	234	Tr401	35.5	35.5	35.5	35.5	35.5
P459	Residence	1.5	293	Tr434	32.0	32.0	32.0	32.0	32.0
P580	Residence	4.5	171	Tr462	35.8	35.8	35.8	35.8	35.8

Table 7-6 Participant noise level comparison.

Point of Reception ID	Description	Height (m)	GREP-Solar NAR-R3 (dBA)	GREP (Wind & Solar) REA (dBA)
P366	Residence	1.5	30.4	34.5
P370	Residence	4.5	32.6	34.9
P376	Residence	4.5	32.6	36.6
P377	Residence	4.5	34.5	37.7
P394	Residence	4.5	35.5	36.5
P459	Residence	1.5	32.0	35.2
P580	Residence	4.5	35.8	37.3

8 NOISE LEVEL ISOPLETH MAP

Figure 8-1 is a noise-level isopleth map of the A-weighted sound pressure levels (dBA) generated by all relevant noise sources over the GREP-Solar project region. It should be noted that in contrast to the requirements of the MoE (2008) Guidelines, this map does not correspond to any specific 10 m a.g.l. wind speed. This is because the MoE “predictable worst case” (for wind turbines) octave band source sound power levels have been used for the relevant wind turbines (see Section 5.2). For information, the “predictable worst case” for the turbines has been determined to occur for a 10 m a.g.l. wind speed of 7 ms^{-1} for both the SWT-2.3-101 (Max Power 2,221 kW) and SWT-2.3-101 (Max Power 2,126 kW) turbine models used in the neighbouring wind projects.

The noise levels are calculated for receptors with 1.5 m (1 storey) and 4.5 m (2 storeys) heights.

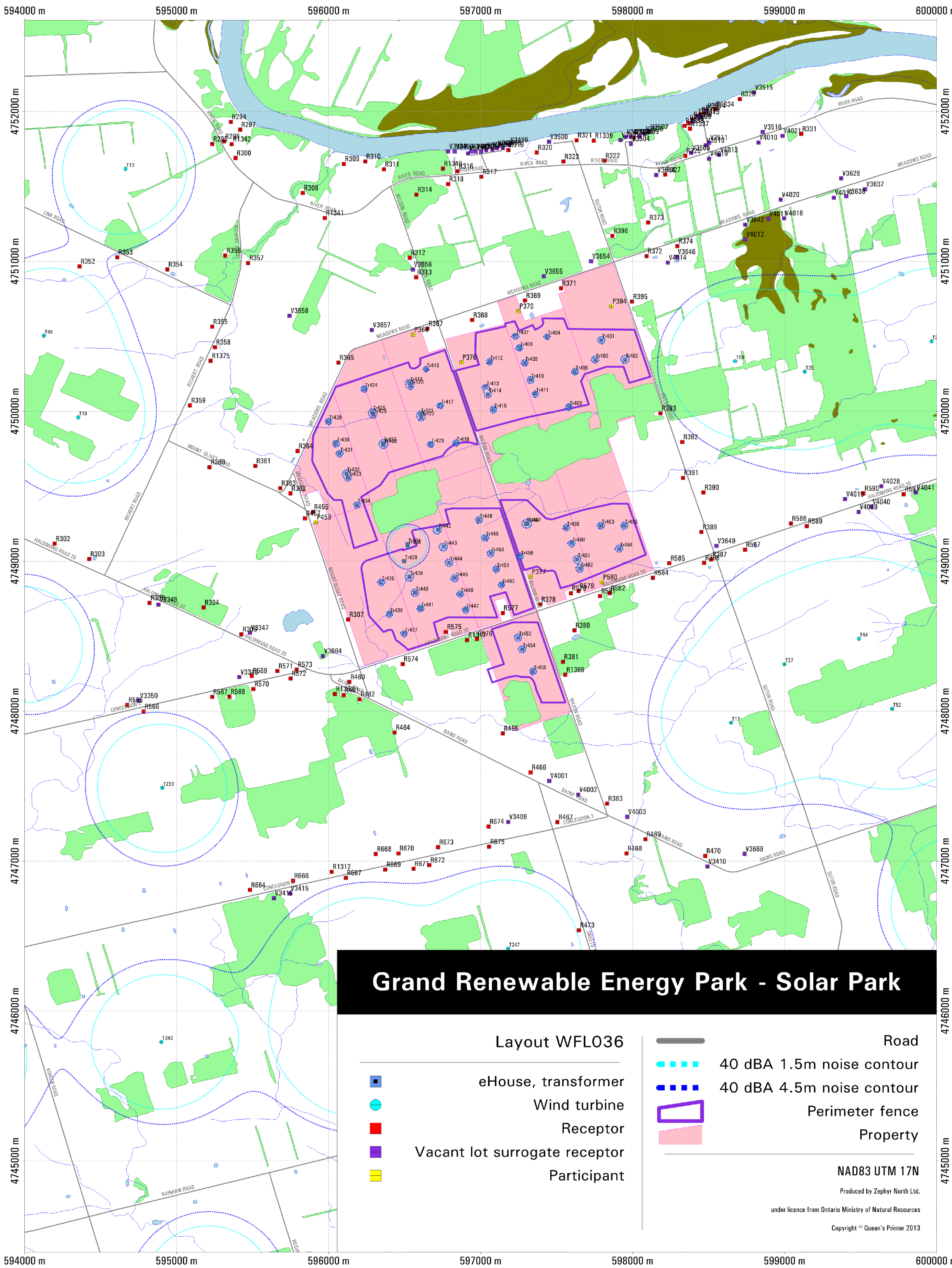


Figure 8-1 40 dBA noise isopleth map for 1.5 and 4.5 m receptor heights.

9 EXAMPLE CALCULATION

9.1 Method of Calculation

The calculation of cumulative receptor noise levels from turbines and transformers uses the methodology of ISO 9613-2, '*Acoustics — Attenuation of sound during propagation outdoors: Part 2: General method of calculation*'.

The calculation is based on equation (5) from ISO 9613-2 shown here:

$$L_{AT}(DW) = 10\log_{10}\left\{\sum_{i=1}^{n}\left[\sum_{j=1}^{8} 10^{0.1\left[L_{fT}(ij)+A_f(j)\right]}\right]\right\}$$

where

$L_{AT}(DW)$ is the equivalent continuous A-weighted downwind sound pressure level at a receptor location,

n is the number of turbines/transformers,

$A_f(j)$ is the standard A-weighting for octave band j,

j is an index indicating the eight standard octave-band mid-band frequencies from 63 Hz to 8 kHz,

$L_{fT}(ij) \equiv L_{fT}(DW)$ is the equivalent continuous downwind octave-band sound pressure level at a receptor location for turbine/transformer i and octave band j, and is given by

$$L_{ft}(DW) = L_W + D_C - A$$

where

L_W is the octave-band sound power level, in decibels, produced by the point sound source relative to a reference sound power of one picowatt,

D_C is the directivity correction in decibels,

A is the octave-band attenuation, in decibels, that occurs during propagation from the turbine/transformer to receptor, and is given by

$$A = A_{\text{div}} + A_{atm} + A_{gr} + A_{\text{bar}} + A_{misc}$$

where

A_{div} is the attenuation due to geometrical divergence,

A_{atm} is the attenuation due to atmospheric absorption,

A_{gr} is the attenuation due to the ground effect,

A_{bar} is the attenuation due to a barrier,

A_{misc} is the attenuation due to miscellaneous other effects,

A_{atm} is given by

$$A = \frac{\alpha d}{1000}$$

where

α is the atmospheric attenuation coefficient, in decibels per kilometre, for each octave band at the midband frequency,

d is the distance from the turbine/transformer to the receptor.

Note that α is calculated using ISO 9613-1, and not interpolated from Table 2 of ISO 9613-2. For this reason, the barometric pressure is one of the input parameters to the present calculation. Note also that A_{bar} and A_{misc} are not treated in here.

9.2 Example

The following sample calculation presents intermediate octave-band results of calculations for A-weighted sound pressure levels corresponding to the MoE-defined “predictable worst case”. All model parameters are the same as previously tabulated.

Table 9-1 lists the intermediate sound pressure levels calculated at receptor R393 due to the single nearby eHouse Tr402. This particular receptor has been chosen as requested by MoE as it will be affected both by the Solar Park eHouses and by the nearby turbine(s). Table 9-2 lists the intermediate sound pressure levels calculated at the same receptor due to the single turbine T56.

Receptor R393 is 428 m from eHouse Tr402 and 602 m from turbine T56. Note that the resultant A-weighted sound pressure level at R393 due to eHouse Tr402 alone is 10.6 dBA, and due to turbine T56 alone is 36.8 dBA.

Table 9-1 Sample calculation for receptor and eHouse.

Intermediate calculations for receptor R393 and eHouse Tr402						
Octave band	Mid-band frequency (Hz)	L_W (dBA)	A_{div} (dB)	A_{atm} (dB)	A_{gr} (dB)	L_{fT}(DW) (dBA)
1	63	67.8	63.6	0.0	-4.4	8.5
2	125	66.9	63.6	0.2	3.6	-0.5
3	250	67.4	63.6	0.4	3.1	0.2
4	500	65.8	63.6	0.8	-0.9	2.3
5	1000	59.0	63.6	1.6	-1.0	-5.2
6	2000	59.2	63.6	4.2	-1.0	-7.6
7	4000	71.0	63.6	14.0	-1.0	-5.7
8	8000	66.9	63.6	50.1	-1.0	-45.8

Table 9-2 Sample calculation for receptor and turbine.

Intermediate calculations for receptor R393 and turbine T56						
Octave band	Mid-band frequency (Hz)	L_W (dBA)	A_{div} (dB)	A_{atm} (dB)	A_{gr} (dB)	L_{fT}(DW) (dBA)
1	63	86.0	66.6	0.1	-3.0	22.4
2	125	91.6	66.6	0.2	1.0	23.8
3	250	97.5	66.6	0.6	-0.1	30.4
4	500	98.3	66.6	1.1	-0.7	31.3
5	1000	99.9	66.6	2.2	-0.7	31.8
6	2000	97.2	66.6	5.8	-0.8	25.5
7	4000	93.5	66.6	19.7	-0.8	7.9
8	8000	77.9	66.6	70.4	-0.8	-58.4

In the table:

L_W is the octave-band sound power level, in decibels, produced by the point sound source relative to a reference sound power of one picowatt,

A_{div} is the attenuation due to geometrical divergence,

A_{atm} is the attenuation due to atmospheric absorption,

A_{gr} is the attenuation due to the ground effect,

$L_{fT}(DW)$ is the equivalent continuous downwind octave-band sound pressure level.

Table 9-3 shows intermediate octave band values of the calculations for the A-weighted sound pressure levels at receptor R393 due to all eHouses, turbines and transformers (from all projects) within 5,000 m of the receptor. The resultant A-weighted sound pressure level at R393 due to all eHouses, turbines and transformers is 39.0 dBA.

Table 9-3 Sample calculation for single receptor and multiple turbines.

Intermediate calculations for R393 and multiple turbines										
Turbine ID	Distance (m)	Turbine L_{ft} contribution (dB) in frequency band (Hz)								Turbine L_{AT} (dBA)
		63	125	250	500	1000	2000	4000	8000	
T10	4466	31.3	20.3	17.6	9.2	-1.3	-31.9	-137.7	-526.8	12.7
T12	4374	31.8	21.1	18.1	10.3	0.8	-29.3	-133.8	-515.6	13.5
T13	3880	32.6	22.3	19.6	12.2	3.6	-23.5	-116.7	-456.9	15.0
T16	3832	32.7	22.4	19.8	12.4	3.9	-23.0	-115.0	-451.2	15.1
T17	2116	37.5	28.2	26.5	20.7	15.3	-1.3	-53.7	-245.4	22.6
T22	3842	32.7	22.4	19.7	12.4	3.9	-23.1	-115.3	-452.3	15.1
T25	989	44.2	35.3	34.3	29.5	26.1	16.3	-10.1	-106.9	31.5
T27	1862	38.6	29.4	27.9	22.3	17.4	2.3	-44.2	-214.5	24.2
T29	1846	38.7	29.5	28.0	22.4	17.5	2.5	-43.6	-212.6	24.3
T35	4708	31.3	20.4	17.2	9.1	-1.0	-33.2	-145.4	-555.3	12.5
T37	4400	31.8	21.1	18.1	10.2	0.7	-29.6	-134.8	-518.8	13.4
T38	4454	31.7	21.0	17.9	10.0	0.4	-30.3	-136.6	-525.2	13.2
T42	2231	37.0	27.7	26.0	20.0	14.4	-2.9	-57.9	-259.3	22.0
T44	1991	38.0	28.8	27.2	21.5	16.3	0.5	-49.0	-230.2	23.4
T48	4091	32.3	21.8	19.0	11.4	2.4	-26.0	-124.0	-482.0	14.3
T52	2491	36.0	26.6	24.7	18.6	12.5	-6.3	-67.4	-290.7	20.6
T53	2671	35.4	25.9	24.0	17.6	11.2	-8.7	-73.9	-312.2	19.7
T55	3843	32.7	22.4	19.7	12.4	3.9	-23.1	-115.4	-452.4	15.1
T56	602	48.6	39.9	39.0	34.5	31.8	24.3	6.9	-57.3	36.8
T68	4092	32.3	21.8	19.0	11.4	2.4	-26.0	-124.0	-482.1	14.3
T233	4121	32.6	21.8	19.0	11.3	2.3	-26.3	-125.0	-485.5	14.4
T244	4201	32.5	21.6	18.7	11.0	1.9	-27.2	-127.8	-495.0	14.1
T245	4664	31.7	20.6	17.4	9.3	-0.7	-32.6	-143.8	-550.0	12.8
T246	4182	32.5	21.7	18.8	11.1	2.0	-27.0	-127.1	-492.7	14.2
T247	3709	33.4	22.9	20.3	13.0	4.7	-21.4	-110.6	-436.4	15.7
Tr300	1884	-2.6	-1.3	3.2	9.7	3.5	-11.6	-60.3	-228.1	8.5
Tr301	1880	-2.6	-1.3	3.3	9.7	3.5	-11.5	-60.2	-227.5	8.5
Tr401	625	31.9	11.6	5.5	1.9	-9.1	-13.9	-16.3	-71.0	7.4
Tr402	428	34.7	15.6	8.8	5.5	-5.2	-8.8	-6.7	-44.7	10.6
Tr403	560	32.7	12.8	6.5	2.9	-7.9	-12.3	-13.2	-62.4	8.3
Tr404	905	29.0	7.8	2.0	-1.8	-13.3	-19.7	-28.6	-106.8	4.2
Tr405	628	31.9	11.6	5.4	1.8	-9.2	-13.9	-16.4	-71.4	7.4
Tr406	605	32.2	12.0	5.8	2.2	-8.8	-13.4	-15.4	-68.4	7.7
Tr407	1085	27.5	6.0	0.3	-3.7	-15.5	-23.0	-36.1	-129.5	2.7
Tr408	1026	28.0	6.5	0.8	-3.1	-14.8	-22.0	-33.7	-122.1	3.2
Tr409	956	28.6	7.2	1.5	-2.3	-13.9	-20.7	-30.8	-113.3	3.8
Tr410	885	29.2	8.0	2.3	-1.5	-13.0	-19.3	-27.8	-104.2	4.4
Tr411	834	29.7	8.6	2.8	-1.0	-12.3	-18.3	-25.6	-97.8	5.0
Tr412	1177	26.9	5.2	-0.5	-4.5	-16.5	-24.6	-39.8	-140.9	2.0
Tr413	1164	27.0	5.3	-0.4	-4.4	-16.4	-24.4	-39.3	-139.3	2.1
Tr414	1142	27.1	5.5	-0.2	-4.2	-16.2	-24.0	-38.4	-136.5	2.2

Intermediate calculations for R393 and multiple turbines										
Turbine ID	Distance (m)	Turbine L_{ft} contribution (dB) in frequency band (Hz)								Turbine L_{AT} (dBA)
		63	125	250	500	1000	2000	4000	8000	
Tr415	1100	27.4	5.8	0.2	-3.8	-15.7	-23.3	-36.7	-131.3	2.5
Tr416	1572	24.5	2.5	-3.4	-7.8	-20.5	-30.9	-55.2	-189.6	-0.6
Tr417	1450	25.2	3.2	-2.5	-6.9	-19.3	-29.0	-50.5	-174.6	0.1
Tr418	1362	25.7	3.8	-1.9	-6.1	-18.5	-27.6	-47.1	-163.7	0.7
Tr419	1666	24.0	1.9	-4.0	-8.5	-21.3	-32.3	-58.8	-201.1	-1.1
Tr420	1657	24.0	2.0	-3.9	-8.4	-21.3	-32.2	-58.5	-200.0	-1.1
Tr421	1582	24.4	2.4	-3.4	-7.9	-20.6	-31.1	-55.6	-190.8	-0.7
Tr422	1575	24.5	2.5	-3.4	-7.8	-20.5	-31.0	-55.4	-190.0	-0.6
Tr423	1527	24.7	2.8	-3.1	-7.4	-20.1	-30.2	-53.5	-184.1	-0.4
Tr424	1957	22.6	0.4	-5.6	-10.4	-23.8	-36.5	-69.7	-236.5	-2.6
Tr425	1898	22.9	0.7	-5.3	-10.0	-23.3	-35.7	-67.5	-229.4	-2.3
Tr426	1891	22.9	0.8	-5.3	-10.0	-23.3	-35.6	-67.3	-228.5	-2.3
Tr427	1837	23.2	1.0	-5.0	-9.6	-22.8	-34.8	-65.3	-221.9	-2.0
Tr428	1834	23.2	1.1	-4.9	-9.6	-22.8	-34.8	-65.2	-221.6	-2.0
Tr429	2187	21.7	-0.6	-6.8	-11.8	-25.6	-39.7	-78.2	-264.3	-3.6
Tr430	2146	21.8	-0.4	-6.6	-11.5	-25.3	-39.2	-76.7	-259.4	-3.4
Tr431	2130	21.9	-0.4	-6.5	-11.5	-25.2	-38.9	-76.2	-257.5	-3.4
Tr432	2107	22.0	-0.2	-6.4	-11.3	-25.0	-38.6	-75.3	-254.6	-3.3
Tr433	2102	22.0	-0.2	-6.4	-11.3	-24.9	-38.6	-75.1	-254.2	-3.2
Tr434	2089	22.1	-0.2	-6.3	-11.2	-24.8	-38.4	-74.6	-252.6	-3.2
Tr435	2157	21.8	-0.5	-6.7	-11.6	-25.4	-39.3	-77.2	-260.8	-3.5
Tr436	2232	21.5	-0.8	-7.0	-12.1	-25.9	-40.3	-79.9	-269.8	-3.8
Tr437	2238	21.5	-0.8	-7.1	-12.1	-26.0	-40.4	-80.1	-270.5	-3.8
Tr438	1955	22.6	0.5	-5.6	-10.4	-23.8	-36.5	-69.7	-236.3	-2.6
Tr439	1980	22.5	0.3	-5.8	-10.5	-24.0	-36.9	-70.6	-239.3	-2.7
Tr440	2011	22.4	0.2	-5.9	-10.7	-24.2	-37.3	-71.7	-243.1	-2.8
Tr441	2047	22.2	0.0	-6.1	-11.0	-24.5	-37.8	-73.1	-247.5	-3.0
Tr442	1659	24.0	2.0	-3.9	-8.4	-21.3	-32.2	-58.6	-200.3	-1.1
Tr443	1682	23.9	1.9	-4.0	-8.6	-21.5	-32.6	-59.4	-203.1	-1.2
Tr444	1711	23.8	1.7	-4.2	-8.8	-21.7	-33.0	-60.5	-206.6	-1.4
Tr445	1746	23.6	1.5	-4.4	-9.0	-22.0	-33.5	-61.8	-210.8	-1.6
Tr446	1787	23.4	1.3	-4.7	-9.3	-22.4	-34.1	-63.4	-215.9	-1.8
Tr447	1834	23.2	1.1	-4.9	-9.6	-22.8	-34.8	-65.2	-221.6	-2.0
Tr448	1391	25.5	3.6	-2.1	-6.4	-18.8	-28.1	-48.2	-167.3	0.5
Tr449	1421	25.3	3.4	-2.3	-6.6	-19.1	-28.6	-49.4	-171.1	0.3
Tr450	1457	25.1	3.2	-2.6	-6.9	-19.4	-29.2	-50.8	-175.5	0.1
Tr451	1501	24.9	2.9	-2.9	-7.2	-19.8	-29.8	-52.5	-180.9	-0.2
Tr452	1551	24.6	2.6	-3.2	-7.6	-20.3	-30.6	-54.4	-187.0	-0.5
Tr453	1766	23.5	1.4	-4.5	-9.1	-22.2	-33.8	-62.6	-213.3	-1.7
Tr454	1819	23.2	1.1	-4.9	-9.5	-22.7	-34.6	-64.6	-219.7	-1.9
Tr455	1915	22.8	0.7	-5.4	-10.1	-23.4	-35.9	-68.2	-231.4	-2.4
Tr456	1153	27.0	5.4	-0.3	-4.3	-16.3	-24.2	-38.8	-137.9	2.1
Tr457	1143	27.1	5.5	-0.2	-4.2	-16.2	-24.0	-38.4	-136.7	2.2
Tr458	1330	25.9	4.0	-1.7	-5.9	-18.1	-27.1	-45.8	-159.8	0.9
Tr459	985	28.3	6.9	1.2	-2.7	-14.3	-21.2	-32.0	-116.9	3.5
Tr460	1048	27.8	6.3	0.6	-3.3	-15.1	-22.4	-34.6	-124.8	3.0
Tr461	1119	27.3	5.7	0.0	-4.0	-15.9	-23.6	-37.4	-133.6	2.4
Tr462	1166	27.0	5.3	-0.4	-4.4	-16.4	-24.4	-39.3	-139.5	2.0
Tr463	845	29.6	8.5	2.7	-1.1	-12.5	-18.6	-26.1	-99.3	4.8
Tr464	943	28.7	7.3	1.6	-2.2	-13.8	-20.4	-30.2	-111.7	3.9
Tr465	787	30.1	9.2	3.4	-0.4	-11.7	-17.4	-23.5	-91.8	5.5

10 CONCLUSIONS

This noise impact assessment for the updated configuration of the Solar Park portion of the proposed Grand Renewable Energy Park has determined that the estimated sound pressure levels at receptors and Vacant Lot Surrogate Receptors (VLSRs) in the project area comply with the Ministry of the Environment sound level limits at all qualified points of reception.

11 REFERENCES

Bird, Thomas, 2012: Email of 2012/02/01 from Thomas Bird (NextEra) to Jim Salmon (Zephyr North) including spreadsheet with receptor and VLSR identifiers and locations.

CAN/CSA, 2007: Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques, CAN/CSA-C61400-11-07, (Adopted IEC 61400-11:2002 + A1:2006, edition 2.1, 2006-11)

CAN/CSA, 2009: Power Transformers and Reactors, Electrical Power Systems and Equipment, A National Standard of Canada, CAN/CSA-C88-M90, Originally published in 1990, Reaffirmed in 2009.

CAN/CSA, 2011: Three-Phase Pad-Mounted Distribution Transformers with Separable Insulated High-Voltage Connectors, CAN/CSA-C227.4-06 Standard, Published 2006, Reaffirmed 2011. Canadian Standards Association.

Golder Associates, 2011: NextEra Energy Canada, ULC, Summerhaven Wind Energy Centre, Application for a Renewable Energy Approval; Noise Study Report, Report Number: 10-1151-0035, August 2011, Golder Associates, 2390 Argentia Road, Mississauga, Ontario, L5N 5Z7, Canada. +1 (905) 567 4444.

Golder Associates, 2012: NextEra Energy Canada, ULC, Summerhaven Wind Energy Centre, Application for an Amended Renewable Energy Approval; Revised Noise Study Report, Report Number: 10-1151-0035, November 2012, Revision 2.0, Golder Associates, 2390 Argentia Road, Mississauga, Ontario, L5N 5Z7, Canada. +1 (905) 567 4444.

Government of Ontario, 1990: Environmental Assessment Act, R.S.O. 1990, Chapter E.18. http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e18_e.htm

Government of Ontario, 1990: Environmental Protection Act, R.S.O. 1990, Chapter E.19. http://www.e-laws.gov.on.ca/html/statutes/english/elaws_statutes_90e19_e.htm

Government of Ontario, 2009: Green Energy Act, 2009, http://www.search.e-laws.gov.on.ca/en/isysquery/abaf99f7-8e6f-4ea9-b8a4-d6d8b0435bac/1/doc/?search=browseStatutes&context=#BK7

Government of Ontario, 2009b: Ontario Regulation 359/09, made under the Environmental Protection Act, Renewable Energy Approvals under Part V.0.1 of the Act. http://www.search.e-laws.gov.on.ca/en/isysquery/e366a7f1-5b0c-4468-b87d-479b33d386b4/1/frame/?search=browseStatutes&context=

Government of Ontario, 2010, O.Reg. 521/10 made under the Environmental Protection Act amending O.Reg. 359/09. http://www.e-laws.gov.on.ca/html/source/regs/english/2010/elaws_src_regs_r10521_e.htm

Government of Ontario, 2011, O.Reg. 231/11 made under the Environmental Protection Act amending O.Reg. 359/09. http://www.e-laws.gov.on.ca/html/source/regs/english/2011/elaws_src_regs_r11231_e.htm

Government of Ontario, 2012, O.Reg. 195/12 made under the Environmental Protection Act amending O.Reg. 359/09. http://www.e-laws.gov.on.ca/html/source/regs/english/2012/elaws_src_regs_r12195_e.htm

HGC Engineering, 2013: Letter dated 2013-00-04 from Ian Bonsma of HGC Engineering to David Oxtoby of Carbon Free Technology / Grand Renewable Solar LP. See Section 13 for copy.

IEEE, 2010: IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers, ANSI/IEEE C57.12.90-2010.

International Standards Organization (ISO), 1993: 9613-1 International Standard: Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=17426

International Standards Organization (ISO), 1996: 9613-2 International Standard: Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=20649

Ontario Ministry of the Environment (MoE), Date unknown: Sound Level Adjustments, Publication NPC-104. http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079360.pdf

Ontario Ministry of the Environment (MoE), 1995a: Sound Level Limits for Stationary Sources in Class 1 & 2 Areas (Urban), Publication NPC-205. October 1995. http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/std01_079360.pdf

Ontario Ministry of the Environment (MoE), 1995b: Sound Level Limits for Stationary Sources in Class 3 Areas (Rural), Publication NPC-232. October 1995. http://www.ene.gov.on.ca/envision/gp/3405e.pdf

Ontario Ministry of the Environment (MoE), 2008: MoE Noise Guidelines for Wind Farms; Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities (October 2008). http://www.ene.gov.on.ca/publications/4709e.pdf. 20 pp.

Ontario Ministry of the Environment (MoE), 2011: Basic Comprehensive Certificates of Approval (Air), User Guide. MoE Environmental Assessment and Approvals Branch. Last Revision Date: March 2011 (Version 2.1). PIBS 4391e01. http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/resource/stdprod_083898.pdf

Siemens Wind Power A/S, 2013a: *SWT-2.3-101, Rev. 4, Max. Power 2221 kW, Contract Acoustic Emission, Hub Height 99.5m, Grand Renewable – Ontario – Canada*. Document ID: E W EN OEN DES TLS-10-0000-1074-01, HST, DRK / 2013.07.05.

Siemens Wind Power A/S, 2013b: *SWT-2.3-101, Rev. 4, Max. Power 2126 kW, Contract Acoustic Emission, Hub Height 99.5m, Grand Renewable – Ontario – Canada*. Document ID: E W EN OEN DES TLS-10-0000-1073-01, HST, JES / 2013.07.05.

Zephyr North, 2012a: Grand Renewable Energy Park, Noise Assessment Report, Revision 2, 2012-05-29. Zephyr North Ltd., 20-850 Legion Road, Burlington, Ontario, L7S 1T5, Canada. Tel: +01 905 335 9670. Fax: +01 905 335 0119. Email: Info@ZephyrNorth.com.

Zephyr North, 2012b: Grand Renewable Energy Park, Noise Assessment Report, Revision 2 – Addendum 1, 2012-05-29. Zephyr North Ltd., 20-850 Legion Road, Burlington, Ontario, L7S 1T5, Canada. Tel: +01 905 335 9670. Fax: +01 905 335 0119. Email: Info@ZephyrNorth.com.

12 APPENDIX A — TURBINE, TRANSFORMER, RECEPTOR, VACANT LOT AND PARTICIPANT LOCATIONS

This appendix contains lists of eHouse, transformer, and turbine locations. Coordinates are given in the Universal Transverse Mercator (UTM) Zone 17 North projection. The datum is North American Datum 1983 (NAD83, Canada).

For reference, the project (transformer/turbine) layout identifier is:

`CFS13-Trbn-WFL036.csv`

eHouses, Transformers

```
Project Name: Grand Renewable Energy Park - Solar Park
Datum and Projection: NAD83 (Canada); UTM 17N
```

Identifier	Equipment Make and Model	X(E,m)	Y(N,m)	Remarks
Tr300	Transformer	596520	4749103	GREP-Wind
Tr301	Transformer	596520	4749113	GREP-Solar
Tr401	eHouse	597795	4750476	GREP-Solar
Tr402	eHouse	597949	4750345	GREP-Solar
Tr403	eHouse	597753	4750345	GREP-Solar
Tr404	eHouse	597438	4750499	GREP-Solar
Tr405	eHouse	597621	4750265	GREP-Solar
Tr406	eHouse	597580	4750029	GREP-Solar
Tr407	eHouse	597229	4750502	GREP-Solar
Tr408	eHouse	597256	4750423	GREP-Solar
Tr409	eHouse	597290	4750324	GREP-Solar
Tr410	eHouse	597328	4750210	GREP-Solar

Tr411	eHouse	597360	4750117	GREP-Solar
Tr412	eHouse	597059	4750331	GREP-Solar
Tr413	eHouse	597034	4750161	GREP-Solar
Tr414	eHouse	597050	4750114	GREP-Solar
Tr415	eHouse	597085	4750011	GREP-Solar
Tr416	eHouse	596640	4750281	GREP-Solar
Tr417	eHouse	596736	4750039	GREP-Solar
Tr418	eHouse	596837	4749789	GREP-Solar
Tr419	eHouse	596531	4750190	GREP-Solar
Tr420	eHouse	596538	4750170	GREP-Solar
Tr421	eHouse	596603	4749980	GREP-Solar
Tr422	eHouse	596610	4749960	GREP-Solar
Tr423	eHouse	596671	4749779	GREP-Solar
Tr424	eHouse	596235	4750149	GREP-Solar
Tr425	eHouse	596287	4749998	GREP-Solar
Tr426	eHouse	596294	4749977	GREP-Solar
Tr427	eHouse	596358	4749788	GREP-Solar
Tr428	eHouse	596362	4749776	GREP-Solar
Tr429	eHouse	595998	4749934	GREP-Solar
Tr430	eHouse	596049	4749785	GREP-Solar
Tr431	eHouse	596072	4749718	GREP-Solar
Tr432	eHouse	596117	4749586	GREP-Solar
Tr433	eHouse	596127	4749557	GREP-Solar
Tr434	eHouse	596187	4749377	GREP-Solar
Tr435	eHouse	596345	4748860	GREP-Solar
Tr436	eHouse	596400	4748647	GREP-Solar
Tr437	eHouse	596497	4748517	GREP-Solar
Tr438	eHouse	596497	4749000	GREP-Solar
Tr439	eHouse	596533	4748895	GREP-Solar
Tr440	eHouse	596569	4748790	GREP-Solar
Tr441	eHouse	596604	4748685	GREP-Solar
Tr442	eHouse	596718	4749210	GREP-Solar
Tr443	eHouse	596758	4749097	GREP-Solar
Tr444	eHouse	596793	4748992	GREP-Solar
Tr445	eHouse	596829	4748887	GREP-Solar
Tr446	eHouse	596865	4748782	GREP-Solar
Tr447	eHouse	596901	4748677	GREP-Solar
Tr448	eHouse	596990	4749276	GREP-Solar
Tr449	eHouse	597030	4749158	GREP-Solar
Tr450	eHouse	597066	4749053	GREP-Solar
Tr451	eHouse	597102	4748948	GREP-Solar
Tr452	eHouse	597138	4748843	GREP-Solar
Tr453	eHouse	597247	4748492	GREP-Solar
Tr454	eHouse	597274	4748413	GREP-Solar
Tr455	eHouse	597345	4748266	GREP-Solar
Tr456	eHouse	597297	4749250	GREP-Solar
Tr457	eHouse	597310	4749250	GREP-Solar
Tr458	eHouse	597260	4749031	GREP-Solar
Tr459	eHouse	597563	4749224	GREP-Solar
Tr460	eHouse	597599	4749119	GREP-Solar
Tr461	eHouse	597635	4749014	GREP-Solar
Tr462	eHouse	597653	4748951	GREP-Solar
Tr463	eHouse	597792	4749238	GREP-Solar
Tr464	eHouse	597912	4749084	GREP-Solar
Tr465	eHouse	597944	4749238	GREP-Solar

Turbines

Project Name: Grand Renewable Energy Park - Solar Park
Datum and Projection: NAD83 (Canada); UTM 17N

Identifier	Equipment Make and Model	X(E,m)	Y(N,m)	Remarks
T5	Siemens SWT-2.3-101 (MP2221kW)	602757	4745791	GREP-Wind
T9	Siemens SWT-2.3-101 (MP2221kW)	600290	4745005	GREP-Wind
T10	Siemens SWT-2.3-101 (MP2126kW	593994	4748442	GREP-Wind
T11	Siemens SWT-2.3-101 (MP2221kW)	603472	4748075	GREP-Wind
T12	Siemens SWT-2.3-101 (MP2221kW)	601479	4747111	GREP-Wind
T13	Siemens SWT-2.3-101 (MP2221kW)	594663	4751618	GREP-Wind
T14	Siemens SWT-2.3-101 (MP2221kW)	603952	4750047	GREP-Wind
T16	Siemens SWT-2.3-101 (MP2221kW)	594352	4749960	GREP-Wind
T17	Siemens SWT-2.3-101 (MP2221kW)	598648	4747922	GREP-Wind
T20	Siemens SWT-2.3-101 (MP2221kW)	592573	4749463	GREP-Wind
T21	Siemens SWT-2.3-101 (MP2221kW)	602692	4746290	GREP-Wind
T22	Siemens SWT-2.3-101 (MP2221kW)	601756	4751401	GREP-Wind
T23	Siemens SWT-2.3-101 (MP2221kW)	591178	4751634	GREP-Wind
T24	Siemens SWT-2.3-101 (MP2221kW)	592283	4749800	GREP-Wind
T25	Siemens SWT-2.3-101 (MP2221kW)	599133	4750265	GREP-Wind
T27	Siemens SWT-2.3-101 (MP2221kW)	598999	4748313	GREP-Wind
T28	Siemens SWT-2.3-101 (MP2221kW)	591339	4752273	GREP-Wind
T29	Siemens SWT-2.3-101 (MP2221kW)	599967	4750467	GREP-Wind
T35	Siemens SWT-2.3-101 (MP2221kW)	602880	4749652	GREP-Wind
T37	Siemens SWT-2.3-101 (MP2221kW)	602481	4749039	GREP-Wind
T38	Siemens SWT-2.3-101 (MP2221kW)	602608	4749469	GREP-Wind
T39	Siemens SWT-2.3-101 (MP2221kW)	603875	4749401	GREP-Wind
T40	Siemens SWT-2.3-101 (MP2221kW)	604239	4749614	GREP-Wind
T42	Siemens SWT-2.3-101 (MP2221kW)	600381	4750377	GREP-Wind
T44	Siemens SWT-2.3-101 (MP2221kW)	599489	4748483	GREP-Wind
T46	Siemens SWT-2.3-101 (MP2221kW)	590582	4751836	GREP-Wind
T48	Siemens SWT-2.3-101 (MP2221kW)	594126	4750504	GREP-Wind
T51	Siemens SWT-2.3-101 (MP2221kW)	601762	4745085	GREP-Wind
T52	Siemens SWT-2.3-101 (MP2221kW)	599708	4748016	GREP-Wind
T53	Siemens SWT-2.3-101 (MP2221kW)	600301	4748359	GREP-Wind
T55	Siemens SWT-2.3-101 (MP2221kW)	600136	4746677	GREP-Wind
T56	Siemens SWT-2.3-101 (MP2221kW)	598675	4750335	GREP-Wind
T58	Siemens SWT-2.3-101 (MP2126kW)	589733	4750362	GREP-Wind
T68	Siemens SWT-2.3-101 (MP2221kW)	602131	4748909	GREP-Wind
T219	Siemens SWT-2.3-101 (MP2221kW)	590644	4749342	SWEC
T228	Siemens SWT-2.3-101 (MP2221kW)	591259	4748123	SWEC
T232	Siemens SWT-2.3-101 (MP2221kW)	590737	4746531	SWEC
T233	Siemens SWT-2.3-101 (MP2221kW)	594906	4747489	SWEC
T238	Siemens SWT-2.3-101 (MP2221kW)	591475	4744600	SWEC
T239	Siemens SWT-2.3-101 (MP2221kW)	591880	4745113	SWEC
T240	Siemens SWT-2.3-101 (MP2221kW)	592721	4744952	SWEC
T241	Siemens SWT-2.3-101 (MP2221kW)	593224	4745318	SWEC
T242	Siemens SWT-2.3-101 (MP2221kW)	593522	4745702	SWEC
T243	Siemens SWT-2.3-101 (MP2221kW)	594899	4745794	SWEC
T244	Siemens SWT-2.3-101 (MP2221kW)	596210	4746279	SWEC
T245	Siemens SWT-2.3-101 (MP2221kW)	596181	4745775	SWEC
T246	Siemens SWT-2.3-101 (MP2221kW)	597119	4745943	SWEC
T247	Siemens SWT-2.3-101 (MP2221kW)	597181	4746416	SWEC
T252	Siemens SWT-2.3-101 (MP2221kW)	593087	4743349	SWEC
T253	Siemens SWT-2.3-101 (MP2221kW)	593930	4743637	SWEC
T254	Siemens SWT-2.3-101 (MP2221kW)	595213	4744131	SWEC
T255	Siemens SWT-2.3-101 (MP2221kW)	596817	4743995	SWEC
T256	Siemens SWT-2.3-101 (MP2221kW)	597076	4743766	SWEC

Receptors

Project Name: Grand Renewable Energy Park - Solar Park
Datum and Projection: NAD83 (Canada); UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
R304	Residence	1.5	3	595177	4748691
R306	Residence	4.5	3	595426	4748513
R307	Residence	1.5	3	596129	4748611
R308	Residence	1.5	3	595830	4751457
R309	Residence	4.5	3	596100	4751651
R310	Residence	4.5	3	596240	4751667
R311	Residence	4.5	3	596363	4751615
R312	Residence	1.5	3	596533	4751025
R313	Residence	4.5	3	596576	4750895
R314	Residence	4.5	3	596578	4751446
R316	Residence	4.5	3	596849	4751602
R317	Residence	1.5	3	597005	4751565
R318	Residence	1.5	3	596786	4751516
R319	Residence	1.5	3	597182	4751744
R320	Residence	4.5	3	597369	4751727
R321	Residence	1.5	3	597631	4751809
R322	Residence	4.5	3	597814	4751672
R323	Residence	4.5	3	597545	4751666
R324	Residence	1.5	3	598007	4751826
R325	Residence	1.5	3	598346	4751705
R327	Residence	4.5	3	598214	4751579
R354	Residence	4.5	3	594938	4750947
R356	Residence	1.5	3	595320	4751040
R357	Residence	1.5	3	595471	4750990
R358	Residence	4.5	3	595252	4750428
R359	Residence	1.5	3	595088	4750040
R360	Residence	1.5	3	595216	4749628
R361	Residence	1.5	3	595517	4749636
R362	Residence	1.5	3	595748	4749453
R363	Church	1.5	3	595682	4749487
R364	Residence	7.5	3	595795	4749735
R365	Residence	1.5	3	596064	4750325
R367	Residence	4.5	3	596650	4750552
R368	Residence	4.5	3	596945	4750609
R369	Residence	4.5	3	597292	4750739
R371	Residence	4.5	3	597528	4750821
R372	Residence	1.5	3	598092	4751035
R373	Residence	1.5	3	598103	4751260
R374	Residence	4.5	3	598295	4751102
R378	Residence	1.5	3	597392	4748712
R380	Residence	1.5	3	597617	4748539
R381	Residence	1.5	3	597542	4748329
R383	Residence	4.5	3	597832	4747384
R387	Residence	1.5	3	598518	4749012
R388	Residence	1.5	3	598470	4748990
R389	Residence	4.5	3	598453	4749195
R390	Residence	4.5	3	598466	4749459
R391	Residence	4.5	3	598331	4749557
R392	Residence	1.5	3	598327	4749796
R393	Residence	4.5	3	598184	4749987
R395	Residence	4.5	3	597996	4750732
R396	Residence	1.5	3	597867	4751171

R455	Residence	4.5	3	595897	4749329
R457	Residence	4.5	3	595844	4749286
R460	Residence	4.5	3	596136	4748195
R461	Residence	1.5	3	596099	4748107
R462	Residence	4.5	3	596203	4748080
R464	Residence	1.5	3	596434	4747858
R466	Residence	4.5	3	597329	4747592
R467	Residence	1.5	3	597505	4747260
R468	Residence	4.5	3	597960	4747051
R469	Residence	1.5	3	598084	4747146
R567	Residence	4.5	3	595233	4748095
R568	Residence	4.5	3	595348	4748097
R569	Residence	4.5	3	595494	4748236
R570	Residence	4.5	3	595505	4748148
R571	Residence	1.5	3	595663	4748268
R572	Residence	4.5	3	595750	4748218
R573	Residence	4.5	3	595790	4748278
R574	Residence	4.5	3	596487	4748315
R575	Residence	4.5	3	596772	4748529
R576	Residence	4.5	3	596975	4748483
R577	Residence	4.5	3	597145	4748655
R578	Residence	1.5	3	597594	4748786
R579	Residence	1.5	3	597644	4748802
R581	Residence	1.5	3	597786	4748768
R582	Residence	1.5	3	597849	4748787
R584	Residence	4.5	3	598134	4748890
R585	Residence	4.5	3	598242	4748987
R588	Residence	4.5	3	599042	4749252
R668	Residence	4.5	3	596310	4747047
R670	Residence	1.5	3	596459	4747052
R672	Residence	1.5	3	596662	4746973
R673	Residence	4.5	3	596720	4747093
R674	Residence	4.5	3	597052	4747231
R675	Residence	4.5	3	597056	4747096
R1339	Residence	4.5	3	597745	4751805
R1340	Residence	4.5	3	596752	4751619
R1341	Residence	4.5	3	595975	4751290
R1362	Residence	1.5	3	596041	4748115
R1369	Residence	4.5	3	597557	4748243
R1375	Residence	1.5	3	595224	4750337
R355	Residence	4.5	3	595233	4750565
R465	Residence	4.5	3	597146	4747852
R587	Residence	4.5	3	598739	4749078
R589	Residence	4.5	3	599146	4749234
R1317	Residence	4.5	3	596911	4749234

VLSRs

Project Name: Grand Renewable Energy Park - Solar Park
Datum and Projection: NAD83 (Canada); UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
V3347	VLSR	4.5	3	595482	4748523
V3348	VLSR	4.5	3	595413	4748227
V3349	VLSR	4.5	3	594881	4748711

V3409	VLSR	4.5	3	597181	4747262
V3489	VLSR	4.5	3	596786	4751735
V3490	VLSR	4.5	3	596829	4751733
V3491	VLSR	4.5	3	596918	4751722
V3492	VLSR	4.5	3	596937	4751733
V3493	VLSR	4.5	3	596967	4751733
V3494	VLSR	4.5	3	597003	4751733
V3495	VLSR	4.5	3	597036	4751743
V3496	VLSR	4.5	3	597077	4751747
V3497	VLSR	4.5	3	597107	4751757
V3498	VLSR	4.5	3	597145	4751757
V3499	VLSR	4.5	3	597189	4751777
V3500	VLSR	4.5	3	597450	4751798
V3501	VLSR	4.5	3	597920	4751810
V3502	VLSR	4.5	3	597954	4751831
V3503	VLSR	4.5	3	597989	4751831
V3504	VLSR	4.5	3	597990	4751785
V3505	VLSR	4.5	3	598047	4751832
V3506	VLSR	4.5	3	598078	4751851
V3507	VLSR	4.5	3	598111	4751864
V3508	VLSR	4.5	3	598386	4751724
V3510	VLSR	4.5	3	598481	4751774
V3511	VLSR	4.5	3	598503	4751793
V3634	VLSR	4.5	3	598156	4751576
V3642	VLSR	4.5	3	598741	4751245
V3646	VLSR	4.5	3	598290	4751031
V3649	VLSR	4.5	3	598552	4749102
V3654	VLSR	4.5	3	597727	4751001
V3655	VLSR	4.5	3	597416	4750900
V3656	VLSR	4.5	3	596554	4750947
V3657	VLSR	4.5	3	596284	4750543
V3658	VLSR	4.5	3	595743	4750638
V3664	VLSR	4.5	3	595963	4748368
V4001	VLSR	4.5	3	597451	4747536
V4002	VLSR	4.5	3	597642	4747443
V4003	VLSR	4.5	3	597964	4747296
V4011	VLSR	4.5	3	598893	4751285
V4012	VLSR	4.5	3	598741	4751148
V4013	VLSR	4.5	3	598570	4751710
V4014	VLSR	4.5	3	598231	4750992
V4015	VLSR	4.5	3	599398	4749414
V4016	VLSR	4.5	3	598997	4751289
V4019	VLSR	4.5	3	598503	4751686
V4020	VLSR	4.5	3	598974	4751412

Participants

Project Name: Grand Renewable Energy Park - Solar Park
Datum and Projection: NAD83 (Canada); UTM 17N

Point of Reception ID	Description	Height (m)	NPC Class	X(E,m)	Y(N,m)
P580	Residence	4.5	3	597798	4748861
P366	Residence	1.5	3	596556	4750512
P370	Residence	4.5	3	597248	4750668
P376	Residence	4.5	3	596873	4750327
P377	Residence	4.5	3	597330	4748897
P394	Residence	4.5	3	597860	4750701
P459	Residence	1.5	3	595916	4749261

13 APPENDIX B — ADDITIONAL DOCUMENTATION

For reference, this appendix contains the following documents.

Brochure for SMA Sunny Central SC800CP-CA Solar Inverter . This brochure provides details on the eHouse inverters.

Brief description of ABB 3-Phase Padmounted Transformer rated at 1600 kVA provided by Grand Renewable Solar LP. This provides a brief description of the proposed eHouse inverter transformer.

Photo. 1.6 MVA eHouse with intake and exhaust rain hoods but no silencers.

Vicwest. Product Information Sheet. DM40 Mesa Wall Panels.

Vicwest. Product Information Sheet. HR4 HR Series Roof & Wall Panels.

VibroAcoustics. Silencer Schedule. Project: Carbon Free Inverter Enclosure Silencers. HDJJ57. Wednesday, August 21, 2013.

Letter dated 2013-09-04 from Ian Bonsma of HGC Engineering to David Oxtoby of Carbon Carbon Free Technology / Grand Renewable Solar LP. This email provides estimates of the net eHouse octave band source sound power levels for the inverters (located in the eHouse enclosure) and the inverter transformer.

Note: The following two documents have been provided to the Ontario Ministry of Environment under separate cover.

Turbine source sound power specification provided by Grand Renewable Solar LP: Siemens Wind Power A/S: *SWT-2.3-101, Rev. 4, Max. Power 2221 kW, Contract Acoustic Emission, Hub Height 99.5m, Grand Renewable – Ontario – Canada*. Document ID: E W EN OEN DES TLS-10-0000-1074-01, HST, DRK / 2013.07.05. Strictly Confidential.

Turbine source sound power specification provided by Grand Renewable Solar LP: Siemens Wind Power A/S: *SWT-2.3-101, Rev. 4, Max. Power 2126 kW, Contract Acoustic Emission, Hub Height 99.5m, Grand Renewable – Ontario – Canada*. Document ID: E W EN OEN DES TLS-10-0000-1073-00, HST, DRK / 2013.07.05. Strictly Confidential.

SUNNY CENTRAL 500CP-CA / 630CP-CA / 720CP-CA / 750CP-CA / 800CP-CA / 850CP-CA / 900CP-CA

Economical

- Savings in balance of system costs due to 1,000 V operating voltage
- Outdoor enclosure allows for direct field deployment
- Small footprint and light weight for easy shipping and installation

Efficient

- Highest efficiency in its power class
- Full nominal power at ambient temperatures up to 50 °C
- 10% additional power for continuous operation at ambient temperatures up to 25 °C

Flexible

- Configurable DC voltage range
- Integrated AC disconnect for NEC 2011 compliance
- Optional DC disconnects

Reliable

- Easy and safe installation and with large, separate connection area
- Powerful grid management functions (incl. Low Voltage Ride Through)
- Full UL1741 and IEEE 1547 compliance

SUNNY CENTRAL 500CP-CA / 630CP-CA / 720CP-CA / 750CP-CA / 800CP-CA / 850CP-CA / 900CP-CA

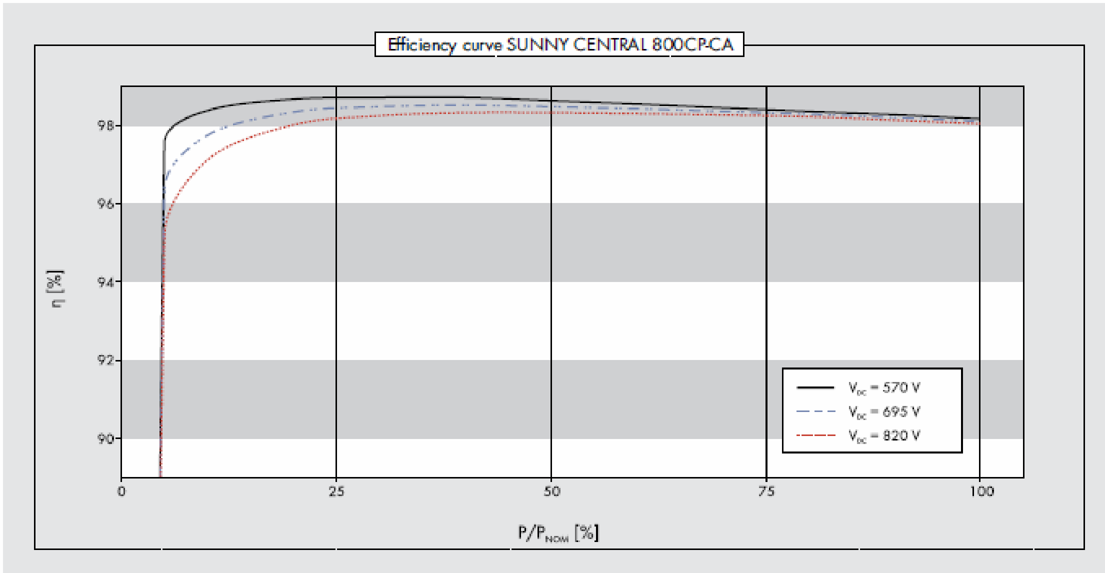
UL listed for commercial and utility-scale projects

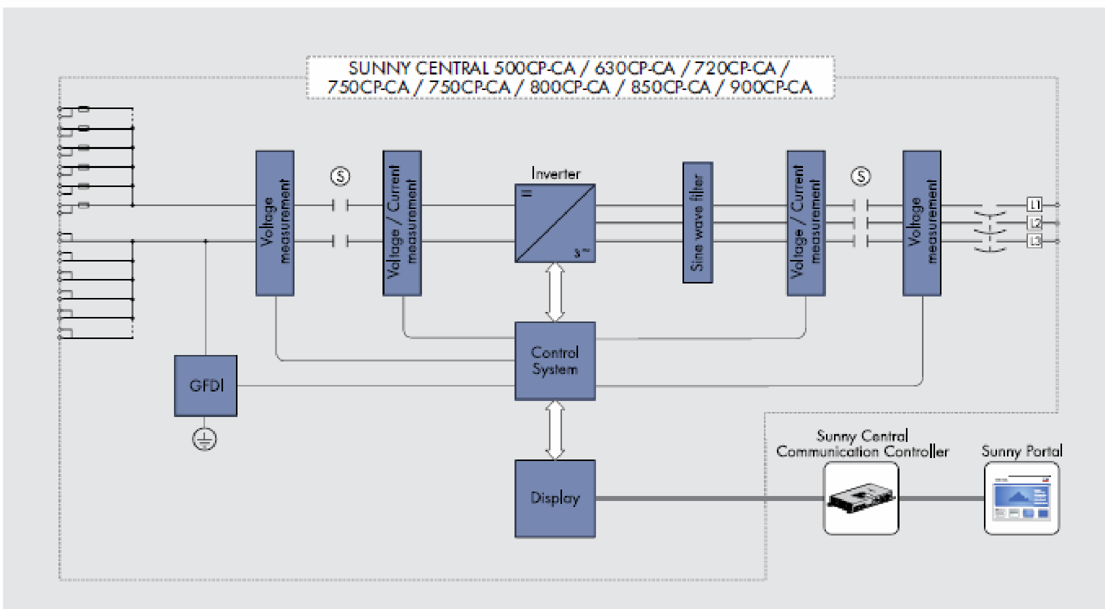
The Sunny Central CP-CA series delivers outstanding performance. In combination with an external transformer, the Sunny Central CP-CA can be connected to any utility grid or three-phase commercial service while directly providing grid management functions. The CP-CA family is UL listed at 1,000 V DC and features an integrated AC disconnect in accordance with NEC 2011 requirements. Both the outdoor enclosure with the OptiCool™ cooling concept and the separate connection area ensures simple installation while maximizing returns. With a peak efficiency of 98.7 percent, it outperforms all other inverters in its class. The Sunny Central CP-CA can also be integrated with the Power Plant Controller as well as the Medium-voltage Power Platform for utility-scale applications.

Technical data	Sunny Central 500CP-CA	Sunny Central 630CP-CA	Sunny Central 720CP-CA
Input (DC)			
Max. DC power (@ cos φ = 1)	560 kW	713 kW	808 kW
Max. input voltage [1]	1000 V	1000 V	1000 V
MPP voltage range (@ 25 °C / @ 50 °C at 60 Hz)	430 V – 820 V / 430 V – 820 V [1] [2]	500 V – 820 V / 500 V – 820 V [1] [2]	525 V – 820 V / 525 V – 820 V [1] [2]
Rated input voltage	480 V	550 V	565 V
Max. input current	1250 A	1350 A	1600 A
Min. input voltage / V_{MPP_min} at $I_{MPP} < I_{DCmax}$	429 V	498 V	515 V
Number of independent MPP inputs	1	1	1
Number of DC inputs: busbar / fuses	Busbar / 6 – 9	Busbar / 6 – 9	Busbar / 6 – 9
Output (AC)			
Rated power (@ 25 °C) / nominal AC power (@ 50 °C)	550 kVA / 500 kVA	700 kVA / 630 kVA	792 kVA / 720 kVA
Rated grid voltage / nominal AC voltage range	270 V / 243 V – 297 V	315 V / 284 V – 347 V	324 V / 292 V – 356 V
AC power frequency / range	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz
Rated power frequency / rated grid voltage	50 Hz, 60 Hz / 270 V	50 Hz, 60 Hz / 315 V	50 Hz, 60 Hz / 324 V
Max. output current	1176 A	1283 A	1411 A
Max. total harmonic factor	< 3 %	< 3 %	< 3 %
Power factor at rated power / displacement power factor adjustable		1 / 0.8 leading ... 0.8 lagging	
Feed-in phases / connection phases	3 / 3	3 / 3	3 / 3
Efficiency [3]			
Max. efficiency / European weighted efficiency / CEC efficiency	98.5 % / 98.3 % / 98.0 %	98.5 % / 98.3 % / 98.0 %	98.6 % / 98.4 % / 98.0 %
Protective devices			
DC disconnect device		DC contactor	
AC disconnect device		AC circuit breaker	
DC overvoltage protection		Surge Arrester Type II	
Grid monitoring	●	●	●
Ground-fault monitoring	○	○	○
Ungrounded PV array [4]	○	○	○
Lightning protection	Lightning protection level III	Lightning protection level III	Lightning protection level III
Insulation monitoring	○	○	○
Surge arresters for auxiliary power supply	●	●	●
Protection class / overvoltage category	I / IV	I / IV	I / IV
General data			
Dimensions (W / H / D)		2562 / 2272 / 956 mm (101 / 90 / 38 inches)	
Weight	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)
Operating temperature range	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F
Noise emission [5]	60 db(A)	60 db(A)	60 db(A)
Max. self-consumption (in operation) [7] / self-consumption (at night) [6]	< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W
Auxiliary power supply via external 208 V / external 400 V / external 480 V / integrated green power	○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○
Cooling concept	OptiCool	OptiCool	OptiCool
Degree of protection: electronics / connection area	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R
Degree of protection	4C2, 4S2	4C2, 4S2	4C2, 4S2
Application	In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments
Max. permissible value for relative humidity (non-condensing)	15 % ... 95 %	15 % ... 95 %	15 % ... 95 %
Max. operating altitude above mean sea level	2000 m	2000 m	2000 m
Fresh-air consumption (inverter)	3000 m³/h	3000 m³/h	3000 m³/h
Features			
DC connection	Ring terminal lug	Ring terminal lug	Ring terminal lug
AC connection	Ring terminal lug	Ring terminal lug	Ring terminal lug
HMI touchscreen	●	●	●
Communication / protocols	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus
Communication with Sunny String-Monitor	RS485	RS485	RS485
SC-COM	●	●	●
Color of enclosure, door, base, roof		RAL 9016 / 9016 / 7004 / 7004	
Warranty: 5 / 10 / 15 / 20 / 25 years	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
Certificates and approvals (more available on request)		EMC conformity according to FCC, Part 15, Class A, UL 1741, UL 1998, IEEE 1547	
● Standard equipment ○ Optional features – Not available			
Type designation	SC 500CP-CA-10	SC 630CP-CA-10	SC 720CP-CA-10

Sunny Central 750CP-CA	Sunny Central 800CP-CA	Sunny Central 850CP-CA	Sunny Central 900CP-CA
853 kW	898 kW	954 kW	1010 kW
1000 V	1000 V	1000 V	1000 V
545 V - 820 V / 545 V - 820 V [1] [2]	570 V - 820 V / 570 V - 820 V [1] [2]	620 V - 820 V / 620 V - 820 V [1] [2]	655 V - 820 V / 655 V - 820 V [1] [2]
595 V	620 V	620 V	620 V
1600 A	1600 A	1600 A	1600 A
545 V	568 V	568 V	568 V
1	1	1	1
Busbar / 6 – 9	Busbar / 6 – 9	Busbar / 6 – 9	Busbar / 6 – 9
825 kVA / 750 kVA	880 kVA / 800 kVA	850 kVA / 935 kVA	900 kVA / 990 kVA
342 V / 308 V - 376 V	360 V / 324 V - 396 V	386 V / 347 V - 425 V	405 V / 364 V - 446 V
50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz	50 Hz, 60 Hz / 47 Hz ... 63 Hz
50 Hz, 60 Hz / 342 V	50 Hz, 60 Hz / 360 V	50 Hz, 60 Hz / 360 V	50 Hz, 60 Hz / 360 V
1411 A	1411 A	1411 A	1411 A
< 3 %	< 3 %	< 3 %	< 3 %
1 / 0.8 leading ... 0.8 lagging			
3 / 3	3 / 3	3 / 3	3 / 3
98.6 % / 98.4 % / 98.0 %	98.7 % / 98.4 % / 98.5 %	98.7 % / 98.4 % / 98.5 %	98.7 % / 98.4 % / 98.5 %
DC contactor			
AC circuit breaker			
Surge Arrester Type II			
●	●	●	●
○	○	○	○
○	○	○	○
Lightning protection level III	Lightning protection level III	Lightning protection level III	Lightning protection level III
○	○	○	○
●	●	●	●
I / IV	I / IV	I / IV	I / IV
2562 / 2272 / 956 mm (101 / 90 / 38 inches)			
< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)	< 1870 kg (4123 lb)
-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F	-25 °C ... +50 °C / -13 °F ... +122 °F
60 db(A)	63 db(A)	63 db(A)	63 db(A)
< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W	< 1800 W / < 150 W
○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○	○ / ○ / ○ / ○
OptiCool	OptiCool	OptiCool	OptiCool
NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R	NEMA 3R / NEMA 3R
4C2, 4S2	4C2, 4S2	4C2, 4S2	4C2, 4S2
In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments	In unprotected outdoor environments
15 % ... 95 %	15 % ... 95 %	15 % ... 95 %	15 % ... 95 %
2000 m	2000 m	2000 m	2000 m
3000 m³/h	3000 m³/h	3000 m³/h	3000 m³/h
Ring terminal lug	Ring terminal lug	Ring terminal lug	Ring terminal lug
Ring terminal lug	Ring terminal lug	Ring terminal lug	Ring terminal lug
●	●	●	●
Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus	Ethernet (optical fiber optional), Modbus
RS485	RS485	RS485	RS485
●	●	●	●
RAL 9016 / 9016 / 7004 / 7004			
● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○	● / ○ / ○ / ○ / ○
EMC conformity according to FCC, Part 15, Class A, UL 1741, UL 1998, IEEE 1547			
SC 750CP-CA-10	SC 800CP-CA-10	SC 850CP-CA-10	SC 900CP-CA-10

(1) At 1.00 $U_{AC, nom}$ and cos φ = 1
(2) The inverter will track MPP to 850V before self-protecting
(3) Measured efficiency includes all auxiliary power
(4) Included in the inverter's UL listing
(5) Sound pressure level at a distance of 10 m
(6) Self-consumption at rated operation
(7) By external 400 V auxiliary power supply





Toll Free +1 877 506 1756
www.SMA-Canada.ca

SMA Canada, Inc.

ABB 3-Phase Padmounted Transformer rated at 1600 kVA

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

ITEM	QTY	kVA	Altitude	NL	TL	Conductor	%Z
70	65	1600	3300	1017 @ 85	17201	Cu/Cu	4.22

ITEM	Iex	Sound	Shipment	%EFF @Load
70	0.1	50	9-11 Weeks	98.94 100% 99.16 75% 99.37 50% 99.5 25%

Quoted loss values are guaranteed average values.
Lead times for orders subject to drawing approval will be confirmed upon receipt of approval and release for manufacturing.

Description:

Type	:	Liquid-Filled MTR Padmounted Transformer
Fluid	:	Natural Ester Fluid
Core	:	Grain Oriented Steel
Phase	:	3 Phase
Frequency	:	60 Hz
Average Winding Rise	:	65 °C
Ambient Temperature	:	30 °C
High Voltage	:	34500 Delta
High Voltage Taps	:	+2 -2 2.5%
High Voltage BIL	:	150kV BIL
Low Voltage	:	360Y x 360Y
Low Voltage BIL	:	30kV BIL x 30kV BIL
Feed Configuration	:	Loop feed
Color	:	Equipment green (Munsell 9GY 1.5/2.6)

Features (included in price):

TANK & CABINET
- Dry Nitrogen Blanket
- Ground strap from tank to cabinet
- No high low barrier
- Penta-head cabinet handle bolt

GROUNDING
- Ground bus
- Core Grounding - Accessible through handhole
- Two 2-Hole ground spades(Canada CSA/CEA) x 3

BUSHINGS
- 600 amp dead-break bushings (dead front) x 6
- Loadbreak inserts (dead front) x 6
- ANSI C57.12.26 Fig 2 & 3 HV bushing pattern (minimum)
- 10-hole Integral Spade Bushings x 3
- Spade Supports

ABB Page 1 of 9 4/1/2013

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

- ANSI C57.12.26 Fig 3&4a minimum stgrd LV bushing pattern
- Porcelain Ho With Spade

ARRESTERS
- 21 kV elbow arrester - 35 kV interface x 3

FUSES
- Internal expulsion fuse x 3
- Oil-immersed partial range current limiting fuse x 3

SWITCHES
- 2-position 300 amp LBOR transformer switch
- Two (2), 2-position 600 amp switch
- Special off circuit switch label

MONITORING
- Dial type thermometer
- Provisions for pressure/vacuum gauge
- Liquid level gauge with alarm contacts
- Pressure relief valve
- Pressure vacuum gauge with alarm contacts
- Schrader valve
- Dial type thermometer with alarm contacts

FITTINGS
- Drain valve and sampler

MARKINGS
- Non-PCB label
- UL Certified Label
- EEMAC decals (Canada)
- Special Canadian nameplate requirements

OTHER
- 30" deep cabinet
- Aluminum Electrostatic Shield
- Copper Electrostatic Shield
- Step-up application
- Dyn11 Phase Shift
- SST hardware
- CSA Standard

TESTS
- One Dissolved Gas Test ‡

Contains less-flammable biodegradable natural ester fluid with no detectable level of PCB, less than 1PPM, at the time of manufacture.

For information about natural ester fluid, go to: http://www.cargill.com/products/industrial/dielectric-fluid/index.jsp

Item 70 General Comments and Exceptions

- ABB Designs applicable to renewable energy offer standard features not typically supplied by others. Our experience in renewable energy led us to provide differentiators for optimal performance and customer satisfaction, among which are the following:

  -Dissolved Gas analysis results with Certified Test Report for each transformer
  -Core ground accessible and removable through the tank hand hole
  -Induction (flux density) well below core saturation levels which provides enhanced protection from system harmonics
  -Heavy 18" stainless steel door rods for improved safety in high wind speed conditions
  -Sloped cabinet cover to channel water, ice, and snow off of the cabinet and away from personnel

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

-Auto-locking device for cabinet cover to allow one hand operation without compromising safety
-Cabinet cover rotable nearly 180 degrees to provide optimal access during installation and maintenance

TRANSFORMER APPLICATION CONDITIONS AND LIMITATIONS
These transformers are designed for application up to 110% no load over-excitation or 105% full load over-excitation in accordance with IEEE C57.12.00, section 4.1.6.1. All other parameters in IEEE C57.12.00 also apply to the design of these transformers. Operations outside these parameters may void product warranty.

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

Terms and Conditions:
- Quote validity period: 30 days
- Payment Terms: Payment is due B_PAIDIN60DAYS_CIT from invoice date.
- Freight Terms: Shipment is DDP - Delivery Duty Paid (ONBU, CA)
- Warranty: 60 months from delivery or 54 months from commissioning, whichever occurs first.

Shipments:
- Lead times are subject to change based on availability of production space and/or materials at time of order. Please contact your ABB representative to confirm the lead time at order entry.
- Lead times for orders requiring drawing approval will be confirmed after receipt of approval and release for manufacturing.
- Transportation costs are based on truckload quantities and one stop within the 48 contiguous states of the United States. Multiple stops will be charged a minimum of $150 per stop.
- Packaging and handling beyond what is stated in the quote, including blue water transport, are at the expense of the purchaser.
- Shipments by dedicated truck must be specified as such on the purchase order and billed accordingly.
- This quote does not include installation, training and field testing unless noted otherwise.
- For destinations outside of the United States, purchaser is to identify seller for customs reporting as ABB Inc, 150 Ardmore Blvd. Suite 401, Pittsburgh, PA 15221, Attention: International Contracts Management.

Price Validity:
- Prices are valid for the quantities stated in this quote and subject to change for orders less than quoted.
- Approval order pricing is firm for 30 days after initial mailing date of approval drawings. Orders not released for manufacture within 30 days of the initial drawing date are subject to price adjustment.
- Prices and lead time are subject to change should there be changes to specifications, configurations and accessories.

Approval Drawings:
- Purchaser to provide e-mail address at time of order entry for transmission of drawings.
- Drawing lead times are typically 3 - 4 weeks after receipt of order for Padmount transformers.
- Drawing lead times are typically 5 - 6 weeks after receipt of order for Secondary Unit Substation transformers.
- Drawings in less than typical lead time are available upon request and will be priced accordingly.
- Drawings can be supplied in "pdf" format at customer request

NEC & NFPA Exception:
Product will be designed, built and tested in accordance with ANSI, NEMA and IEEE (and UL if applicable) standards. Cabinetry is designed in accordance with NEMA 3R unless stated otherwise in the body of the quote. Exception is taken to NEC & NFPA as compliance is the responsibility of the installing contractor and/or end user.

Testing:
- Routine production tests are in accordance with IEEE C57.12.00.
- Fluid supply is regularly tested for PCB content.
- Nameplates state "Filled with non-PCB fluid that contains less than 1 ppm at time of manufacture."
- Comprehensive leak testing is completed on all products.
- Computer generated certified test reports provided as standard.

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

Special Test Price Adders:

- Chopped Wave at $1,000 net each.
- Temperature Rise (base rating only) at $2,000 net each.
- Temperature Rise (base rating plus max) at $3,000 net each.
- Sound Level for product rated less than 2000 kVA at $1,000 net each
- Power Factor at $1,000 net each.
- Witness Testing at $5,000 net each. (may be of a similar unit depending on availability of product at time of testing)

General Notes:

Quote expires under any of the following conditions referred to the quote's date listed above:
- After 60 days.
- If the cost of any of the 5 main materials increases by more than 5%.

Notes and Exceptions:
- Only routine test are included, if customer needs Special test please refer to the price list on the bottom of this Doc.
- ANSI/IEEE standards apply. We do not meet IEC or NEC standards
- Padlocks not supplied.
- Vegetable Oil (FR3) has some limitations in extreme low temperatures, please refer to Oil Specs for more detail or contact us, customer is responsible for the selection made.
- Standard Mineral Oil included, if Luminol is required please request a revision.
- Special certification upon request & confirmation, this offer does not include any Special Certification or Calculations.
- We do not build our transformers any differently verses step-up or step down. The HV will always be on the left with the LV on the right. It's up to the installer to bring the incoming lines to the transformer correctly.
- The Transformers provided in this quote are build with Mild Steel. Suitability for installation conditions, site characteristics, environment (gases, dust, etc) are responsibility of the company in charge of the engineering, planning and start up or commissioning not of ABB.
- Termination for the high voltage or low voltage connections not supplied unless suspectfully stated in the bill of material.
- ABB is only responsible for the bill of material as quoted. This is our best interpretation of the data supplied. If the transformer is manufactured, shipped and does not meet the customer's needs, it's solely the responsibility of the end user to rectify and bare all cost associated with the mistake. ABB will not be held liable for transformers made which do not meet the customer's needs.
- BayOnet Fuses are not available for HV 27.6 kV Delta
- Partial Range Current Limited Fuse included.
- If Seismic Anchor are needed please add $750 per unit.
- Transformer can be used with arresters and fuses only if power lines feeding transformers belong to a 4-wire multi-grounded neutral system. If power lines belong to a delta connected system; no fuses or arresters are applicable.
- Feed Thru inserts NOT available for 600A .
- Customer must use a Cooper T-OP Elbow connector to be able to connect the surge arresters to the 600A Bushing. Without this elbow customer cannot connect the surge arresters to the 600A Bushing.
- Exception to Cover mounted Primary Bushing, we are quoting Side Wall Mounted Bushings.
- Removable radiators can be provided, but will have TamperResistand issues. If Customer need us to include this feature we need confirmation.
- If Impact rec. are needed, please add $350 per unit.

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

Please note:

- Quoted unit(s) as listed below. Any change in accessories and/or performance(s) may change price(s).Exception is taken to any requirement contained in a customer spec and not specifically identified above or contained in our standard product offering.
- Prices valid for total package - if individual items and/or less quantity(ies) are required; prices will change.
- Ex-works shipment time frame does not include time spent to design unit, send drawings for approval and received approved drawings.
- If shipments by dedicated truck are required; it must be specified in P.O.
- If dedicated truck shipment; it will be billed accordingly.
- Export crating not supplied unless listed in below bill of materials.
- The following guidelines apply for cancellation:
  - 10% After ABB has received P.O.
  - 20% After ABB has issued approval drawings and sent them to customer.
  - 50% After ABB has received approved drawings from customer.
  - 100% After ABB has released unit(s) for manufacturing.
- This quote assumes these products will have as final destination the country specified in the request for quote. Diverting them to a different country is prohibited and it may be punishable with fines and prison by USA Federal Laws.

Kirk key interlocks not provided in base price of quote. Please use adder of $450 per unit if needed.
Standard ANSI C57.12.28 provided. Paint process and coverages will be supplied. ABB Paint system meets or exceeds all applicable industry standards with a nominal 3 mil thickness. Since the paint thickness is not associated with the protection quality of the finish, we will not always meet the specified 4 mil minimum paint thickness.
Routine tests are listed below:

- Core demagnetization
- Transformer turns ratio
- Polarity
- No-load loss and exciting current test at rated voltage
- Resistance, load loss, and impedance test at rated voltage
- Low frequency test
- Induced voltage
- Impulse
- Leaks

- Witness test and inspection adders are as follows:
- $2000 per unit tested for standard ANSI tests.
- $2000 per order for inspection of final product.
- Inspection must not interfere with production or manufacturing flow.
- Adders for witness test and final inspection must be added to price quoted. Order must be entered with this adder; if not, then witness test and inspection requirements will be considered waived.
- Transformer factory routine tests are free of charge.
- Temperature rise test is design test. if required, add $2000 (base rating), $3000 (max rating) per unit. If not included with order, test will be considered waived.
- Test reports of similar units may be available on request.
- If other tests are required; price adders are:

Test	Adder/unit
Fluid	$ 500
DGA	$ 350

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

Radio Interference Voltage	$ 2000
Insulation Power Factor	$ 2000
Insulation Resistance	$ 2000
Polarization Index	$ 2000
Sound Level	$ 2000
Short Circuit Force Withstand	$80000 plus price of transformer
No-load loss and exciting current at 90 to 110% rated voltage in 5% steps	$ 3000
Resistance measurement on extreme taps	$ 2000
Impedance measurement on extreme taps	$ 2000
Chopped wave impulse test	$ 2000

- Zero-phase-sequence impedance voltage not required for Delta/Wye connected unit.
- Impulse test: Written approval allowing ANSI C57.12.90 section 10.4 method 1 test must accompany the order. Without written approval from customer the order will be returned.
- Photograph or oscilloscope display waveforms are available only with witness test.
- Above charges do not include transportation, meals or lodging expenses to visit plant and/or witness tests.

ABB Jefferson City takes exception to all documentation required except the following which can be provided.

- Drawings:
  - Outline/Bill of Material Drawing
  - Base Detail
  - Bushing Details
  - Wiring Drawings
  - Nameplate
- Certified Test Reports
- Certificate of Compliance
- Instruction Manuals
- Spare Parts List
- Standard Cut Sheets for Monitoring, etc. Devices
- Inspection and Test Plan
- Milestone Schedule
- Fluid MSDS

▪ Order should reference this negotiation number and applicable items.
▪ Extended warranty available upon request and will be priced accordingly.
▪ Units are quoted for normal service conditions as defined by ANSI/IEEE standards.
▪ Notify ABB should unit(s) be subject to harmonics, motor starting, shovel duty or other.
▪ Accessories not included with the product are T-Ops, secondary terminating lugs, grounding lugs, padlocks, wrenches and warning signs unless noted otherwise in the quote.
▪ UL labeling and FM certification are available for most configurations upon request.
▪ Nameplates are laser etched anodized aluminum.
▪ Penta-head door fastening bolt compliant to ANSI C57.12.28-1998.
▪ Door fastening hardware made of stainless steel or silicon bronze.
▪ Paint system is compliant with ANSI/IEEE C57.12.28.
▪ Ground pads are made of stainless steel.

ABB Page 1 of 9 4/1/2013

ABB

ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

- Instruction manuals and order status information are available at www.abb.us/transformers. Select *United States of America* as a preference, click OK and then select *Jefferson City Distribution Transformer site*.

ABB

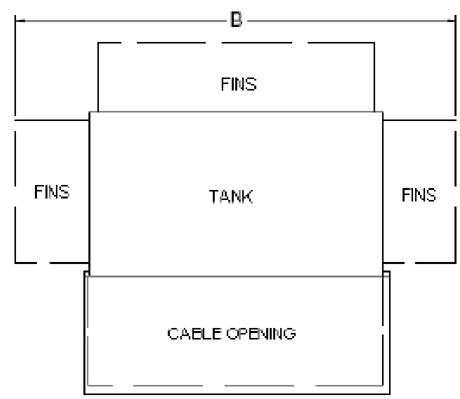
ABB Inc. / ABB Inc. / Canada Solar -- SMA Inverters

KVA	FEED	A	B	C	D	E	F	WT
1600	Loop (Dead)	72	96	88.8	74.8	70	30	12800
1000	Loop (Dead)	68	86	74.8	66.8	66	30	8200

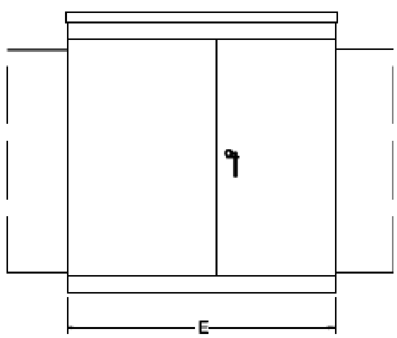
All weights and dimensions are approximate. Dimensions may change to meet specific customer requirements. Weights are in pounds. Dimensions are in inches.

Cooling fins may be required on the back and/or side of the tank if necessary. Maximum cooling fin depth is 16".

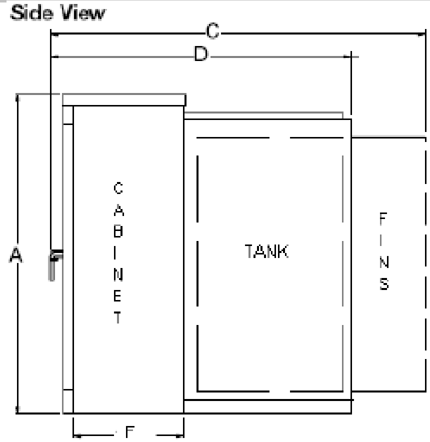
Top View



Front View



Side View



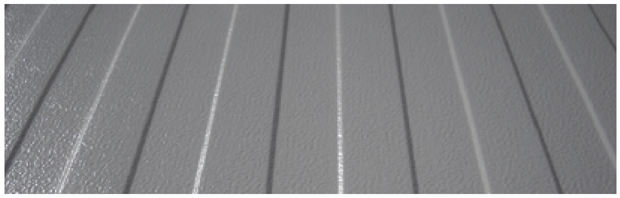
	Canada Solar -- SMA Inverters	
4/1/2013	**3-Phase Padmounted Transformer**	ABB Inc, Jefferson City, MO

ABB Page 1 of 9 4/1/2013

Photo: 1.6 MVA eHouse with intake and exhaust rain hoods but no silencers

Product Information Sheet

Innovative.
Adaptable.
Energy Efficient.



DM40 Mesa Wall Panels

TESTED & APPROVED

AWIP / Vicwest insulated metal panels have been extensively tested under a variety of North American standards:

FM 4880: Class 1 Fire Rating

FM 4881: Class 1 Exterior Wall System

FM 4471: Class 1 Roof Assembly

CAN/ULC S102: Flame Spread

CAN/ULC S101: Fire Endurance

CAN/ULC S138: Fire Endurance

CAN/ULC S127: Flammability

CAN/ULC S126: Flame Spread (Roof)

ASTM C518/C1363: Thermal Transmission

ASTM E283: Air Infiltration

ASTM E1680: Air Infiltration

ASTM E331: Water Infiltration

ASTM E1646: Water Infiltration

ASTM E72: Structural Strength

ASTM E84: Flame Spread

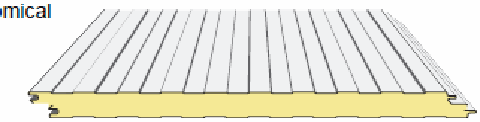
ASTM E119: Fire Endurance

AAMA 501.1: Air/Water Infiltration

CAN/ULC S134: Fire Test of Exterior Wall Assemblies

FM APPROVED

Our Mesa profile panel is the perfect economical choice for exterior / interior wall and ceiling applications on industrial and cold storage buildings.



FEATURES AND BENEFITS

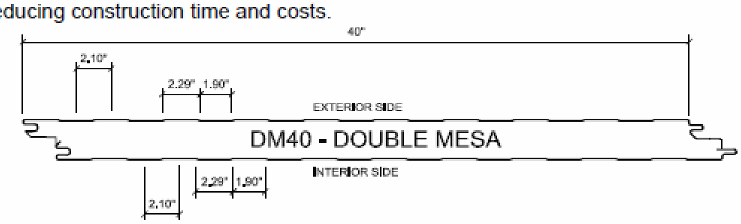
The low profile linear exterior surface simplifies flashing connections designed to inhibit moisture vapor transmission compared with other deep fluted products on the market.

The additional mesa profile on the interior face makes this panel particularly suited for thicker, long-length walls.

The panel's overlapping joint is self-aligning and allows for easy sealant application at the panel joinery.

The standard metal surface is 26ga G-90 galvanized steel with standard PVDF and SMP exterior coatings (other coatings may be available).

The panel arrives on site in one piece and requires a simple one step installation reducing construction time and costs.



PRODUCT PARAMETERS

Panel Thickness:	2"	2.5"	3"	4"	5"	6"
Insulating Values (R):**	16	20	24	32	41	49
Panel Width:	40"					
Panel Length:	from 8' to 50' maximum					
Insulation Material:	CFC-free foamed-in-place isocyanurate foam 2.2 to 2.5 pcf density					
Joint Configuration:	offset tongue and groove with concealed fastener					
Metal facings:	26ga galvanized steel (22ga, 24ga available)					
Coatings:	PVDF & SMP (other coatings available)					
Accessories:	fasteners, concealed fastener clips, sealants, brake formed flashings					

***R-Value tested in accordance with ASTM C518/C1363 at 40°F mean temperature, adjusted for a windspeed of 15 mph.*

U.S.A
929 Aldridge Rd.
Vacaville CA 95688
Ph: (707) 359-2280
awipanels.com

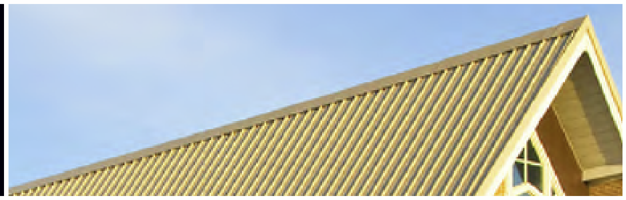
AWIP ALL WEATHER INSULATED PANELS

vicwest

Canada
1296 South Service Rd. W.
Oakville ON L6L 5T7
Ph: 1-800-265-8653
vicwest.com

Product Information Sheet

Innovative.
Adaptable.
Energy Efficient.



HR4
HR Series Roof & Wall Panels

TESTED & APPROVED

AWIP / Vicwest insulated metal panels have been extensively tested under a variety of North American standards:

FM 4880: Class 1 Fire Rating

FM 4881: Class 1 Exterior Wall System

FM 4471: Class 1 Roof Assembly

CAN/ULC S102: Flame Spread

CAN/ULC S101: Fire Endurance

CAN/ULC S138: Fire Endurance

CAN/ULC S127: Flammability

CAN/ULC S126: Flame Spread (Roof)

ASTM C518/C1363: Thermal Transmission

ASTM E283: Air Infiltration

ASTM E1680: Air Infiltration

ASTM E331: Water Infiltration

ASTM E1646: Water Infiltration

ASTM E72: Structural Strength

ASTM E84: Flame Spread

ASTM E119: Fire Endurance

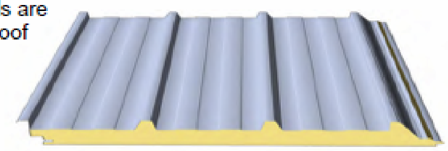
AAMA 501.1: Air/Water Infiltration

CAN/ULC S134: Fire Test of Exterior Wall Assemblies

FM APPROVED

All Weather / Vicwest HR4 roof and wall panels are an ideal solution to field assembled High Rib roof and wall applications.

This 42" wide panel installs quickly and economically.

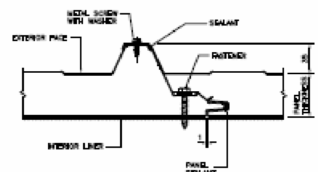


FEATURES AND BENEFITS

The panel's overlapping joint is self-aligning and allows for easy sealant application at the panel joinery.

The standard metal surface is 26ga G-90 galvanized steel with standard PVDF and SMP exterior coatings (other coatings may be available).

The panel arrives on site in one piece and requires a simple one step installation reducing construction time and costs.



PRODUCT PARAMETERS

Panel Thickness:	2"	3"	4"
Insulating Values (R):**	16	24	32
Panel Width:	42"		
Panel Length:	from 8' to 50' maximum		
Insulation Material:	CFC-free foamed-in-place isocyanurate foam 2.2 to 2.5 pcf density		
Joint Configuration:	overlapping with concealed clip and fastener		
Metal facings:	26ga galvanized steel (22ga, 24ga available)		
Coatings:	PVDF & SMP (other coatings available)		
Accessories:	fasteners, sealants, brake formed flashings		

***R-Value tested in accordance with ASTM C518/C1363 at 40°F mean temperature, adjusted for a windspeed of 15 mph.*

U.S.A
929 Aldridge Rd.
Vacaville CA 95688
Ph: (707) 359-2280
awipanels.com

ALL WEATHER INSULATED PANELS

Canada
1296 South Service Rd. W.
Oakville ON L6L 5T7
Ph: 1-800-265-8653
vicwest.com

VIBRO-ACOUSTICS®
Noise Control | Vibration Isolation | Restraint Systems

Silencer Schedule

HDJJ57
Wednesday, August 21, 2013

Project: Carbon Free Inverter Enclosure Silencers

Engineer:

Tag	Qty	Fan System	Face Dimension W (in)	H (in)	Length (in)	Flow cfm	Velocity ft/min	Silencer P.D.* in wg	P.D. incl. System Effects⊕ in wg	Dynamic Insertion Loss 63	125	250	500	1000	2000	4000	8000	Vibro-Acoustics® Model	Notes
SA-D	2		6 (16)	40	72	1,765	+212	0.01	0.02	6	11	18	25	35	39	29	20	RED-MV-FX	1,2
Comes with 16 Gauge Rain hood and flanges to connect to building																			
SA-I	2		23	82	36	1,765	-135	0.02	0.03	9	15	25	31	37	28	29	21	RED-ULV-F4	1,2
Comes with connection flanges																			

NOTES:

- Length shown for elbow silencers is centerline length
- Velocity shown is +(forward flow) or -(reverse flow) as defined by ASTM E477-06a
- Pressure drop, dynamic insertion loss and self generated noise per ASTM E477-06a
- Maximum pressure drop with system effects = silencer pressure drop per ASTM E477-06a + system effects for nearby duct elements.

1. RED = Rectangular Elbow Dissipative
2. Elbow silencer

(+/-) The symbol (+) designates forward flow and the symbol (-) designates reverse flow.

* The scheduled silencer pressure drop(s) are reported in accordance with ASTM E477 test methods. The pressure drop(s) are at IDEAL FLOW CONDITIONS (3-4 duct diameters of straight duct on silencer inlet and 4-5 duct diameters of straight duct on silencer outlet). Less than ideal conditions will result in increase in pressure drop - see VA representative for assistance.

⊕ Silencer Pressure Drop including estimated system effects based on less than ideal inlet and outlet flow conditions.

HGC ENGINEERING

Howe Gastmeier Chapnik Limited
2000 Argentia Road, Plaza One, Suite 203
Mississauga, Ontario, Canada L5N 1P7
t: 905.826.4044

September 4, 2013

VIA E-MAIL TO: doxtoby@carbonfreetechnology.com

Mr. David Oxtoby
CarbonFree Technology
22 St. Clair Avenue E., Suite 1401
Toronto, Ontario
M4T 2S3

Re: Sound Level Prediction for Inverter MV Station with Two SC800CP Power Inverter Units

Dear David,

HGC Engineering was retained by CarbonFree Technology to determine the sound power level of an inverter MV station containing two inverter units and one electrical transformer. Initial sound level predictions, summarized in our letter of May 27, 2013, indicated a sound power level of 96.5 dBA for a standard MV Station design utilizing the same mechanical components presented below. The target sound power level for the MV stations associated with the Grand Renewable Energy Park is 71.0 dBA. Noise control measures are specified herein to achieve the target sound power level.

Input Data

The total sound power level of the MV Station was estimated based on engineering drawings of the subject installation, sound data for one inverter unit, included in a test report by SMA Canada, dated May 22, 2013, and sound data for the transformer; included in a Sound Test Report by ABB Inc. (all attached).

Octave band sound level information was available for the proposed inverters, but for the 1600 kVA transformer only the NEMA sound rating was available. CarbonFree Technology provided NEMA sound ratings and drawings with dimensions for the transformer. The total A-weighted sound power level of the transformer was determined using the NEMA rating and the transformer dimensions, assuming the sound level ratings apply at the distance of 0.3 m from the transformer. The shape of the octave band spectrum for the transformers was based on established engineering prediction methods. The NEMA sound ratings, drawings and details of the calculation are attached.

Noise Control

The intake and exhaust openings into the MV Station will require acoustic silencers. The exhaust silencers are proposed to be located on the exterior of the MV station. Breakout sound from the casing of the exhaust silencers was considered to be acoustically insignificant in comparison to the exhaust opening. The intake silencers are proposed to be contained within the MV Station enclosure. Silencers providing the following minimum sound insertion losses are required:

Table 1: Minimum Required Insertion Loss for MV Station Ventilation Openings [dB]

Source Description	Octave Band Centre Frequency [Hz]							
	63	125	250	500	1000	2000	4000	8000
Exhaust Opening	6	11	18	25	35	39	29	20
Intake Opening	9	15	25	31	37	28	29	21

The MV Station walls and roof must be upgraded from the standard wall/roof type to provide the following minimum transmission losses:

Table 2: Minimum Required Sound Transmission Loss for MV Station Walls, Roof and Doors [dB]

Source Description	Octave Band Centre Frequency [Hz]							
	63	125	250	500	1000	2000	4000	8000
Walls, Roof, Door	8	18	25	35	40	40	45	40

Doors and other access points (electrical and communication connections) will need to be sufficiently sealed to provide an equivalent sound transmission loss. Additionally, the interior surface of the roof was assumed to be acoustically absorptive with a minimum Noise Reduction Coefficient of 0.85.

Results

With the above information, the sound levels were predicted of the inverter exhaust openings, and the two air intakes in the side walls of the MV Station, the external transformer, as well as sound emanating through the walls and roof assemblies of the MV Station. The total sound power level of the MV Station, including sound emitted from the electrical transformer, is expressed in Table 3 as a linear weighted octave band spectrum and an A-weighted overall sound power level.

Table 3: Estimated Sound Power Level [dB re 10^{-12} Watt] – MV Station With Two SC800CP Inverters And 1600 kVA Transformer

Octave Band Centre Frequency [Hz]								Overall A-weighted
63	125	250	500	1000	2000	4000	8000	
89	78	71	64	54	53	65	63	71

The sound levels from Table 3, above, are appropriate for the purposes of calculating the far field sound levels at sound-sensitive points of reception (e.g, for environmental noise impact assessments, etc.). Note also that the sound character of the MV Station and the transformer will exhibit pure-tone characteristics, which should be taken into consideration during environmental noise impact assessments, according to the guidelines appropriate to the jurisdiction of the site where the inverter package will be situated. In Ontario, for instance, an additional penalty of 5 dBA should be added to the stated sound power level, according to guidelines of the Ministry of the Environment.

Trusting this is satisfactory, please do not hesitate to contact the undersigned, should you have any questions or concerns.

Yours truly,
Howe Gastmeier Chapnik Limited

Ian Bonsma, PEng.

Attachments:
- MV Station detailed calculation
- Eclipse MV Station Design Details
- SMA Test Report, SC800CP-XP Sound Power Acoustic Environment Test
- ABB South Test Report, 1600 kVA

Calculation Summary Page 1 of 2

Sound Power Level Predictions
MV Station with Two SC800 CP SMA Inverters and One 1600 kVA Transformer

		63	125	250	500	1000	2000	4000	8000	dBA
PWL from SMA test report	Lw (linear)	85.6	83.3	83.5	84.4	78.8	82.4	90.8	79.6	93.1
Outdoor Sound Fraction		1	1	1	1	1	1	1	1	
Indoor Sound Fraction		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	

Equipment Dimensions

	a	b	H	R1	R2	R3	R4	Floor/Roof	Wall Surface
Enclosure Dimensions	8.4	3.3	2.4	20.16	7.92	20.16	7.92	27.72	56.16

	a	b	H	l1	l2	l3	l4	Front+Sides	Back
Inverter Dimensions	2.56	0.95	2.3	5.89	2.19	5.89	2.19	10.26	5.89

	a	b	S
Intake Louver Dimensions	2	0.2	0.8
Fan Openings	0	0	0

Exhaust Louver	63	125	250	500	1000	2000	4000	8000	dBA
Outdoor Lw of 1 Inverter Exhaust	86	83	83	84	79	82	91	80	93.1
Exhaust Silencer IL (Vibro-Acoustics)	6	11	18	25	35	39	29	20	
Lw w/ Silencer	80	72	65	59	44	43	62	60	66.2

Interior Sound Level Calculations

Absorptions	Absorption Type	63	125	250	500	1000	2000	4000	8000	Surface Area (m2)
Wall Surface	3	0.03	0.05	0.1	0.1	0.1	0.07	0.02	0.02	43.6
Inverter Surface	3	0.03	0.05	0.1	0.1	0.1	0.07	0.02	0.02	20.5
Roof	6	0.18	0.3	0.7	0.9	0.9	0.9	0.8	0.8	27.7
Floor	3	0.03	0.05	0.1	0.1	0.1	0.07	0.02	0.02	27.7
Louver and Fan Openings	2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.8
Average Alpha		0.071	0.114	0.244	0.290	0.290	0.267	0.206	0.206	Total Area
Room Constant		9.2	15.5	38.9	49.2	49.2	43.9	31.2	31.2	120.3

Intake Louver (1 of 2)	63	125	250	500	1000	2000	4000	8000	dBA
Indoor Lw of 2 Inverter Casings	86	83	83	84	79	82	91	80	93
Li (Lp inside enclosure) - Direct	72	69	69	70	65	68	77	66	79
Li (Lp inside enclosure) - Refl.	76	71	68	67	62	66	76	65	78
Li (Lp inside enclosure) - Direct+Refl.	77	73	72	72	67	70	79	68	82
Lw	73	69	68	68	63	66	75	64	78
Intake Silencer (Vibro-Acoustics)	9	15	25	31	37	28	29	21	
Lw (w/ IL)	64	54	43	37	26	38	46	43	50

Enclosure Walls+Roof

Overall Wall Surface 83.1 m^2 Excluding Air-Intake Louver Surface and Including Inverter Back Area

	63	125	250	500	1000	2000	4000	8000	dBA
Lp Incident	77	73	72	72	67	70	79	68	82
Wall TL	8	18	25	35	40	40	45	40	
Wall Li	69	55	47	37	27	30	34	28	46
Wall Overall Lw	88	75	66	56	46	50	54	47	66

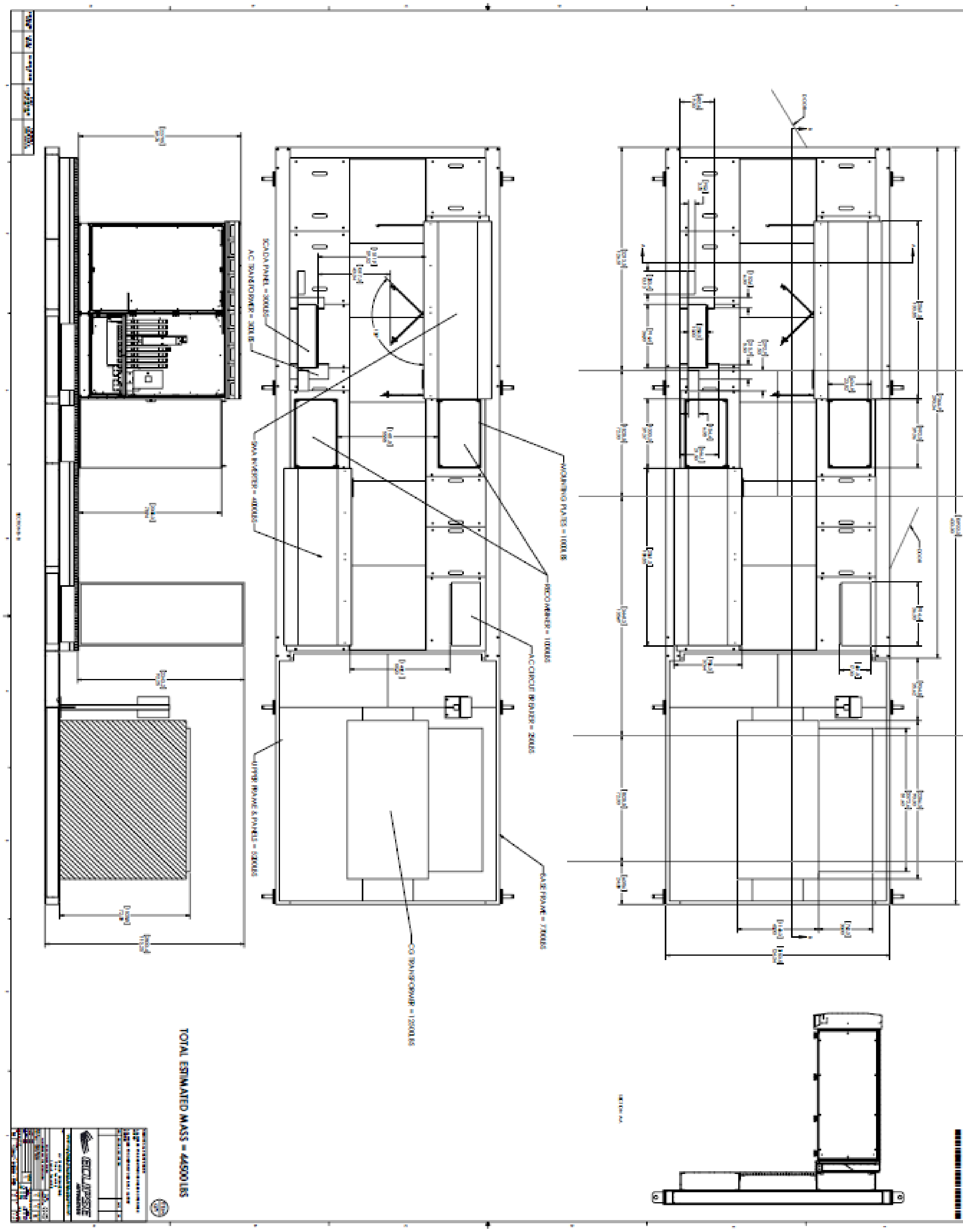
External Transformer

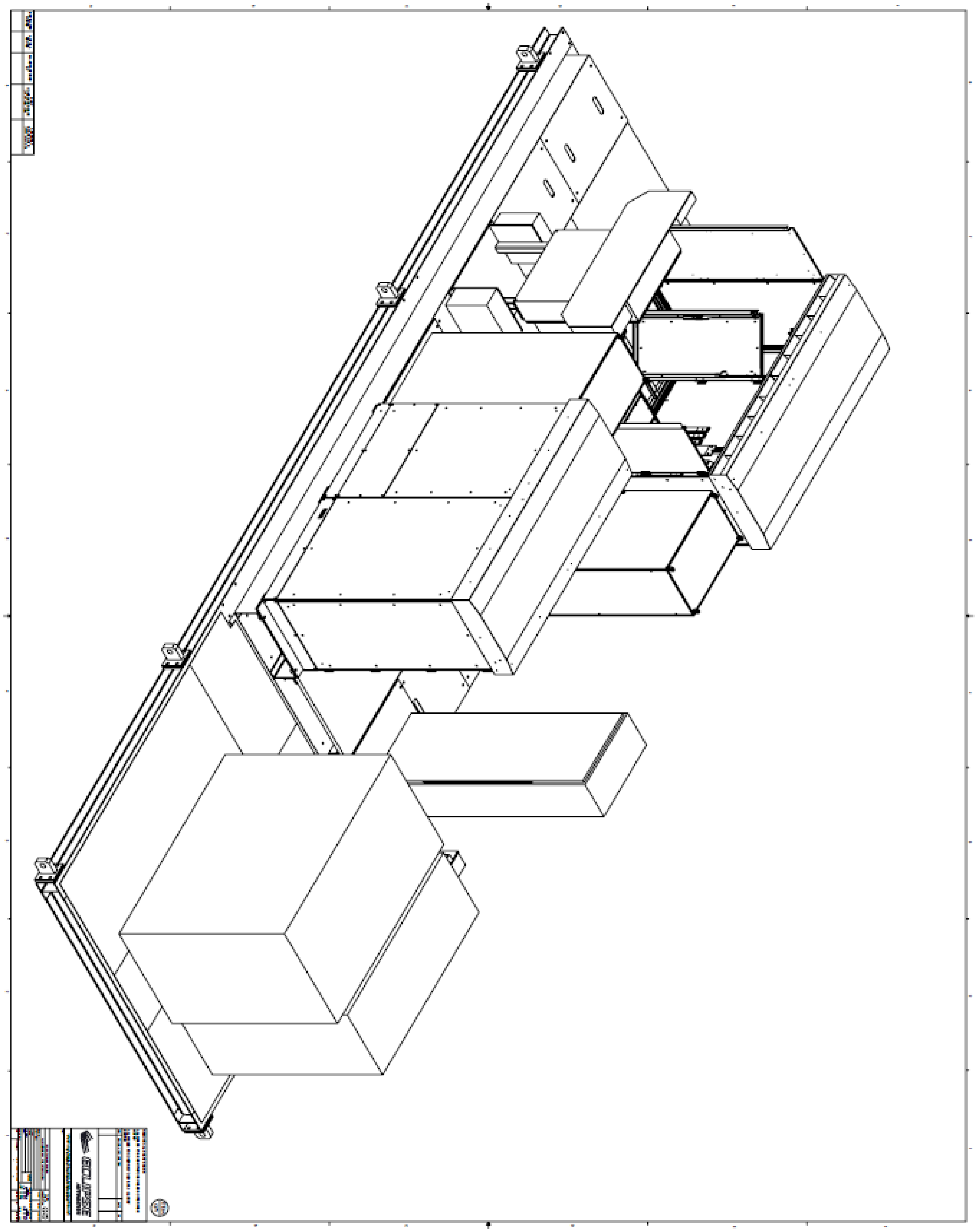
	a	b	H	S
Transformer Dimensions	2.89	2.51	1.83	26.9

(includes 1 ft measurement distance and top)

	63	125	250	500	1000	2000	4000	8000	
Lp (Avg. @ 1 ft) - NEMA									43.4
Correction	3	5	0	0	-6	-11	-16	-23	
Lw	61	63	58	58	52	47	42	35	58

Overview	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**	**dBA**
Inverter Exhausts (2 pcs)	83	75	68	62	47	46	65	63	**69**
Intake Louvers (2 pcs)	67	57	46	40	29	41	49	46	**53**
Enclosure Walls & Roof	88	75	66	56	46	50	54	47	**66**
Transformer	61	63	58	58	52	47	42	35	**58**
Total Enclosure	89	78	70	63	49	52	65	63	**71**
Total Installation Including Transformer	**89**	**78**	**71**	**64**	**54**	**53**	**65**	**63**	**71**


TOTAL ESTIMATED MASS = 44500 LBS



Inspection Report

Acoustic Environmental Test

SC800CP-XP

Sound power

 Page 1/24

Test Documentation | Version 1.0 | SC800CP-XT-92:LE2113

Revision History

Document number SC800CP-XT Sound Power	Version and revision type [1])		Comments	Author
-91:LE1613	1.0	-	First version	S. Vorderbruegge
-91:LE2013	1.1	A	Incorrect serialnumber replaced	S. Vorderbruegge
-92:LE2113	2.0	B	Only sound power is shown and complete measuring data is given	S. Vorderbruegge

[1]) A: First version or revision due to inaccurate documentation or improvement of the documentation

B: Revision assuring complete or forward compatibility

C: Revision limiting or excluding compatibility

	Name	Date	Signatur
Editor	S. Vorderbruegge	2013-05-21	Digital unterschrieben von Stephan Vorderbrügge
Released by	N. Berger	2013-05-22	Digital unterschrieben von Niels Berger

Explanation of Symbols Used

To aid your understanding of this inspection report, please note the following explanations of symbols used.

This symbol indicates an important note.
Therefore, read this section carefully.

This symbol indicates an example.

This symbol indicates an opinion or interpretation of facts.

Table of Contents

1 Overview of Results

Customer:	Manufacturer:	Test center:
SMA Solar Technology AG Sonnenallee 1 34266 Niestetal (Germany) Developer	**SMA** Solar Technology AG Miramstrasse 28 34123 Kassel (Germany) J. Alter	**SMA** Solar Technology AG Sonnenallee 1 EMC and Environmental Laboratory 34266 Niestetal (Germany) Building 4

Order number/account assignment:	850562
Project title:	SC800CP-XT
Type of test / thresholds and requirements:	Sound Power according to DIN EN ISO 9614-2:2010-11 of sinusoidal, irregularly shaped, transient signals. Classification of ambient conditions in compliance with the German Noise Control Guidelines (TA Lärm). (according to Section 2)
Type of device:	Solar central inverter for large-scale PV power plants
Type designation:	SC800CP-XT
Test specification:	Level of emissions according to the German Noise Control Guidelines and Sound power

ID of the unit under test:

EUL ID:	Serial number:	Hardware version:	Firmware version:
1193	180191199	P1	BFRV1.30.21.R_DSPV1.30.50.B

The results outlined in this inspection report only apply to the test item that has been tested. Any modification, e.g. in terms of the design, circuit technology or components used, can produce different test results.
Partial duplication of this report is not permitted without written permission from the test center.

No research into additional relevant standards (such as ETSI standards in radio frequency applications, Bluetooth, etc.) applicable to this unit under test was carried out as part of this test.
It is therefore the responsibility of the client to obtain information in this regard.

2 Overview of Results

Parameter	Requirement		Results [dB_A]/ without fan	Results [dB_A]/ with fan
	Standard (Germany)	SMA		
EN 9614-2 sound power L_{WA} [3]	-	-	-	93,30
Sound pressure derived via sound power L_{PA} [3]	–[5]	–[5]	-	78,81
Sound pressure level in 10 m L_{pA10} [4]	-	-	-	65,31
Sound pressure level in 50 m L_{pA50} [4]	-	-	-	50,32
Overall result (if applicable)			*Standard requirements: *SMA requirements:	

* Dependent on the local conditions at the mounting location (distance of 10m standard)

Please note the detailed description of the measurement environment. See Section 4.3Test Environment

[2] Calculated average sound pressure level over the entire measurement area (see Section 5.1.2).

[3] Sound power resulting from sound intensity measurement (see Section 5.1.2). To be save with the given level 1 dB_A was added rising up to 93,3 dB_A.

[4] Calculated sound pressure level at the desired distance (see Section 5.1.3).

[5] The value of the maximum sound level as stated in the German Noise Control Guidelines refers to the so-called vulnerable area (e.g. residential buildings, offices). This is dependent on the local conditions at the mounting location (see also Section 2.1.1). This applies in particular to large-scale PV power plants!

2.1.1 Emission Guide Values for the Rating Level According to the German Noise Control Guidelines

Criterion	Rating level in vulnerable areas inside buildings in dBA	Rating level outside buildings in dBA
A Industrial areas	By day 35	By day 70
	At night 25	At night 70
B Industrial parks	By day 35	By day 65
	At night 25	At night 50
C Core, village and mixed areas	By day 35	By day 60
	At night 25	At night 45
D Housing estates and small housing estates	By day 35	By day 55
	At night 25	At night 40
E Purely residential areas	By day 35	By day 50
	At night 25	At night 35
F Spas and hospitals	By day 35	By day 45
	At night 25	At night 35
Noise spikes above the rating level	By day 10	By day 30
	At night 10	At night 20

2.1.2 Test Protocol

Date of the test:	2013-03-06
	21°C; 51.3%r.F.; air pressure corresponds to the normative requirement
Sound level:	10 dBA - 140 dBA
Radio spectrum:	25 Hz - 10 kHz, +/- 1.0%
Distance between the microphone and the unit under test: 0.20 - 0,25m	
Holding time:	≥ 20 s
Resolution:	log 1%
RMS measurement:	average value over 20 s for each segment.
Segment size:	08m x 1,6m square 1,27 m² area
Test technician:	S. Vorderbruegge

3 Measurement results

3.1 General Information

The noise level of a device must be agreed between the manufacturer and the user. This agreement must comply with the local requirements (German Noise Control Guidelines). After the manufacturer and the user have reached an agreement, a test needs to be carried out to determine the effect of noise radiating from the device. Other sources of noise during operation, e.g. fans, motors or other hydraulic-pneumatic mechanisms, must also be taken into consideration.

Inspection Reference According to EN ISO 9614-2:2010-11

The sound level is determined according to DIN EN ISO 9614-2
"Determination of sound power levels of noise sources using sound intensity"

Part 2: "Measurement by scanning"
This measurement procedure keeps interference on the measurement result caused by noises from the environment to a minimum.

3.2 Test Setup

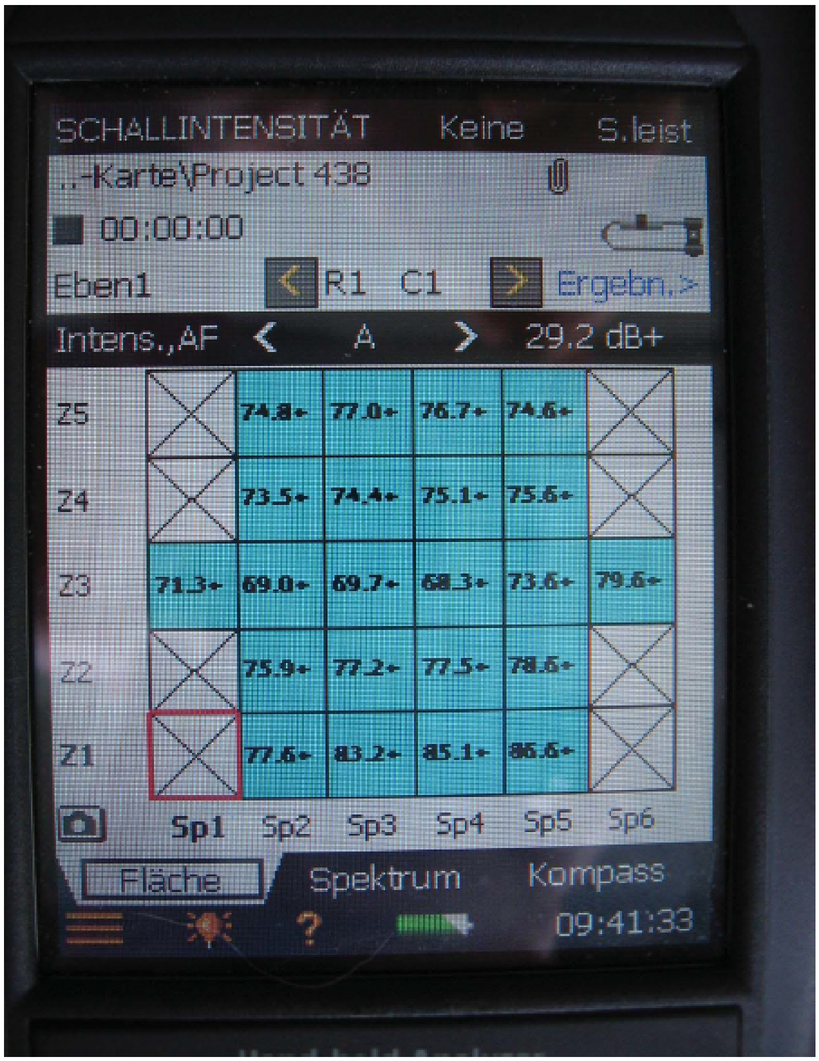
Depending on the source of the sound (object to be tested), two different measuring arrangements can be used that give approximately the same A-rated measured values.

Procedure

Sound intensity method

The probe microphone is aligned above the stand space of the unit under test, perpendicular to the center of the respective sound source segment, at a measuring **distance of 0.2 to 0,25m** and along a rather **meandering horizontal and vertical route**. The measurement time per coordinate field or side of the enclosure must be at **least 20 seconds**, to ensure that fluctuations are reliably excluded. The measuring surface (cube-style) of the EUT is put into segments shown below. Cuboid measurement surface with its single segments of approx 0,8m x 1,6m and 1,27m² areal.

The (cube-style) measuring surface of the EUT was put into segments shown below
Cuboid measurement surface with its single segments of approx 0,8m x 1,6m and 1,27m² areal.



Surface segments with its Intensity

Table with single data of each surface segment

Segment of surface	Intensity, A [dB+]	Sound pressure level L_{pA} [dB_A]	p-I-Index, A [dB+]	Measurement time [sec]
Sp1/Z3 left	71,1+	74,5	3,2+	22
Sp2/Z1 back bottom	77,6+	83,0	5,4+	23
Sp2/Z2 back up	75,9+	80,9	4,9+	21
Sp2/Z3 top	69,0+	72,5	3,4+	20
SP2/Z4 front up	73,5+	77,9	4,4+	21
Sp2/Z5 front bottom	74,8+	78,5	3,7+	22
Sp3/Z1 back botton	83,2+	87,3	4,1+	22
Sp3/Z2 back up	77,2+	82,4	5,2+	24
Sp3/Z3 top	69,7+	71,7	2,0+	22
Sp3/Z4 front up	74,4+	78,5	4,1+	23
Sp3/Z5 front bottom	77,0+	80,6	3,6+	21
Sp4/Z1 back bottom exhaust	85,1+	89,4	4,3+	22
Sp4/Z2 back up	77,5+	83,2	5,7+	22
Sp4/Z3 top	68,3+	70,7	2,4+	22
Sp4/Z4 front up	75,1+	78,5	3,4+	23
Sp4/Z5 front bottom	76,7+	80,1	3,4+	24
Sp5/Z1 back bottom exhaust	86,6+	89,6	3,0+	22
Sp5/Z2 back up	78,6+	83,3	4,7+	23
Sp5/Z3 top	73,6+	77,1	3,5+	23
SP5/Z4 front up	75,6+	78,4	2,8+	23
Sp5/Z5 front bottom	74,6+	79,7	5,1+	22
Sp6/Z4 right	79,6+	82,0	2,5+	25
Sound power above the surface	**A-rated 92,3**			

4 Operating States, Test Setup and Test Environment

4.1 Operating States

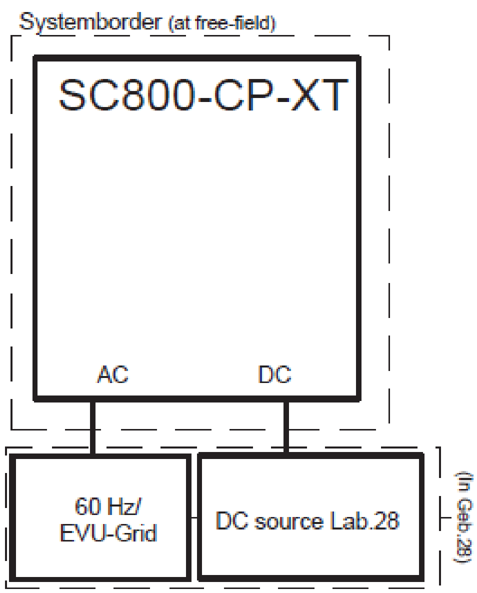
The following states and configurations have been defined as operating conditions:

- Operation of the inverter.
- Operating conditions: U_{DC}=820 V; 800 kW
- The device fans must be running.
- The unit under test must have reached its operating temperature.
- The unit under test must have reached an operating temperature of 25°C.

The following operating conditions and thresholds must be complied with (evaluation criteria):

- The extraneous noise level in the measurement environment must be kept as low as possible.
- The unit under test may not leave MPP operation.
- The unit under test may not leave feed-in operation.
- Error messages may not be displayed/issued.
- No function deviations are permitted.

4.2 System Structure (Outline):



Lines and auxiliary equipment used			
EUT connection	Line	Auxiliary equipment/remote terminal	Notes
DC power supply	2 x 195 mm²	DC source SMA bldg. 28	-
AC feed-in	3 x 150 mm²	AC high-voltage transformer SMA bldg. 28	-
AC internal power supply	5 x 25 mm²	AC grid SMA bldg. 28	-
X501 (RJ45)	SFTP LAN line	PC/Notebook	-

4.2.1 Information About the Unit Under Test

- Dimensions of the unit under test (H x W x D): 2,272 mm x 2,562 mm x 956 mm
- Device type of the unit under test:

☐ Desktop device (80 cm above the floor)

The unit under test is set up on the table. The measurements are carried out.

at a distance of 0,2 m.

☒ Floor-standing device with increased height > 90 cm .

The unit under test is set up on the floor. The measurements are carried out at a distance of 0,2m on a cuboid measurement surface with its single segments of approx 0,8m x 1,6m and 1,27m² areal.

4.3 Test Environment

- Free-field measurement – lowest distance to buildings or other structures: 35 m
- Measurement space – dimensions (H x W x D): open Air x 25 m x 25 m – lowest distance from EUT to other structures: 15 m
- Increased ambient/test temperature of 21 °C

5 Determining the Sound Power L_{WA} According to EN ISO 9614-2

5.1.1 Determining the Overall Measurement Surface S and the Partial Measurement Surface PS

The surface of the measuring cube (not including base area) is the measurement surface S in m².

This image corresponds to another measurement, but the enclosure corresponds to the device being tested.

Cuboid measurement surface with its single segments of approx 0,8m x 1,6m and 1,27m² areal.
Dimensions of the unit under test (H x W x D): 2,272 mm x 2,562 mm x 956 mm
Measurement distance d = 0.2 to 0,25m

5.1.2 Calculating the Sound Pressure

L_{pA} =	average sound pressure level on the measurement surface [dB_A] *	78.81
S =	overall measurement surface [m²]	28.09
S_0 =	1 [m²]	

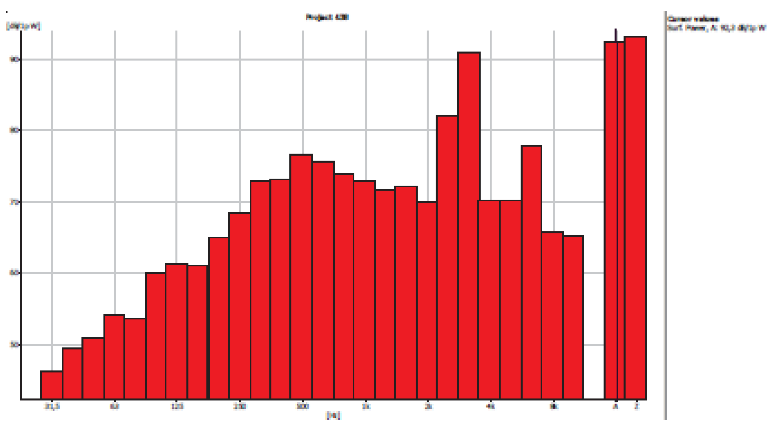
* This specified spatially/temporally averaged sound pressure level was determined using the calculated acoustic power level.

$L_{pA} = L_{WA} - 10\log(S/S_0)$

Sound power of L_{WA} = **92,3 $dB_{A/W}$** results for the measurement.

Sound power of L_{WA} = **93,3 $dB_{A/W}$** result *plus added 1 dBA* for the manifest level.

Sound Power Levels of the Third Octave Band Frequencies According to EN ISO 9614-2



A-rated sound power = 92.3 $dB_{A/W}$

Z-rated sound power = 93.1 $dB_{A/W}$

A-rated sound power – based on physiologic human hearing

Z-rated sound power – technically linear measured value

To be save with the levels given in the inverter data sheets 1dB_A was added to the measured A-rated sound power due to former result experience.

The resulting value is a sound power level of L_{WA} = **93,3 $dB_{A/W}$**

Overview of the Sound Power

Third octave band center frequency [Hz]	Sound power- level L_{wa} [$dB_{A/pW}$] 800 kW	Sound power- level L_{wz} [$dB_{A/pW}$] 800 kW
25 Hz	42,33	-
31.5 Hz	46,34	-
40 Hz	49,56	-
50 Hz	51	-
63 Hz	54,21	-
80 Hz	53,57	-
100 Hz	60,14	-
125 Hz	61,23	-
160 Hz	61,13	-
200 Hz	64,88	-
250 Hz	68,36	-
315 Hz	72,83	-
400 Hz	73,24	-
500 Hz	76,54	-
630 Hz	75,64	-
800 Hz	73,99	-
1 kHz	72,93	-
1.25 kHz	71,67	-
1.6 kHz	72,11	-
2 kHz	69,89	-
2.5 kHz	81,96	-
3.15 kHz	90,89	-
4 kHz	70,19	-
5 kHz	70,24	-
6.3 kHz	77,78	-
8 kHz	65,76	-
10 kHz	65,2	-
Acoustic power above the surface	A-rated	Z-rated
	92,3	93.1

5.1.3 Deriving the Emission Sound Pressure Level at a Distance

The calculated acoustic power can be used to derive an A-rated sound pressure level L_{xpA} for undirected sources at any distance x.

$$LxpA = LwA + Ko - 10 \cdot \log\left(4 \cdot \pi \cdot \frac{X^2}{So}\right)$$

K_o = solid angle index on the floor 3 [dB]

X = distance from the source [m]

S_o = 1 m

Device	Distance X [m]	Sound pressure level L_{xpA} [dB_A] without fan	Sound pressure level L_{xpA} [dB_A] with fan
SC800CP-XT	10	–	65,31
	50	–	51.33

Measurement Equipment Used

Used	Type	Model	Manufacturer	Serial number/inventory number	Last/next calibration
X	Open area test site	Building 28	SMA	-/-	-/-
	Sound level meter	2250 A / E	BRÜEL&KJÄR	2611671	11-2012/11-2013
	Class 1 acoustic calibrator	Kal-4231	BRÜEL&KJÄR	2652003	11-2012/11-2013
	Class 1 Falcon microphone	MI-4189	BRÜEL&KJÄR	2616324	11-2012/11-2013
X	Frequency analysis software	BZ-7230	BRÜEL&KJÄR	-/-	-/-
X	Signal recording	BZ-7223	BRÜEL&KJÄR	-/-	-/-
X	FFT measurement software	BZ-7226	BRÜEL&KJÄR	-/-	-/-
X	Intensity software	BZ-7233	BRÜEL&KJÄR	-/-	-/-
X	Sound analyzer	2270 A / E	BRÜEL&KJÄR	2746662	11-2012/11-2013
	Class 1 Falcon microphone	MI-4189	BRÜEL&KJÄR	2771953	11-2012/11-2013
X	Intensity probe	UA 2683	BRÜEL&KJÄR	2759069	11-2012/11-2013
X	Class 1 Set microphone	MI-4197	BRÜEL&KJÄR	Part1 2751711 Part2 2751711	11-2012/11-2013 11-2012/11-2013
X	Intensity calibrator Class 1	Kal-4297	BRÜEL&KJÄR	2774959	08-2012/08-2013
	Tripod	C 3060	CULLMANN	-/-	-/-

5.1.4 Test Setup

The test is set up in accordance with the normative specifications and documented in the following "Photographs of the plant".

5.1.5 Photographs of the Plant

Test Setup

Measuring acoustic power using the intensity probe
Cuboid measurement surface with its single segments of approx 0,8m x 1,6m and 1,27m² areal.

Zephyr North

6 Appendix

6.1 Calculations

The following formulas are used to calculate the required values for the previous sections.

deriving sound pressure level at a distance

LxpA=LWA+K0-10log(4*PI*(x²/S0))

LWA	93,3 dB		
K0	3 dB	**LxpA**	**65,31 dBA**
x	10 m		
S0	1 m		

Flächenberechnung

(Unterseite nicht betrachtet, z.B. Sunny Central)

s of Measurement / m 0,2

		Length / m	Hight / m	Surface
	front	2,562	2,727	8,67 m²
	left	0,956	2,272	3,35 m²
automaticly	rear	2,562	2,727	8,67 m²
automaticly	right	0,956	2,272	3,35 m²
	top	2,562	0,965	4,04 m²
			coplete surface:	**28,09 m²**

RMS Sound presure level ontof measurement surface

(via sound intensity)

LpA=LWA-10log(S/S0)

LWA	93,3 dB		
S	28,09 m²	**LpA**	**78,81 dBA**
S0	1 m²		

Zephyr North

6.2 Definition of Terms

Area Affected by a Plant

The area affected by a plant includes areas in which the noises coming from the plant

a) generate a rating level that is less than 10 dB(A) below the emission guide value specified for this area, or

b) generate noise peaks that reach the emission guide value specified for their rating.

Defining a Significant Emission Area (German Noise Control Act)

Significant emission areas are,

a) in the case of built-up areas, 0.5 m away from the center of the open window of the vulnerable area that is most affected by the noise, in accordance with DIN 4109, (german version) dated November 2009;

b) in the case of undeveloped land or built-up areas in which no buildings contain vulnerable areas, at the edge of the area that is most affected, where buildings with vulnerable areas are permitted according to building and planning law; in vulnerable areas that are similar in structure to the plant to be evaluated, in terms of structure-borne sound transfer and the effect of low-frequency noises in the vulnerable areas that are most affected. In addition, the provisions of DIN 45645-1, (german version) dated July 2006, section 6.1 regarding substitute measurement areas, arranging the microphone and carrying out the measurement apply.

Sound Pressure p

The change in pressure caused by sound that is superimposed on the static air pressure. It is given in pascals.

Sound Pressure Level Lp or LAF(t)

Definition: Ten times the common logarithm of the ratio of the squared sound pressure to the square of the reference sound pressure. The sound pressure level is given in decibels. The reference sound pressure is 20 μPa (2 x 10^{-5} Pa).

The sound pressure level LAF(t) is the instantaneous value of the sound pressure level formed using frequency weighting A and time weighting F according to DIN EN 60651, (german version) dated May 2004. It is the main basis for determining the level according to this "Technical Manual."

Average Level LAeq

The sound pressure level of a continuous, steady noise for which the sound pressure, within the averaging period T, has the same root mean square value as the time-dependent noise to be examined.

The average level LAeq is the time-based average for the sound pressure level based on the course of the sound pressure level over time, as per DIN 45641 (german version) dated June 2009, or as derived with the help of sound level meters, as per DIN EN 60804 (german version) dated May 2004.

Short-Term Noise Peaks

Short-term noise peaks in the sense of this "Technical Manual" are maximum values of the sound pressure level caused by individual events that occur during normal operation. Short-term noise peaks are described using the maximum level LAFmax of the sound pressure level LAF(t).

Sound Power W

The sound energy radiating from a source as airborne noise divided by the time. It is given in watts.

Average acoustic power level

The average acoustic power level LWeq is the average level of acoustic power over the exposure time. The frequency rating or radio spectrum to which the average acoustic power level applies is indicated by indices, e.g. LWA, LWOkt.

Sound Power Level Relevant for Emissions

Definition: Ten times the common logarithm of the ratio of the acoustic power radiating from the converter station to be tested to the reference sound pressure. It is given in decibels.
The acoustic power level of an installation that is relevant for emissions is the acoustic power level resulting from the total acoustic power of all sound sources within the installation, not including losses on the propagation path within the installation and taking into consideration the directivity measurements of the sound sources. It can, for example, be determined using an all-round measurement according to ISO 8297, (german version) dated December 2004.

Structure-Borne Sound Transfer

In the event of structure-borne sound transfer, the sound is transferred from the source via the floor and/or components to the boundary surfaces of the vulnerable areas.

ABB

Sound Test Report
1600kVA and 800kva Quotation
[Ref: 13Q1833961]

Proprietary Class III

Jefferson City, MO

Prepared by: Susmitha Tarlapally
Electrical Engineering Lead

I. Sound Test Data

ABB, Jefferson City performs Sound test as per IEEE C57.12.90 section 13. The transformer under test is connected and energized from the low voltage side at rated voltage and rated frequency and is energized at no load with the tap changer, if any, on the rated/nominal tap.

A total of 8 Measurements are taken at 1 foot distance from the transformer wall with microphones positioned at the 4 corners and in the middle of the 4 sides. Microphones are positioned such that the measurements are made at the half height of the transformer.

Measurements are taken in an environment having an ambient sound pressure level of at least 5 dB below the combined transformer and ambient sound pressure level. When the ambient sound pressure level is 5 dB or more below the combined transformer and ambient sound pressure level, the corrections shown in Table 1 below is applied to the combined transformer and ambient sound pressure level to obtain the transformer sound pressure level.

Table 1 —Ambient sound corrections

Difference between the ambient sound pressure level and the combined transformer and ambient sound pressure level (dB)	Correction to be added to the combined transformer and ambient sound pressure level to obtain the ambient-corrected sound pressure level of the transformer (dB)
5	-1.6
6	-1.3
7	-1.0
8	-0.8
9	-0.6
10	-0.4
Over 10	0.0

Table 2 represents the sound test data of actual units made in Jefferson City, MO. The test data meets the IEEE c57.12.00 and NEMA TR1 standards. All of the sound tests were performed at ABB, Jefferson City, Missouri test laboratory.

Table 2 —Ambient sound corrections

		Ambient(dB)		Microphone Position(dB)								Final Result(dB)
ABB_SN	Kva	Before Test	After Test	1	2	3	4	5	6	7	8	AvgdB
12J037182	1688	39.1	39.4	43.3	43.6	47.1	46.5	47.3	44.1	44.5	41.6	43.4
07J790181	1000	49.3	49.3	54.2	53.4	53.0	52.6	49.1	50.7	52.7	53.8	50.8

Table 2 shows the sound test data for the two quoted transformers.

II. Conclusion

ABB Jefferson city, MO confirms that all the transformer meet or exceed the NEMA/IEEE standards for sound test requirements.

END