Acoustical Study

West Hill Road Solar

West Hill Road
Torrington, CT

PREPARED FOR

LSE Serpens LLC
40 Tower Lane Suite 201
Avon, CT 06001

PREPARED BY

260 Arsenal Place
Suite 2
Watertown, MA, 02471

December 2024

Table of Contents

List of Tables

List of Figures

1

Introduction

The purpose of this acoustical study is to evaluate the potential noise impacts associated with the operation of the proposed LSE Serpens LLC, West Hill Road Solar Project (the Project) located along West Hill Road in Torrington, Connecticut. This acoustical assessment evaluated the potential sound levels generated by the mechanical equipment, including the inverters and transformers, that will be part of the Project. The acoustical assessment was based on the site plans titled West Hill Road Solar, dated October 16, 2024, prepared by SLR. The sound levels were compared to the Connecticut Department of Energy and Environmental Protection's (CT DEEP) noise control regulations (Regulations of Connecticut State Agencies (RCSA), Title 22a, Section 22a-69-1 to 22a-69-7).

Project Description

The proposed Project consists of the development of a 2.988-Megawatt (MW) alternating current (AC) ground-mounted solar photovoltaic (PV) facility located on an approximately 19-acres encompassed by multiple parcels on West Hill Road in Torrington, Connecticut (M/B/L 253/03/018,033-043 & 045). These collective parcels are referred to herein as the Project Site.

Fundamentals of Noise

Noise is defined as unwanted or excessive sound. Sound becomes unwanted when it interferes with normal activities such as sleep, communication, work, or recreation. How people perceive sound depends on several measurable physical characteristics, which include the following:

- **Intensity** – Sound intensity is often equated to loudness.
- **Frequency** – Sounds are comprised of acoustic energy distributed over a variety of frequencies. Acoustic frequencies, commonly referred to as tone or pitch, are typically measured in Hertz. Pure tones have all their energy concentrated in a narrow frequency range.

Sound levels are most often measured on a logarithmic scale of decibels (dB). The decibel scale compresses the audible acoustic pressure levels which can vary from the threshold of hearing (zero dB) to the threshold of pain (120 dB). Because sound levels are measured in dB, the addition of two sound levels is not linear. Adding two equal sound levels creates a 3 dB increase in the overall level. Research indicates the following general relationships between changes in sound level and human perception:

- A 3 dB increase is a doubling of acoustic energy and is the threshold of perceptibility to the average person.
- A 10 dB increase is a tenfold increase in acoustic energy but is perceived as a doubling in loudness to the average person.

The human ear does not perceive sound levels from each frequency as equally loud. To compensate for this phenomenon in perception, a frequency filter known as A weighted [dB(A)] is used to evaluate environmental noise levels. **Table 1** presents a list of common outdoor and indoor sound levels.

Table 1. Common Outdoor and Indoor Sound Levels

Outdoor Sound Levels	Sound Pressure (μPa)*		Sound Level dB(A)**	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 5 m
Jet Over Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area—Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
	20,000	-	60	
Quiet Urban Area—Daytime		-	55	Quiet Conversation at 1 m
	6,325	-	50	Dishwasher Next Room
Quiet Urban Area—Nighttime		-	45	
	2,000	-	40	Empty Theater or Library
Quiet Suburb—Nighttime		-	35	
	632	-	30	Quiet Bedroom at Night
Quiet Rural Area—Nighttime		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	
Reference Pressure Level	20	-	0	Threshold of Hearing

Source: Highway Noise Fundamentals. Federal Highway Administration, September 1980.

* mPA – MicroPascals, which describe pressure. The pressure level is what sound level monitors measure.

** dB(A) – A weighted decibels, which describe sound pressure logarithmically with respect to 20 mPa (the reference pressure level).

A variety of sound level indicators can be used for environmental noise analysis. These indicators describe the variations in intensity and sequential pattern of the sound levels. The indicators used in this analysis are defined as follows:

- Leq is the equivalent continuous A-weighted sound level, which is the value or level of a steady, non-fluctuating sound with the same acoustic energy as the actual time-varying sound levels over a given time period.

- L10 is the A-weighted sound level, which is exceeded for 10 percent of the time over a given time period.
- L90 is the A-weighted sound level, which is exceeded for 90 percent of the time over a given time period. The L90 is generally considered to be the background sound level.

Noise Impact Criteria

The CT DEEP has developed noise impact criteria that establish sound level thresholds deemed to prevent adverse impacts for new developments. The acoustic analysis for the Project used these criteria to evaluate whether the Project will generate sound levels that result in adverse impacts.

The CT DEEP's noise control regulations identify the limits of sound that can be emitted from specific premises and what activities are exempt. The noise control regulations (Title 22a, §§ 22a-69-1 to 22a 69-7) are contained in the RCSA. The proposed Project is considered a Class C (Industrial) emitter by the CT DEEP. Nearby residences are Class A (Residential) Receptors. The land use in Class A noise zone is characterized as generally residential where human beings sleep, or areas where serenity and tranquility are essential to the intended use of the land.

The CT DEEP policy states that a source (emitter) located in the various zones shall not emit noise exceeding the levels stated in **Table 2** at the adjacent noise zones.

Table 2. Noise Zone Standards (dB(A))

	Receptor Noise Zone			
Emitter Zone	Class A (Daytime)	Class A (Nighttime)	Class B	Class C
Class A (Residential)	55	45	55	62
Class B (Commercial)	55	45	62	62
Class C (Industrial)	61	51	66	70

Source: Control of Noise (Title 22a, Section 22a-69-1 to 22a-69-7.4), RCSA, Revised 2015-3-6.

The CT DEEP's noise regulation includes a prominent discrete tone criteria which identifies limits which each one-third octave band center frequency should not exceed any adjacent one-third octave band center frequency (Title 22a, §§ 22a-69-1.2(r)). The manufacturer specifications for the proposed equipment did not provide one-third octave band sound levels. As such, a 5 dBA penalty was applied to the criteria to conservatively evaluate the potential for tonal noise from the facility.

The noise control regulations (Title 22a, §§ 22a-69-3.6) take into consideration projects that are to be located in areas with high existing background noise. For such areas, the noise emitted by the project sources are considered to cause excessive noise if they emit levels 5 dB(A) above the background noise. It was conservatively assumed that existing sounds levels in this area would not be above the CT DEEP criteria; as such, the sound levels in **Table 2,** with a 5 dBA penalty for tonal noise would be applicable to this Project. The town of Torrington does not have a noise ordinance, therefore, the project will be subject to CT DEEP's noise regulation and limited to 56 dBA daytime and 46 dBA nighttime sound level limits.

2

Acoustical Assessment

Methodology

This acoustical assessment evaluated the sound levels from the Project's proposed mechanical equipment. The Project's noise sources consist of twenty electrical inverters used to convert the solar energy to usable electricity and two transformers. Equipment locations are presented in **Figure 1**.

The Project-generated sound levels were calculated using manufacturer's sound data and the principles of acoustical propagation of sound over distance and were calculated for each sensitive receptor location. The sources of operational noise associated with the proposed project include:

- Twenty (20) SMA Highpower PEAK3 SHP 150-US-21 inverters and
- Two (2) 1750 kVA Maddox transformers.

The sound power level data for these pieces of equipment are provided in **Table 3**. The sound power level for the inverters was based on the manufacturer's specifications. The reference sound levels for the transformers are based on an empirical approach obtained from the literature that relates the kVA-rating of an air-cooled transformer to its sound power level.[1] Reference sound level data for the inverters were obtained from the manufacturer's specifications. See **Attachment A** for manufacturer's specifications.

Table 3. Modeled Sound Power Levels

		Sound Power Levels (dB) by Octave Band Center Frequency (Hz)								Overall	
Equipment	**Qty**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**	**dB**
SMA inverter[1]	20	--	--	--	80	--	--	--	--	77	80
1750 kVA transformer[2]	2	82	86	80	76	76	70	65	59	80	89

1 SMA Sunny Highpower PEAK3-US 125/150/165/172.
2 Barron, 2003.

[1] Barron, Randall F., "Industrial Noise Control and Acoustics," Marcel Dekker, Inc., Table 5-7, pp. 177-178, 2003.

The A-weighted sound pressure levels due to the operation of the Project were predicted at the receptor locations using the acoustic modeling software CadnaA[2] (Computer Aided Noise Abatement) by Datakustik. CadnaA is an internationally accepted sound prediction program that implements the International Standards Organization (ISO) 9613-2 (2024) outdoor sound propagation standard. The noise prediction model accounts for the sound emissions of equipment, the ground cover, terrain, and the geometry of the project area. The assessment assumed all equipment operating simultaneously during the daytime period. Sound propagation was assumed to occur over acoustically "soft" ground (G=1.0). The ground at the equipment pad – the location at which the inverters and transformers would be installed – was assumed to be acoustically "hard" ground (G=0.0). The ISO standard conservatively assumes there are moderate downwind conditions where the wind would blow from the source to each receptor location. Receptors were modeled at a height of 1.5 m (5-feet) above the ground at the nearest property lines to the equipment. The noise prediction model did not account for excess attenuation provided by trees, or by any on-site or off-site structures, lending some conservatism to the results. The results were compared to the CT DEEP noise impact criteria for determining compliance.

Receptor Locations

A total of five receptor locations were identified in the vicinity of the Project Site (see **Figure 1**). The receptor locations were selected based on their proximity to the Project Site and their land use. These receptor locations represent the nearest property lines of the Project and nearest residential property line.

[2] DataKustik GmbH, 2024. Computer Aided Noise Abatement Model.

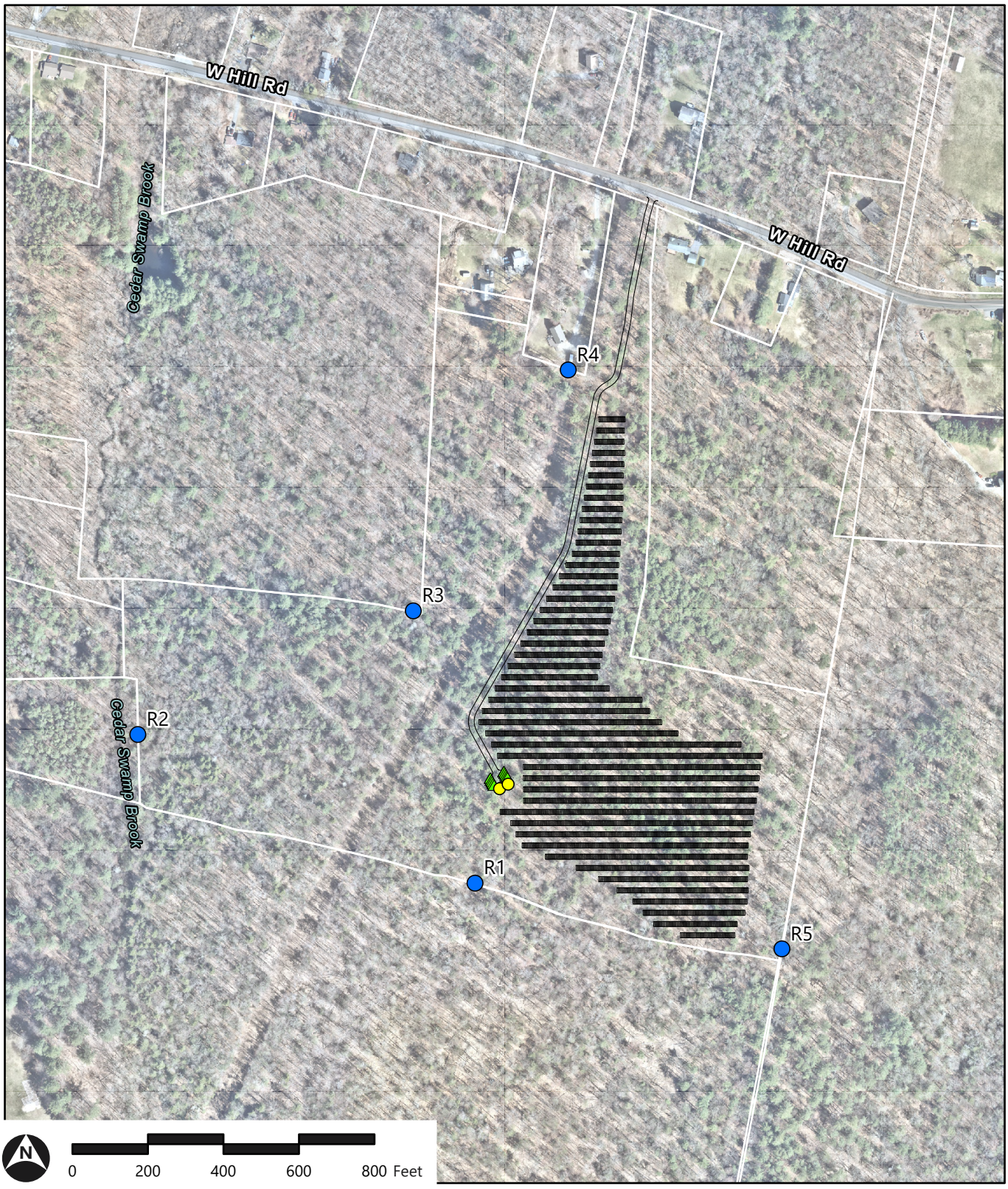


Figure 1: Noise Receptor and Equipment Locations
Lodestar Energy
Torrington, CT
December 5, 2024

Source: NearMap, and VHB 2024.

Future Conditions

VHB evaluated the potential sound level impacts associated with the Project's proposed mechanical equipment at the nearby sensitive receptor locations. This analysis evaluated the potential sound level impacts from the twenty inverters and two transformers operating simultaneously.

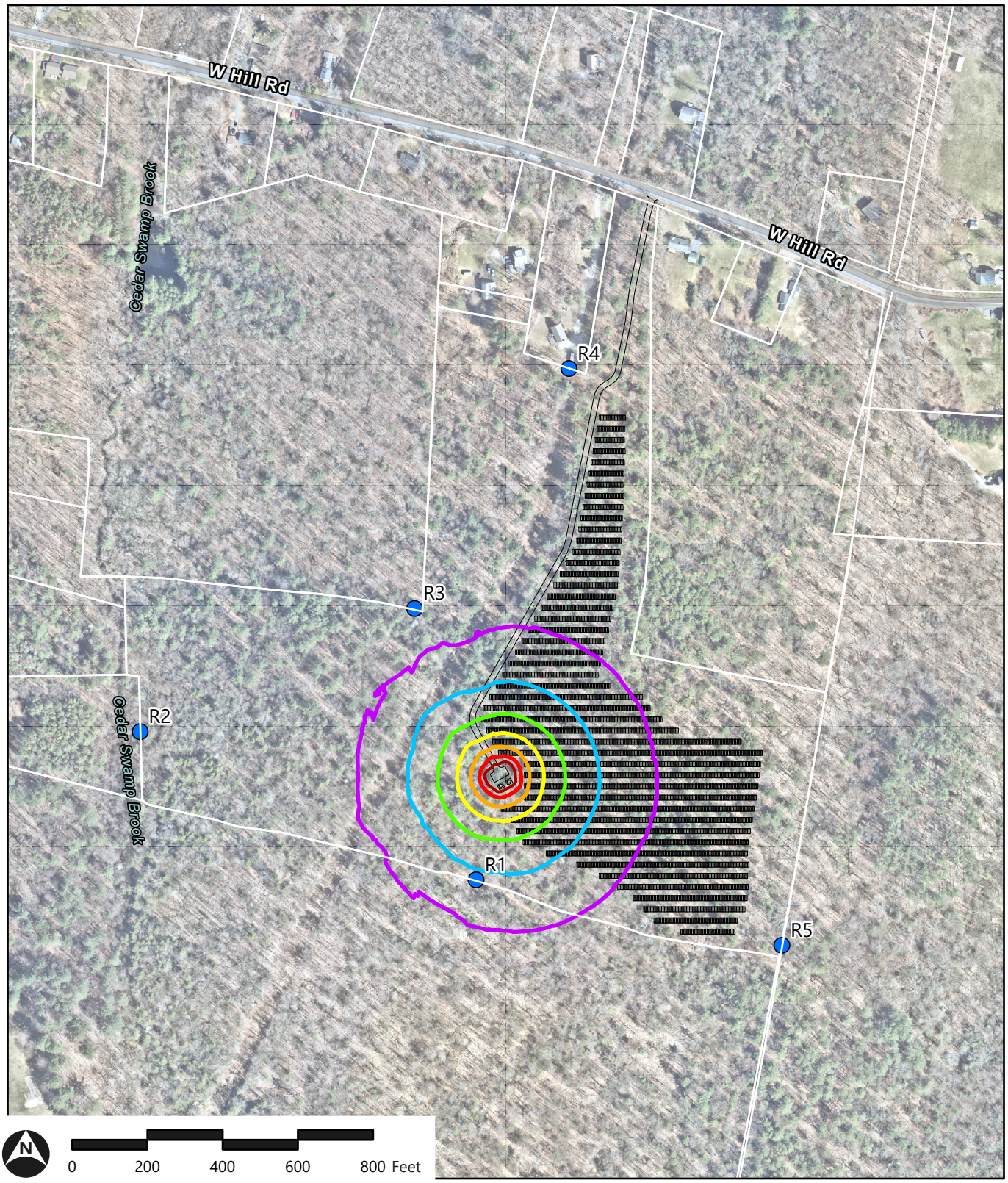
The potential sound levels associated with the proposed equipment were determined by comparing the predicted Project generated sound levels to CT DEEP's noise standards with a 5 dBA penalty applied for potential tonal noise from the proposed mechanical equipment. The results of the acoustical analysis demonstrated that the operation of the proposed equipment will comply with CT DEEP's noise standards at the sensitive receptor locations. The sound levels attributed to the proposed equipment range from approximately 21 dB(A) at Receptor R4, the northern property line, to 35 dB(A) at Receptor R1, the southern property line. These sound levels are below CT DEEP's daytime criteria of 56 dB(A) and the nighttime criteria of 41 dB(A) with a 5 dBA penalty applied for potential tonal noise. Due to the nature of the Project, the solar equipment will not be operating during the nighttime period and therefore would not make noise during the nighttime. However, the nighttime criteria comparison has been included for information purposes to demonstrate compliance. **Table 4** summarizes the sound levels due to the operation of the inverters and transformers at the receptor locations.

Table 4. Daytime Sound Levels at Receptor Locations, dB(A) – Due to Inverters and Transformers

Receptor Locations	CT DEEP Noise Standard* (Daytime/Nighttime)	Project Generated Sound Levels
R1 – south property line	56/46	35
R2 – west property line	56/46	21
R3 – northwest property line	56/46	28
R4 – north property line	56/46	21
R5 – east property line	56/46	23

* Noise standard for Class C emitter and Class A receptor, unless otherwise noted.
CT DEEP noise standard with 5 dBA penalty applied.

Figure 2 presents sound level contours (i.e., lines of equal sound level that are analogous to topographic contours that are lines of equal ground elevation) for the operation of the inverters and transformers. The sound level contours in **Figure 2** excludes contributions from off-site sources of sound.



* CTDEEP Nighttime Standard with tonal penalty applied
** CTDEEP Daytime Standard with tonal penalty applied

Figure 2: Modeled Sound Level Contours with Transformers and Inverters
Lodestar Energy
Torrington, CT
December 5, 2024

Source: NearMap, and VHB 2024.

3

Findings

Conclusion of Acoustical Assessment

In this acoustical analysis, VHB evaluated the sound levels associated with the Project's mechanical equipment which includes 20 inverters and two transformers. This analysis conservatively assumed that the properties abutting the Project Site currently experience sound levels below CT DEEP's noise standards and the high background noise areas guidance (Sec 22a-69-3.6) do not apply to the Project. Additionally, the project conservatively assumed a 5 dBA penalty for the potential tonal noise generated by the proposed mechanical equipment.

Due to the low noise equipment and sufficient distance between the proposed equipment and the nearby property boundaries, the sound levels associated with the Project's mechanical equipment are expected to comply with CT DEEP's noise standards and have no adverse noise impacts at nearby sensitive receptor locations. Noise mitigation is not necessary for the Project.

Construction Activities

Construction activities, including the intermittent use of heavy machinery, may result in temporary increases in nearby sound levels at the proposed Project. The Project is expected to generate typical sound levels from construction activities, including truck movements, heavy equipment operations, and general construction activities. Heavy machinery, such as front-end loaders, graders, bull dozers, and backhoes, would be used intermittently throughout the proposed Project's construction.

Section 22a-69-1.8(g) of the CT DEEP's noise control regulation states that noise associated with construction activities are exempt from the regulation. Construction activities such as site excavation/grading and installation of the solar panel systems would typically be limited to normal daytime working hours. While construction noise is exempt from the regulation, construction activities beyond normal daytime work hours would be minimized to the extent practicable.

ATTACHMENT A

/ SHP 125-US-21 / SHP 150-US-21 / SHP 165-US-21 / SHP 172-US-21

Sunny Highpower PEAK3-US

125 / 150 / 165 / 172

A superior distributed generation solution for large-scale power plants

25 YEAR DESIGN LIFE

SMA Smart Connected

c UL us

Cost effective
- Modular architecture reduces BOS and maximizes system uptime
- Compact design and high power density maximize transportation and logistical efficiency

Maximum flexibility
- Scalable 1,500 VDC building block with best-in-class performance
- Flexible architecture creates scalability while maximizing land usage

Simple install, commissioning
- Ergonomic handling and simple connections enable quick installation
- Centralized commissioning and control with SMA Data Manager

Highly innovative
- SMA Smart Connected reduces O&M costs and simplifies field-service
- Powered by award winning ennexOS cross sector energy management platform

The Sunny Highpower PEAK3 1,500 VDC inverter offers high power density in a modular architecture that achieves a cost-optimized solution for large-scale PV integrators.

With fast, simple installation and commissioning, the PEAK3 is accelerating the path to energization. SMA has also brought its field-proven Smart Connected technology to the PEAK3, which simplifies O&M and contributes to lower lifetime service costs. The PEAK3 power plant solution is powered by the ennexOS cross sector energy management platform, 2018 winner of the Intersolar smarter E AWARD.

Technical Data	Sunny Highpower PEAK3 125-US	Sunny Highpower PEAK3 150-US	Sunny Highpower PEAK3 165-US	Sunny Highpower PEAK3 172-US
Input (DC)				
Maximum array power [1]	250 kWp	300 kWp	330 kWp	344 kWp
Maximum system voltage	1500 Vdc			
Rated MPP voltage range	705 V ... 1450 V	880 V ... 1450 V	924 V ... 1450 V	968 V ... 1450 V
MPPT operating voltage range	684 V ... 1500 V	855 V ... 1500 V	898 V ... 1500 V	941 V ... 1500 V
MPP trackers	1			
Maximum operating input current	180 A			
Maximum input short-circuit current	325 A			
Output (AC)				
Nominal AC power	125 kW	150 kW	165 kW	172 kW
Maximum apparent power	125 kVA	150 kVA	165 kVA	172 kVA
Output phases / line connections	3 / 3-PE			
Nominal AC voltage	480 V	600 V	630 V	660 V
Compatible transformer winding configuration	Wye-grounded			
Maximum output current	151 A			
Rated grid frequency	60 Hz			
Grid frequency / range	50 Hz, 60 Hz / -6 Hz ... +6 Hz			
Power factor at rated power / adjustable displacement	1 / 0.8 leading ... 0.8 lagging			
Harmonics (THD)	<3%			
Efficiency				
CEC efficiency	98.5 %	99.0 %	99.0 %	99.0 %
Protection and safety features				
Ground fault monitoring: Riso / Differential current	● / ●			
DC reverse polarity protection	●			
AC short circuit protection	●			
Monitored surge protection (Type 2): DC / AC	● / ●			
Protection class / overvoltage category (as per UL 840)	I / IV			
General data				
Device dimensions (W / H / D)	770 / 830 / 462 mm (30.3 / 32.7 / 18.2 in)			
Device weight	99 kg (218 lbs)			
Operating temperature range	-25°C ... +60°C (-13°F ... +140°F)			
Storage temperature range	-40°C ... +70°C (-40°F ... +158°F)			
Audible noise emission (full power @ 1m and 25°C)	< 69 dB(A)			
Internal consumption at night	< 5 W			
Topology	Transformerless			
Cooling concept	OptiCool (forced convection, variable speed fans)			
Enclosure protection rating	Type 4X			
Maximum permissible relative humidity (non-condensing)	100%			
Additional information				
Mounting	Rack mount			
DC connection	Terminal lug (up to 600 kcmil CU/AL)			
AC connection	Screw terminal (up to 300 kcmil CU/AL)			
LED indicators (Status/Fault/Communication)	●			
SMA Speedwire (Ethernet network interface)	● (2 x RJ45 ports)			
Data protocols: SMA Modbus / SunSpec Modbus	● / ●			
Integrated Plant Control / Q on Demand 24/7	● / ●			
Off-grid capable / SMA Hybrid Controller compatible	– / ●			
Monitoring				
SMA Sunny Portal (monitoring portal)	No cost for the lifetime of the system			
SMA Smart Connected (monitoring and remote O&M service)	No cost on inverters under warranty			
Supported protocols for outbound data	SMA external API, Modbus, FTP			
Certifications				
Certifications and approvals (pending)	UL 62109, UL 1998, CAN/CSA-C22.2 No.62109			
Manufacturer's Declaration of Design Life	25 years			
FCC compliance	FCC Part 15, Class A			
Grid interconnection standards	IEEE 1547:2018, UL 1741-SA - CA Rule 21, HECO Rule 14H, UL1741SB			
Advanced grid support capabilities	L/HFRT, L/HVRT, Volt-VAr, Volt-Watt, Frequency-Watt, Ramp Rate Control, Fixed Power Factor			
Warranty				
Standard	5 years			
Optional extensions (total warranty coverage cannot exceed 25 years)	+5 / +10 / +15 / +20 years			
1) Higher DC array power permitted via site inverter load modeling in SMA Sunny Design				
Type designation	SHP 125-US-21	SHP 150-US-21	SHP 165-US-21	SHP 172-US-21

● Standard features ○ Optional features – Not available

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Maddox

THREE PHASE PADMOUNT TRANSFORMERS

Maddox padmount transformers are constructed of the highest quality materials and built in the US to heavy duty industrial standards. Our padmounts are built and tested in accordance with industry standards (NEMA, ANSI, DOE, and IEEE as applicable). Maddox padmounts are ideal for commercial and industrial applications such as data centers, solar step-up, utility projects, manufacturing facilities, shopping centers, etc.

Maddox has the manufacturing ability to produce almost any custom design, we also stock all standard configurations. With thousands of new and reconditioned units in stock and ready-to-ship, Maddox is ready to meet your transformer needs.

DESIGN

HV Bushing Config:
1. Dead front or live front
2. Loop feed or radial feed

Fluid Options:
1. Type II Mineral Oil
2. Envirotemp™ FR3™

Standard Gauge/Accessory Package:
1. Pressure relief valve
2. Pressure vacuum gauge
3. Liquid temp & level gauges
4. Drain & sample valve
5. Adjustment taps

Switch Options:
1. 2 Position LBOR Switch
2. 4 Position LBOR Switch (V-blade or T-blade)
3. (3) 2 Position LBOR Switches

Fusing Options:
Bayonets w/ isolation links or CLFs

Construction:
1. 5-legged core
2. Rectangular wound copper or aluminum windings
3. Carbon reinforced or stainless steel tank
4. Steel divider between HV and LV cabinets
5. Penta-head captive bolt

Optional Design Features & Accessories:
1. Gauges w/ Contacts
2. External drain and sample valve
3. Electrostatic Shielding
4. K-Factor Design
5. Step-up Design
6. Surge-Arresters

AVAILABLE RATINGS

Sizes (kVA)	45, 75, 112.5, 150, 225, 300, 500, 750, 1000, 1250, 1500, 1750, 2000, 2250, 2500, 2750 3000, 3750, 5000
Frequency	60 Hz or 50 Hz
Cooling Class	ONAN or KNAN
Temp Rise	55°C, 65°C, 55/65°C
Voltages	Available in Δ or Y configuration
600V	208 240 416 480 600
2.5kv – 5kv	2400 4160 4800
15kV	12000 12470 13200 13800 14400
25kV	20780 21600 22900 24940 26400
35kV	33000 34500

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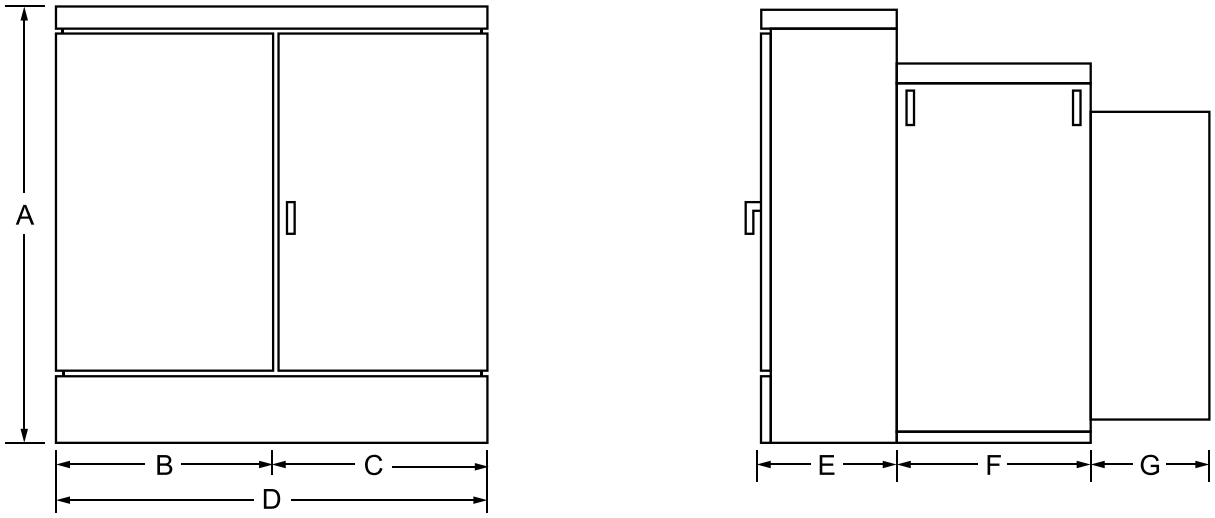
PADMOUNT TRANSFORMER OUTLINE



APPROXIMATE TRANSFORMER DIMENSIONS

kVA	A	B	C	D	E	F	G	Gallons	Weight (Lbs)
300	59”	29.5”	22”	51.5”	20.5”	24”	10”	196	4,056
500	59”	33”	26.5”	59.5”	24”	26.5”	10”	210	5,023
750	73”	36”	29”	65”	24”	26.5”	10”	358	7,664
1000	73”	36”	29”	65”	24”	27”	10”	354	8,530
1500	73”	36”	35.5”	71.5	24”	33.5”	10”	410	10,782
2000	75”	39.5”	28”	67.5	24”	35”	27”	433	12,490
2500	78”	39.5”	35.5”	75.5”	24”	37.5”	22.5”	545	14,246
3000	84”	30.5”	32”	62.5”	24”	37.5”	38”	550	14,014
3750	75”	50.5”	30”	80.5”	25.5”	42”	38”	730	17,785

THREE PHASE MADDOX PADMOUNT TRANSFORMER

COMMON ACCESSORIES

1. Bayonet Fuses

2. Loadbreak Switch

3.Tap-changer

4. Bushings

5. Parking Stand

6. Gauges

Quote	Product	RefTemp	COILSPEC	ATO COILSPEC	REV	RKVA	100% NL	LL	IZ	SHIPWT	UNITWT
SO-81525	PAD	85	583003003134001	583003003134001	152	1750	1908	10246	5.74	12039	11979

GALS	CCWGT	OILTYPE	IZ MIN (ATO)	IZ MAX (ATO)	COREWIDTH	QTTABL	QTREFF	QTDEFF	QEFPAS
487.6	5111.2	Mineral	5.32	6.18	DOUBLE	DOE2016	99.50	99.51	Y

DSGNEFF	DSGNEFPAS	SOUNDLEVEL
99.51	Y	61