



March 25, 2025

Mr. Gregory Rondeau, Chairman
Franklin Planning Board
355 East Central Street
Franklin, MA 02038

***RE: Response to BETA Site Plan Peer Review Comments dated March 18, 2025
50 Constitution Blvd Solar Canopy & Ground Mount Project – Franklin, MA
ADE Job #3402.00***

Dear Mr. Rondeau:

This response letter addresses the comments made in the BETA Site Plan Peer Review Letter dated March 18, 2025, for above-referenced project. Please note the peer review comments are italicized, and our responses follow in bold text:

GENERAL

G1. Based upon the size of the parcel and the current impervious surface coverage, the change in impervious coverage associated with the proposed improvements are limited to concrete pads and footings. Based upon the stormwater analysis, this area is only 699 sq. ft. When compared to the existing impervious on site (1,035,709 sq. ft.), the differential is only 0.04%.

No response is necessary.

ZONING

The Site is located within the industrial (I) Zoning District. The proposed use is a Large-Scale Ground-Mounted Solar Energy System, which is permitted within this district following Planning Board Site Plan Review.

No response is necessary.



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SCHEDULE OF LOT, AREA, FRONTAGE, YARD, AND HEIGHT REQUIREMENTS (§185 ATTACHMENT 9)

As shown on the schedule on the Zoning table on Sheet 4 of 6, the Site meets the requirements for lot area, depth, frontage, building height, and impervious area coverage. The parcel is exempt from the current definition of lot width since it was created prior to the bylaw in 1992.

No response is necessary.

PARKING, LOADING AND DRIVEWAY REQUIREMENTS (§185-21)

The project proposes no changes in the overall parking and/or access to and from the site. There are no buildings or additions proposed with the panel arrays, thus there will be no impact on existing parking or access requirements. The ground mounted units will be enclosed by a fence in an area that was formerly a recreation field.

P1. BETA recommends the applicant consult with the town of Franklin fire department to determine if there are any additional access issues associated with the fenced area around the ground mounted units.

Per a letter from J.S. Barbieri, Deputy Fire Chief, dated 02/12/2025, the Franklin Fire Department has reviewed the project and indicated it provides enough space to drive a brush truck around the enclosed ground mounted solar array. There were no further comments.

P2. The proposed canopy arrays will displace nine of the fifteen pole mounted lights in this parking lot. The plans indicate that these lights will be replaced with lighting beneath the solar array. BETA recommends that these fixtures be identified. It does appear that the perimeter fixtures will not be impacted by the canopies, thus light intensity levels on the perimeter access driveway will not be impacted by the proposed development.

See revised Site Development Plans dated March 25, 2025, and Lighting Plan & Photometrics Plan prepared by PurePower Engineering revised 03/17/2025, where the light fixtures are identified. Accordingly, the applicant is no longer requesting a waiver of the Photometric Plan regulation per Section §185-31.C(3)(I). A revised waiver request list has been prepared and included with this response letter.



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P3. The plans should identify the disposition of the existing trees (8) in the landscaped islands beneath the proposed solar canopies. If they are to be removed, applicant should show that compliance with the shade tree requirements in the parking lot area continues to meet the bylaw requirement. (§185-21. C. (5))

The existing eight (8) trees beneath the proposed solar canopies will be replaced or transplanted along the perimeter of the parking lot. A note to this affect has been added to Site Development Plans dated March 25, 2025.

INDUSTRIAL DISTRICT PERFORMANCE CONTROLS (§185-22)

The project is located within an Industrial District and therefore must conform to these requirements. Given the nature of the project, BETA does not anticipate vibration, odor, or flashing related impacts.

II. As noted in previous solar array hearings, the inverter noise levels will be approximately 65 decibels. In accordance with §185-22.

- A. Disturbances. No sound, noise, vibration, odor or flashing (except for warning devices, temporary construction or maintenance work, parades, agricultural activities or other special circumstances) shall be perceptible without instruments more than 400 feet from the boundaries of the originating premises within an Industrial District or more than 200 feet inside the boundaries of a commercial or business district or more than 100 feet inside the boundaries of a residential district.*

Based on the proximity of the invertors to the abutting buildings along Discovery Lane (200+ ft) BETA recommends that the applicant determine if a noise barrier is needed to comply with this section of the bylaws.

Refer to the Noise Attenuation Analysis dated 03/25/2025 by Atlantic Design Engineers, which addresses noise impacts from the invertors and shows compliance with this section of the bylaws.

EARTH REMOVAL REGULATIONS (§185-23)

The project disturbance will be limited to those soils that will be removed as needed to provide the foundations and pier supports for the proposed facilities. Otherwise, no other grade changes are proposed in conjunction with the proposed solar facilities.



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E1. Indicate approximate earth removal volume to determine compliance with this section or designate areas on site where materials excavated in conjunction with the foundation construction will be disposed of or reused.

The only anticipated earth removal as part of the proposed project is associated with the construction of the solar canopy concrete piers and stone trench. Accordingly, the anticipated soil volume equals approximately 4,836 Cu. Ft. (± 179 Cu. Yds.). Excavated material to be removed from the site. This volume meets the exemption requirements listed within §185-23.

SITE PLAN AND DESIGN REVIEW (§185-31)

The project has been submitted for Site Plan Review and is required to conform to the requirements of this section. The submitted plan set appears to be in compliance with all drawing requirements and review criteria, pending further review by the Fire Department to determine access requirements.

See response to review comment P1.

STORMWATER MANAGEMENT

The stormwater management design proposes a stone filled trench just down gradient of the proposed electrical equipment pads. In addition, the rack mounted invertors will be set on a gravel base. Each of these measures will ensure that runoff generated by these impervious surfaces will be directed into an infiltration SCM.

G1. BETA recommends that a construction detail for the proposed gravel base at the invertors be provided to ensure that it will encourage infiltration.

It has been determined that these four (4) invertors for the ground mount portion of the project will no longer be ground mounted on a gravel base and will be mounted to the back of the solar racking system. See revised Site Development Plans dated March 25, 2025.



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STORMWATER MANAGEMENT REGULATIONS (CHAPTER 153)

Although there are no proposed grade changes, the construction process will disturb land in excess of one acre within the Town of Franklin. It is therefore subject to the Stormwater Management Regulations. The project is also required to comply with the Town of Franklin Best Development Practices Guidebook (BDPG). Compliance with these regulations is outlined below and throughout the following sections.

SW1. The disturbance in the recreation field associated with the new ground mounted solar will require revegetation. The plans should indicate what seed mix will be used to replace the disturbed turf area. (BDPG Pg 6).

See revised Site Development Plans dated March 25, 2025, for the seed mix to be used to revegetate disturbed areas.

MASSDEP STORMWATER STANDARDS

The project is subject to the Massachusetts Stormwater Standards as outlined by MassDEP. Compliance with these standards is outlined below:

NO UNTREATED STORMWATER (STANDARD NUMBER 1): No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. The project proposes infiltration trenches adjacent to the proposed equipment pads. Calculations have been provided which document that the trench will provide the water quality volume.

No response is necessary.

SW2. The proposed impervious surfaces will discharge to infiltration measures. These surfaces are not subject to vehicular traffic and therefore are only subject to pretreatment to the maximum extent possible. Accordingly, the proposed stone trenches will provide the treatment for these surfaces intended by the standards.

No response is necessary.



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POST-DEVELOPMENT PEAK DISCHARGE RATES (STANDARD NUMBER 2): Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. As previously noted, the project will have no impact on the current runoff peak discharge rates and the manner which the runoff is being directed towards the receiving resource areas.

No response is necessary.

RECHARGE TO GROUNDWATER (STANDARD NUMBER 3): Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to maximum extent practicable. NRCS soil maps indicate the soils at the site are primarily Woodbridge fine sandy loam which is rated HSG-C (low infiltration potential).

Soil testing has not been conducted at the Site to date nor is any proposed.

No response is necessary.

TOTAL SUSPENDED SOLIDS (STANDARD NUMBER 4): For new development, stormwater management systems must be designed to remove 80% (90% per Town Bylaw) of the annual load of Total Suspended Solids (TSS). The project is required to treat the 1.0-inch water quality volume per Town Bylaws. Since none of the existing impervious surfaces are being impacted by the proposed development, this requirement will only apply to the new impervious surfaces. The proposed infiltration trenches will provide the storage necessary to meet the bylaw requirements.

No response is necessary.

HIGHER POTENTIAL POLLUTANT LOADS (STANDARD NUMBER 5): Stormwater discharges from Land Uses with Higher Potential Pollutant Loads (LUHPPLs) require the use of specific stormwater management BMPs. The project is not considered a LUHPPL – not applicable.

No response is necessary.



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CRITICAL AREAS (STANDARD NUMBER 6): Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. The project is not in a critical area as defined by the standards– not applicable.

No response is necessary.

REDEVELOPMENT (STANDARD NUMBER 7): Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. The project is not considered a redevelopment– The solar panel arrays are not defined by MASS DEP as an impervious surface; thus, the only new impervious surfaces will be the concrete equipment pads and foundations. None of the existing impervious surfaces on the site will be modified in conjunction with the proposed development. Thus, the standard is not applicable to the proposed development.

No response is necessary.

EROSION AND SEDIMENT CONTROLS (STANDARD NUMBER 8): Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities. Although no surface disturbance is anticipated in conjunction with the development of the canopies, the development of the ground mounted array based on the nature of the construction, will disturb greater than one acre of land.

Accordingly, it will be required to file a Notice of Intent with EPA and develop a Stormwater Pollution Prevention Plan (SWPPP). Erosion control measures are identified on sheet 5 of 6 but are limited to a mulch log surrounding the proposed ground mounted array area.

Understood, an eNOI will be filed and a SWPPP will be prepared prior to earth disturbance.

SW3. Provide construction scheduling plan (BDPG Pg. 11)

See Sheet 4 of the revised Site Development Plans dated March 25, 2025, for the anticipated construction sequence.

SW4. Provide dust control plan (BDPG Pg. 11)

See Sheet 6 of the revised Site Development Plans dated March 25, 2025, for appropriate dust control measures.



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SW5. Provide a construction entrance onto the ground mounted array area and a construction detail for the same.

See Sheets 5 & 6 of the revised Site Development Plans dated March 25, 2025, for the construction entrance location and detail.

SW6. BETA recommends that silt sacks be placed on the catch basins surrounding the recreation field especially since most direct runoff into a subsurface infiltration system in the field.

See Sheet 5 of the revised Site Development Plans dated March 25, 2025, for silt sack locations downgradient of the recreational field.

SW7. Indicate if existing topsoil is to be retained and/or stockpiled and screened for re-use.

Top soil is to be retained and respread on the site. See revised Site Development Plans dated March 25, 2025, for a note to this effect.

SW8. The applicant is reminded that a Stormwater permit from the Franklin DPW is required based upon the size of the disturbance.

Understood. Per a discussion with Town Engineer, Mike Maglio, the eNOI and SWPPP will be submitted the Town of Frankline DPW for review as part of the Building Permit process. Mr. Maglio indicated this would meet the requirement of the Stormwater Permit.

OPERATIONS/MAINTENANCE PLAN (STANDARD NUMBER 9): A Long-Term Operation and Maintenance Plan shall be developed and implemented to ensure that stormwater management systems function as designed. A Stormwater Operation and Maintenance Manual was provided with the Stormwater Management Report. The only item noted on the manual is maintenance of the proposed infiltration trench, which is the only SCM associated with the proposed development.

SW20. Provide plan showing location of SCM.

See provided BMP Locations Plan dated March 25, 2025, that is included in the Revised Poat-Construction Long Term Operation & Maintenance Plan.



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SW21. Provide signature of owner in area designated in the manual.

See revised Post-Construction Long Term Stormwater Operation & Maintenance Plan dated March 25, 2025, signed by the owner.

SW22. BETA will defer to the DPW whether Operations & Maintenance Manual for the entire site should be developed and updated to include the newest SCM.

No response is necessary.

ILLICIT DISCHARGES (STANDARD NUMBER 10): All illicit discharges to the stormwater management system are prohibited. An Illicit Discharge Compliance Statement was not provided with the submission.

SW23. Provide illicit discharge compliance statement with owner's signature.

See revised Post-Construction Long Term Stormwater Operation & Maintenance Plan dated March 25, 2025, signed by the owner.

Please call us at (508) 888-9282 if you should have any questions.

Sincerely,

ATLANTIC DESIGN ENGINEERS, INC.

A handwritten signature in black ink, appearing to read 'Richard J. Tabaczynski', written in a cursive style.

Richard J. Tabaczynski, P.E.
Vice President

CC: EMC Corporation

NOISE ATTENUATION ANALYSIS



March 25, 2025

Mr. Gregory Rondeau, Chairman
Franklin Planning Board
355 East Central Street
Franklin, MA 02038

Re: *Noise Attenuation Analysis*
50 Constitution Boulevard Solar Canopy and Ground Mount Project – Franklin MA
ADE Project #3402.00

Dear Members of the Planning Board:

In accordance with Chapter 185: *Special Regulations* of the Town of Franklin Zoning Bylaws and Section 185-22: *Industrial District performance controls* of the Town of Franklin General Code, Atlantic Design Engineers, Inc (Atlantic) has prepared the following Noise Attenuation Analysis on behalf of EMC Corporation (the Applicant) in order to assess potential impacts from noise generated by proposed electrical transformers and central inverters.

The Applicant is proposing a large-scale solar canopy and ground mounted solar photovoltaic installation off of Constitution Boulevard in the Town of Franklin. The proposed solar project will be located on the lot identified by the Town of Franklin's Assessors Department as Map 319 - Lot 015 (the Subject Property). The Subject Property is ±39-acres and is located within in the Industrial Zoning District and with all abutting properties also within the Industrial Zoning District.

As outlined within Town of Franklin's *Industrial District Performance Controls Bylaw* (Section 185-22), no sound, noise, vibration, odor or flashing (except for warning devices, temporary construction or maintenance work, parades, agricultural activities or other special circumstances) shall be perceptible without instruments more than 400 feet from the boundaries of the originating premises within an Industrial District or more than 200 feet inside the boundaries of a commercial or business district or more than 100 feet inside the boundaries of a residential district.



Specific to the Constitution Boulevard Solar Canopy and Ground Mount project, Atlantic has performed a noise attenuation analysis to demonstrate any noise emitted from the proposed transformers and inverters will meet the requirements outlined within Section 185-22 of the Town of Franklin’s Bylaws.

The Constitution Boulevard Solar Canopy and Ground Mount project proposes to use approximately four (4) pad mounted Solis 185KW and seven (7) canopy mounted SolarEdge SE100KUS 100KW three phase inverters. According to the specification data sheet provided by SolarEdge and Solis, the average sound emitted by the inverters are between ±65 and ±67 dBA at an assumed distance of 1-foot from the equipment. According to the manufacturer, the average sound emitted by the 1500KVA transformer was ±60 dBA at an assumed distance of 1-foot from the equipment (See **Exhibit A**). If the difference between two sound sources is greater than 10 dBA, the sound level is equal to the louder source. Therefore, for the purpose of this study, only the inverters, with the higher decibel level (67 dBA) will need to be used to approximate noise level attenuation since the inverters produce a sound greater than 10 dBA higher than the sound produced by the transformer (60 dBA).

The audible sound level produced by the inverter, transformer, or similar device over a given distance can be estimated using the following sound attenuation formula, which is based on the inverse square law:

$$L_2 = L_1 - \left| 20 \times \log \frac{r_1}{r_2} \right| \qquad \text{Eq. 1.0}$$

Where r_1 (ft) is the reference distance, r_2 (ft) is the distance from the sound source, L_1 is the sound (dBA) at source (i.e. sound level at r_1), and L_2 is sound level (dBA) at distance r_2 .

In order to assess potential impacts from the sound levels generated by the inverters, the distance was measured from the equipment pad to the nearest property boundary located East of the equipment pad where the inverters will be located. The impact from the sound levels were also measured at 400’ from the nearest property boundary as well as the nearest residential abutter’s

property lines adhering to Section 185-22 *Industrial District performance controls* in the Town of Franklin’s Bylaws.

The input parameters for Equation 1.0 utilizing 400’feet from the closest property boundary located to the East of the equipment pad and proposed SolarEdge SE100KUS inverter noise ratings, are as follows: (L1) 70 dBA, (r1) 1-foot, and (r2) 511 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{511} \right| && \text{Eq. 1.1} \\ L_2 &= 70 - |20 \times -2.70| \\ L_2 &= 70 - |-54| \\ L_2 &= 70 - 54 \\ L_2 &\cong 16 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L2) from the Equipment Pad at the nearest property boundary generated by the SE120KUS inverter is estimated to be 30 dBA during operation (i.e. daytime hours). For comparison, 20 dBA is a quiet study room, or rustling leaves.

The input parameters for *Equation 1.0* utilizing the closest property boundary located to the East of the equipment pad and proposed SolarEdge SE100KUS inverter noise ratings, are as follows: (L1) 70 dBA, (r1) 1-foot, and (r2) 111 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{111} \right| && \text{Eq. 1.2} \\ L_2 &= 70 - |20 \times -2.04| \\ L_2 &= 70 - |-40| \\ L_2 &= 70 - 40 \\ L_2 &\cong 30 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L2) from the Equipment Pad at the nearest property boundary generated by the SE120KUS inverter is estimated to be 30 dBA during operation (i.e. daytime hours). For comparison, 40 dBA is comparable to an operating refrigerator or quiet rural area.



The input parameters for *Equation 1.0* utilizing the closest residential property to the Northeast of the equipment pad distance and proposed pad mounted SolarEdge SE100KUS inverter, are as follows: (L_1) 70 dBA, (r_1) 1-foot, and (r_2) 1750 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{1750} \right| && \text{Eq. 1.3} \\ L_2 &= 70 - |20 \times -3.24| \\ L_2 &= 70 - |-65| \\ L_2 &= 70 - 65 \\ L_2 &\cong 5 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L_2) from the equipment pad at the nearest residential property boundary located northeast of the equipment pad generated by the SE120KUS inverter is estimated to be 5 dBA during operation (i.e. daytime hours). For comparison, 10 dBA is comparable to the sound of breathing.

As previously mentioned, per Section 185-22 in the Town of Franklin’s Bylaws, no sound, noise, vibration, odor or flashing (except for warning devices, temporary construction or maintenance work, parades, agricultural activities or other special circumstances) shall be perceptible without instruments more than 400 feet from the boundaries of the originating premises within an Industrial District or more than 200 feet inside the boundaries of a commercial or business district or more than 100 feet inside the boundaries of a residential district.

As shown in *Equation 1.1*, *Equation 1.2* and *Equation 1.3* above, the sound level generated by the project at 400’ from the closest property boundary (16 dBA), closest property boundary (30 dBA) and the nearest residential property boundaries (5 dBA) are at permissible levels and abide by the Town of Franklin’s Industrial District Performance Controls Bylaw (Section 185-22).

In practice, the noise generated by the inverters and transformers will often be deflected by abutting or on-site industrial uses, vegetation, solar modules, and terrain, reducing the level even further. Therefore, in our opinion, the calculated values are conservatively high. Accordingly, we can estimate the sound produced by the proposed Constitution Boulevard Solar Canopy and Ground



*Noise Attenuation Analysis
EMC Corporation
50 Constitution Boulevard Solar Canopy &
Ground Mount Project
Franklin, MA
ADE Project #3328.00
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Mount project will be negligible at abutting properties and, in our opinion, will not be perceptible without an instrument within 400' of the closest property line, or at the nearest residential property.

If you have any questions, please feel free to contact us at (508) 888-9282.

Very truly yours,

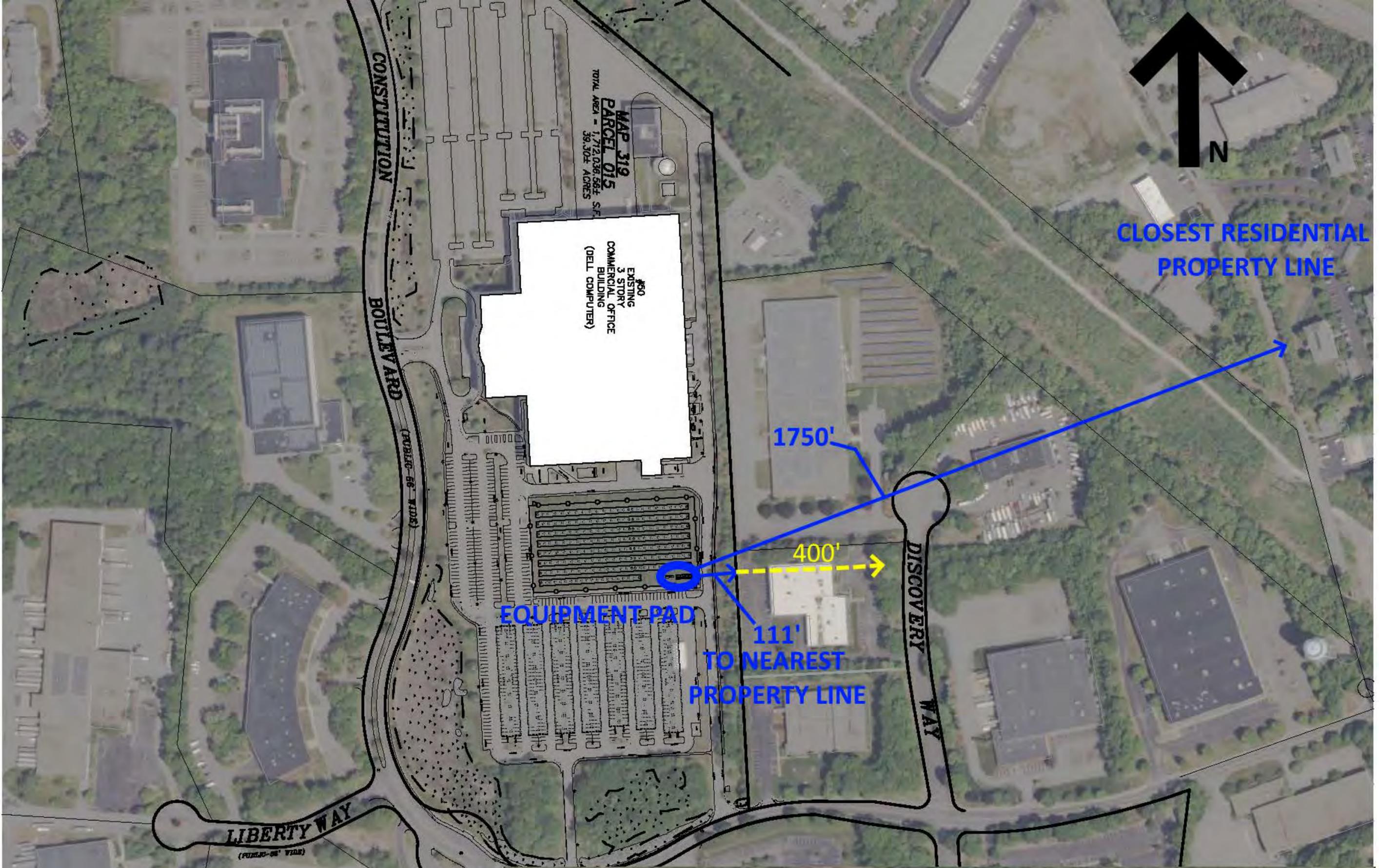
ATLANTIC DESIGN ENGINEERS, INC.

Richard Tabaczynski, PE
Vice President

cc: EMC Corporation

TABLE 1: NOISE ATTENUATION CALCULATIONS

LOCATION	Distance to Equipment Pad (ft)	Sound-Pressure Level (dBA)
400' from Nearest Property Boundary	511	16
Nearest Property Boundary (Eastern Property Boundary)	111	30.0
Closest Residential Property	1750	5.0



Atlantic[®] DESIGN ENGINEERS, INC.
 P.O. Box 1051, Sandwich, MA 02563 (508) 888 - 9282

PREPARED FOR:
EMC CORPORATION

FIGURE 1:
NOISE ATTENUATION ANALYSIS

Sheet	of
1	1
JOB NUMBER	
3402.00	

EXHIBIT A

Electrical Equipment Specification Sheets

Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / SE100KUS / SE110KUS / SE120KUS



Powered by unique pre-commissioning process for rapid system installation

- Pre-commissioning feature for automated validation of system components and wiring during the site installation process and prior to grid connection
- Easy 2-person installation with lightweight, modular design (each inverter consists of 2 or 3 Synergy units and 1 Synergy Manager)
- Independent operation of each Synergy unit enables higher uptime and easy serviceability
- Built-in thermal sensors detect faulty wiring, ensuring enhanced protection and safety
- Built-in arc fault protection and rapid shutdown
- Built-in PID mitigation for maximized system performance
- Monitored* and field-replaceable surge protection devices, to better withstand surges caused by lightning or other events
- Built-in module-level monitoring with Ethernet or cellular communication for full system visibility

*Applicable only for DC and AC SPDs

/ Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / SE100KUS / SE110KUS / SE120KUS

MODEL NUMBER	SE80KUS	SE100KUS	SE110KUS	SE120KUS	
APPLICABLE TO INVERTERS WITH PART NUMBER	SExxK-USx8lxxxx				UNITS
OUTPUT					
Rated AC Active Output Power	80000	100000	110000	120000	W
Maximum AC Apparent Output Power	80000	100000	120000	120000	VA
AC Output Line Connections	3W + PE, 4W + PE				
Supported Grids	WYE: TN-C, TN-S, TN-C-S, TT, IT; Delta: IT				
AC Output Voltage Minimum-Nominal-Maximum ⁽¹⁾ (L-N)	244 – 277 – 305				Vac
AC Output Voltage Minimum-Nominal-Maximum ⁽¹⁾ (L-L)	422.5 – 480 – 529				Vac
AC Frequency Min-Nom-Max ⁽¹⁾	59.5 – 60 – 60.5				Hz
Maximum Continuous Output Current (per Phase, PF=1)	96.5	120	144.3		Aac
GFDI Threshold	1				A
Utility Monitoring, Islanding Protection, Configurable Power Factor, Country Configurable Thresholds	Yes				
Total Harmonic Distortion	≤ 3				%
Power Factor Range	±0.85 to 1				
INPUT					
Maximum DC Power (Module STC) Inverter / Synergy Unit	140000 / 70000	175000 / 58300	210000 / 70000		W
Transformer-less, Ungrounded	Yes				
Maximum Input Voltage DC+ to DC-	1000				Vdc
Operating Voltage Range	850 – 1000				Vdc
Maximum Input Current	2 x 48.25	3 x 40	3 x 48.25		Adc
Reverse-Polarity Protection	Yes				
Ground-Fault Isolation Detection	167kΩ sensitivity per Synergy Unit ⁽²⁾				
CEC Weighted Efficiency	98.5				%
Nighttime Power Consumption	< 8	< 12			W
ADDITIONAL FEATURES					
Supported Communication Interfaces ⁽³⁾	2 x RS485, Ethernet, Wi-Fi (optional), Cellular (optional)				
Smart Energy Management	Export Limitation				
Inverter Commissioning	With the SetApp mobile application using built-in Wi-Fi access point for local connection				
Arc Fault Protection	Built-in, User Configurable (According to UL1699B)				
Photovoltaic Rapid Shutdown System	NEC 2014 – 2023, built-in				
PID Rectifier	Nighttime, built-in				
RS485 Surge Protection (ports 1+2)	Type II, field replaceable, integrated				
AC, DC Surge Protection	Type II, field replaceable, integrated				
DC Fuses (Single Pole)	25A, integrated				
VAR at Night ⁽⁴⁾	Yes				
DC SAFETY SWITCH					
DC Disconnect	Built-in				
STANDARD COMPLIANCE					
Safety	UL1699B, UL1741, UL1741 SA, UL1741 SB, UL1998, CSA C22.2#107.1, Canadian AFCl according to T.I.L. M-07				
Grid Connection Standards	IEEE 1547-2018, Rule 21, Rule 14 (H1)				
Emissions	FCC part 15 class A				

(1) For other regional settings please contact SolarEdge support.

(2) Where permitted by local regulations.

(3) For specifications of the optional communication options, visit the [Communication product page](#) or the [Knowledge Center](#) to download the relevant product datasheet.

(4) For details, see [Set Volt Ampere Reactive at Night](#).

/ Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / SE100KUS / SE110KUS / SE120KUS

MODEL NUMBER		SE80KUS	SE100KUS	SE110KUS	SE120KUS	
APPLICABLE TO INVERTERS WITH PART NUMBER		SExxK-USx8lxxxx				UNITS
INSTALLATION SPECIFICATIONS						
Number of Synergy Units per Inverter		2		3		
Ac Max Conduit Size		2 ½"				in
Max AWG Line / PE		4/0 / 1/0				
DC Max Conduit Size		1 x 3"; 2 x 2"				in
DC Input Inverter/ Synergy Unit	Multi-input (SExxK-USxxxxZ4)	8 / 4 pairs; 6-12 AWG		12 / 4 pairs; 6-12 AWG		
	Combined input (SExxK-USxxxxW4)	2 pairs / 1 pair, Max 2 AWG; copper or aluminum		3 pairs / 1 pair, Max 2 AWG; copper or aluminum		
Dimensions (H x W x D)		Synergy Unit: 22 x 12.9 x 10.75 / 558 x 328 x 273 Synergy Manager: 14.17 x 22.4 x 11.6 / 360 x 560 x 295				in / mm
Weight		Synergy Unit: 70.4 / 32 Synergy Manager: 39.6 / 18				lb / kg
Operating Temperature Range		-40 to +140 / -40 to +60 ⁽⁴⁾				°F / °C
Cooling		Fan (user replaceable)				
Noise		< 67				dBA
Protection Rating		NEMA 3R				
Mounting		Brackets provided				

(5) For power de-rating information refer to the [Temperature Derating Technical Note for North America](#).

SolarEdge is a global leader in smart energy technology. By leveraging world-class engineering capabilities and with a relentless focus on innovation, SolarEdge creates smart energy solutions that power our lives and drive future progress.

SolarEdge developed an intelligent inverter solution that changed the way power is harvested and managed in photovoltaic (PV) systems. The SolarEdge DC optimized inverter maximizes power generation while lowering the cost of energy produced by the PV system.

Continuing to advance smart energy, SolarEdge addresses a broad range of energy market segments through its PV, storage, EV charging, UPS, and grid services solutions.

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User Manual

for 5G Series Grid Inverter



Applicable models

Solis-185K-EHV-5G-US

Solis-255K-EHV-5G-US

Solis-125K-EHV-5G-US-PLUS

Solis-185K-EHV-5G-US-PLUS

Solis-255K-EHV-5G-US-PLUS

10. Specifications

Model	Solis-185K-EHV-5G-US
Max. DC input voltage (Volts)	1500
Rated DC voltage (Volts)	950
Start-up voltage (Volts)	500
MPPT voltage range (Volts)	570...1500
Full load MPPT voltage range (Volts)	860...1300
Max. input current (Amps)	14x26
Max short circuit input current (Amps)	14x40
MPPT number/Max input strings number	14/28
Rated output power (Watts)	185000
Max. output power (Watts)	185000
Max. apparent output power (VA)	185000
Rated grid voltage (Volts)	3/PE~600
Rated output current (Amps)	178.0
Power Factor (at rated output power)	>0.99 (0.8 leading - 0.8 lagging)
THDi (at rated output power)	<3%(at rated output power)
Rated grid frequency (Hertz)	60
Max. efficiency	98.7%
CEC efficiency	98.3%
Surge Protection	DC Type II / AC Type II
Integrated AFCI (DC arc-fault circuit protection)	YES
Integrated PID recovery	YES
Dimensions (W*H*D)	1170x770x384 (mm) / 46.1x30.3x15.1 (inch)
Weight	113kg / 249lb
Topology	Transformerless
Self consumption (night)	< 2W
Operating ambient temperature range	-13...140°F / -25...+60°C
Storage environment	-40...176°F / -40...+80°C
Relative humidity	0~100%
Ingress protection	Type 4X
Noise emission	≤65dB(A)
Cooling concept	Intelligent redundant cooling
Max.operation altitude	13120ft / 4000m
Compliance	UL 1741, UL 1741SA, Rule 21, UL 1998, IEEE 1547,FCC Part 15 (Class A & B), UL 1699B CAN/CSA C22.2 107.1-1,Rule 21 Phase II&III
DC connection	MC4 connectors
AC connection	OT Terminal connectors (Max.300mm ²)
Display	LCD,2x20Z
Communication connections	RS485, Optional: PLC
Warranty	5 years standard (extend to 20 years)

10. Specifications

Model	Solis-255K-EHV-5G-US
Max. DC input voltage (Volts)	1500
Rated DC voltage (Volts)	1080
Start-up voltage (Volts)	500
MPPT voltage range (Volts)	570...1500
Full load MPPT voltage range (Volts)	860...1300
Max. input current (Amps)	14x26
Max short circuit input current (Amps)	14x40
MPPT number/Max input strings number	14/28
Rated output power (Watts)	255000
Max. output power (Watts)	255000
Max. apparent output power (VA)	255000
Rated grid voltage (Volts)	3/PE~800
Rated output current (Amps)	184.0
Power Factor (at rated output power)	>0.99 (0.8 leading - 0.8 lagging)
THDi (at rated output power)	<3%(at rated output power)
Rated grid frequency (Hertz)	60
Max. efficiency	99.0%
CEC efficiency	98.3%
Surge Protection	DC Type II / AC Type II
Integrated AFCI (DC arc-fault circuit protection)	YES
Integrated PID recovery	YES
Dimensions (W*H*D)	1170x770x384 (mm) / 46.1x30.3x15.1 (inch)
Weight	113kg / 249lb
Topology	Transformerless
Self consumption (night)	< 2W
Operating ambient temperature range	-13...140°F / -25...+60°C
Storage environment	-40...176°F / -40...+80°C
Relative humidity	0~100%
Ingress protection	Type 4X
Noise emission	≤65dB(A)
Cooling concept	Intelligent redundant cooling
Max.operation altitude	13120ft / 4000m
Compliance	UL 1741, UL 1741SA, Rule 21, UL 1998, IEEE 1547,FCC Part 15 (Class A & B), UL 1699B CAN/CSA C22.2 107.1-16,Rule 21 Phase II&III
DC connection	MC4 connectors
AC connection	OT Terminal connectors (Max.300mm ²)
Display	LCD,2x20Z
Communication connections	RS485, Optional: PLC
Warranty	5 years standard (extend to 20 years)

10. Specifications

Model	Solis-125K-EHV-5G-US-PLUS
Max. DC input voltage (Volts)	1500
Rated DC voltage (Volts)	950
Start-up voltage (Volts)	500
MPPT voltage range (Volts)	570...1500
Full load MPPT voltage range (Volts)	860...1300
Max. input current (Amps)	9x30
Max short circuit input current (Amps)	9x50
MPPT number/Max input strings number	9/18
Rated output power (Watts)	125000
Max. output power (Watts)	137500
Max. apparent output power (VA)	137500
Rated grid voltage (Volts)	3/PE~600
Rated output current (Amps)	132.3
Power Factor (at rated output power)	>0.99 (0.8 leading - 0.8 lagging)
THDi (at rated output power)	<3%(at rated output power)
Rated grid frequency (Hertz)	60
Max. efficiency	98.6%
CEC efficiency	98.3%
Surge Protection	DC Type II / AC Type II
Integrated AFCI (DC arc-fault circuit protection)	YES
Integrated PID recovery	YES
Dimensions (W*H*D)	1170x770x384 (mm) / 46.1x30.3x15.1 (inch)
Weight	109kg / 240lb
Topology	Transformerless
Self consumption (night)	< 2W
Operating ambient temperature range	-13...140°F / -25...+60°C
Storage environment	-40...176°F / -40...+80°C
Relative humidity	0~100%
Ingress protection	Type 4X
Noise emission	≤65dB(A)
Cooling concept	Intelligent redundant cooling
Max.operation altitude	13120ft / 4000m
Compliance	UL1741, UL1741SA, UL1741SB, Rule21, UL 1998 IEEE 1547,FCC Part 15 (Class A & B), UL1699B CAN/CSA C22.2 107.1-1,Rule 21 Phase II&III
DC connection	MC4 connectors
AC connection	OT Terminal connectors (Max.300mm ²)
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Communication connections	RS485, Optional: PLC
Warranty	5 years standard (extend to 20 years)

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Max. DC input voltage (Volts)	1500
Rated DC voltage (Volts)	950
Start-up voltage (Volts)	500
MPPT voltage range (Volts)	570...1500
Full load MPPT voltage range (Volts)	860...1300
Max. input current (Amps)	12x30
Max short circuit input current (Amps)	12x50
MPPT number/Max input strings number	12/24
Rated output power (Watts)	185000
Max. output power (Watts)	185000
Max. apparent output power (VA)	185000
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DC connection	MC4 connectors
AC connection	OT Terminal connectors (Max.300mm ²)
Display	LCD,2x20Z
Communication connections	RS485, Optional: PLC
Warranty	5 years standard (extend to 20 years)

10. Specifications

Model	Solis-255K-EHV-5G-US-PLUS
Max. DC input voltage (Volts)	1500
Rated DC voltage (Volts)	1080
Start-up voltage (Volts)	500
MPPT voltage range (Volts)	570...1500
Full load MPPT voltage range (Volts)	860...1300
Max. input current (Amps)	12x30
Max short circuit input current (Amps)	12x50
MPPT number/Max input strings number	12/24
Rated output power (Watts)	255000
Max. output power (Watts)	255000
Max. apparent output power (VA)	255000
Rated grid voltage (Volts)	3/PE~800
Rated output current (Amps)	184.0
Power Factor (at rated output power)	>0.99 (0.8 leading - 0.8 lagging)
THDi (at rated output power)	<3%(at rated output power)
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DC connection	MC4 connectors
AC connection	OT Terminal connectors (Max.300mm ²)
Display	LCD,2x20Z
Communication connections	RS485, Optional: PLC
Warranty	5 years standard (extend to 20 years)

THREE PHASE PADMOUNT TRANSFORMERS



Short for "Tamper-proof, compartmentalized, liquid-filled, pad mounted transformer", all padmount designs feature fully enclosed tamper-proof terminal compartments and can be supplied with dead-front or live-front configuration, for loop or radial feed applications, with Type II mineral oil, or environmentally friendly and high flash-point Envirotemp™ FR3™.

All new Maddox padmount transformers are constructed of the highest quality materials and built in the US to heavy duty industrial standards, making them ideal for commercial and industrial applications such as data centers, solar step-up, manufacturing facilities, shopping centers, etc. Our padmounts are designed to the latest department of energy efficiency standards built and tested in accordance with industry standards including NEMA, ANSI C.57, DOE, and IEEE as applicable.

With thousands of new units in stock and ready-to-ship, and the manufacturing ability to produce almost any custom design, Maddox stands ready to meet your transformer need(s). Maddox stocks all standard configurations to match most common applications and deliver on short notice.

Design

HV Bushing Config.:

- Dead front or live front
- Loop feed or radial feed

Fluid Options:

- Type II Mineral Oil
- Envirotemp™ FR3™

Standard Gauge/Accessory Package:

- Pressure relief valve
- Pressure vacuum gauge
- Liquid temp & level gauges
- Drain & sample valve
- Adjustment taps

Switch Options:

- 2 Position LBOR Switch
- 4 Position LBOR Switch (V-blade or T-blade)
- (3) 2 Position LBOR Switches

Fusing Options:

- Bayonets w/ isolation links or CLFs

Construction:

- 5-legged core
- Rectangular wound copper or aluminum windings
- Carbon reinforced or stainless steel tank
- Steel divider between HV and LV cabinets
- Penta-head captive bolt

Optional Design Features & Accessories:

- Gauges w/ Contacts
- External drain and sample valve
- Electrostatic Shielding
- Step-up Design
- Surge-Arresters

Available Ratings

Table 1. Typical Transformer Ratings

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

Fig 1. Padmount Transformer Outline

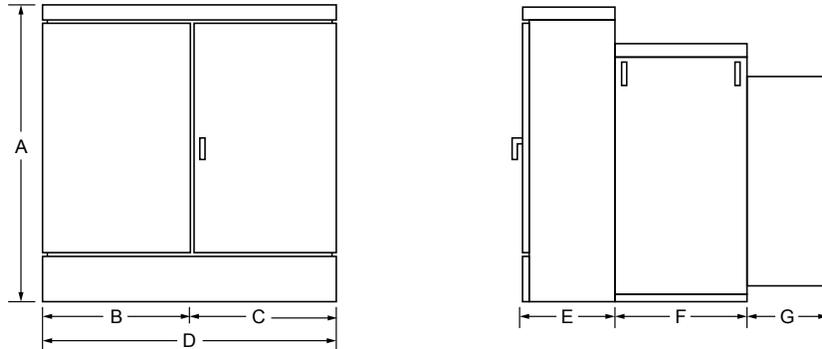


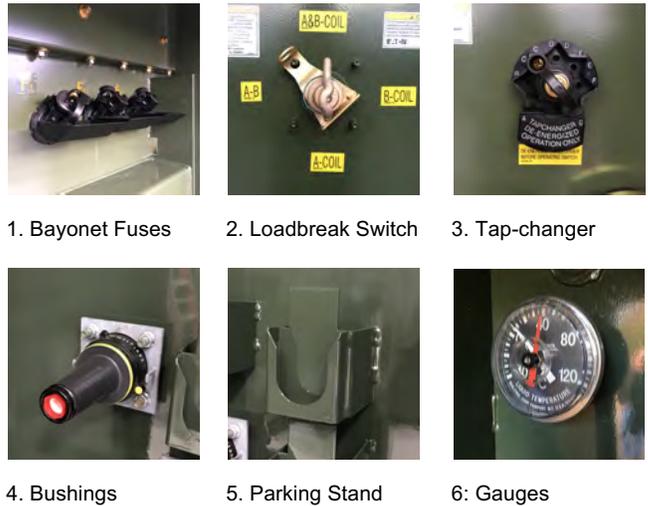
Table 2. Approximate Transformer Dimensions

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

Fig 2. Three Phase Maddox Padmount Transformer



Table 3. Common Accessories



[◀ All Articles](#)

Audible sound levels in liquid-filled transformers

All transformers make some noise when operating, but certain regulations are in place to ensure they are built to operate as quietly as practically possible.

Written by: **Mac Spiller**

March 12, 2020

HOW TO'S



All transformers have a slight hum (or buzz) when operating, but certain regulations are in place to ensure they are built to operate as quietly as practically possible.

Below are the latest **NEMA TR-1** Average decibel ratings as of 2020.

Self-Cooled, Two Winding kVA Rating	Average Decibels (dB)
45-500	56
501-700	57
701-1000	58
1001-1500	60
1501-2000	61
2001-2500	62
2501-3000	63
3001-4000	64
4001-5000	65
5001-6000	66
6001-7500	67
7501-10000	68

Maddox Industrial Transformer liquid-filled [padmount](#) and [substation transformers](#) are built to the latest NEMA, IEEE, ANSI standards, and [Department of Energy regulations](#).

Call us if you have any questions: 1-866-984-1856



Get more info

Find out how Maddox can power on your next project

Your Name *

First

Last

Email *

EXHIBIT B

*EPA Protective Noise Levels Condensed Version of EPA Levels Document
November 1978*

United States
Environmental Protection
Agency

Office of Noise
Abatement & Control
Washington, D.C. 20460

November 1978
EPA 550/9-79-100



Protective Noise Levels

Condensed Version of EPA Levels Document



PURPOSE

This publication is intended to complement the EPA's "Levels Document,"* the 1974 report examining levels of environmental noise necessary to protect public health and welfare. It interprets the contents of the Levels Document in less technical terms for people who wish to better understand the concepts presented there, and how the protective levels were identified. In that sense, this publication may serve as an introduction, or a supplement, to the Levels Document.

*"Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," EPA/ONAC 550/9-74-004, March, 1974.

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INTRODUCTION

During the last 20 years there has been increasing concern with the quality of the environment. Along with air and water contaminants, noise has been recognized as a serious pollutant. As noise levels have risen, the effects of noise have become pervasive and more apparent.

Noise is defined as "unwanted sound." In the context of protecting the public health and welfare, noise implies adverse effects on people and the environment. Noise causes hearing loss, interferes with human activities at home and work, and is in various ways injurious to people's health and well-being. Although hearing loss is the most clearly measurable health hazard, noise is also linked to other physiological and psychological problems.

Noise annoys, awakens, angers and frustrates people. It disrupts communication and individual thoughts, and affects performance capability. Noise is one of the biological stressors associated with everyday life. Thus, the numerous effects of noise combine to detract from the quality of people's lives and the environment.

Noise emanates from many different sources. Transportation noise, industrial noise, construction noise, household noise, and people and animal noise are all large-scale offenders. It is important, then, to examine the total range and combination of noise sources and not to focus unduly on any one source.

Through the Noise Control Act of 1972, Congress directed the Environmental Protection Agency (EPA) to publish scientific information about the kind and extent of all identifiable effects of different qualities and quantities of noise. EPA was also directed to define acceptable levels under various conditions which would protect public health and welfare with an adequate margin of safety. The EPA collaborated with other Federal agencies and the scientific community to publish a "Levels Document,"* which would fulfill these requirements in the Noise Control Act.

Initial public reaction was quite favorable, but it was discovered that the document was too complex, too technical, and too long for some audiences. This summary presents the contents of the Levels Document in less technical terms. It defines the basic measurement of noise, analyzes noise exposure, and presents the best understood effects of noise — hearing damage, speech interference, and annoyance — using information contained in the Levels Document. The identified protective levels are then summarized, followed by a number of often-asked questions and answers about the Levels Document.

No attempt has been made here to incorporate recent research findings pertaining to effects of noise on people. Considerable new information has developed since initial publication of the Levels Document, including new findings on community response to noise, sleep disruption, and speech interference. Summaries and analyses of some recent information on noise effects are available through EPA and other agencies.

* "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", EPA 550/9-74-004, March, 1974, U.S. Environmental Protection Agency, Washington, D.C. 20460.

ABOUT SOUND

The sound we hear is the result of a sound source inducing vibration in the air. The vibration produces alternating band of relatively dense and sparse particles of air, spreading outward from the source in the same way as ripples do on water after a stone is thrown into it. The result of the movement of the particles is a fluctuation in the normal atmospheric pressure, or sound waves. These waves radiate in all directions from the source and may be reflected and scattered or, like other wave actions, may turn corners. When the source stops vibrating, the sound waves disappear almost instantaneously, and the sound ceases. The ear is extremely sensitive to sound pressure fluctuations, which are converted into auditory sensations.

Sound may be described in terms of three variables:

1. Amplitude (perceived as loudness)
2. Frequency (perceived as pitch)
3. Time pattern

Amplitude

Sound pressure is the amplitude or measure of the difference between atmospheric pressure (with no sound present) and the total pressure (with sound present). Although there are other measures of sound amplitude, sound pressure is the fundamental measure and is the basic ingredient of the various measurement descriptors in the next section, "Measurement of Environmental Noise."

The unit of sound pressure is the decibel (dB); thus it is said that a sound pressure level is a certain number of decibels. The decibel scale is a logarithmic scale, not a linear one such as the scale of length. A logarithmic scale is used because the range of sound intensities is so great that it is convenient to compress the scale to encompass all the sounds that need to be measured. The human ear has an extremely wide range of response to sound amplitude. Sharply painful sound is 10 million times greater in sound pressure than the least audible sound. In decibels, this 10 million to 1 ratio is simplified logarithmically to 140 dB.

Another unusual property of the decibel scale is that the sound pressure levels of two separate sounds are not directly (that is, arithmetically) additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (to 73 dB), not a doubling to 140 dB. Furthermore, if two sounds are of different levels, the lower level adds less to the higher as this difference increases. If the difference is as much as 10 dB, the lower level adds almost nothing to the higher level. In other words, adding a 60 decibel sound to a 70 decibel sound only increases the total sound pressure level less than one-half decibel.

Frequency

The rate at which a sound source vibrates, or makes the air vibrate, determines frequency. The unit of time is usually one second and the term "Hertz" (after an early investigator of the physics of sound) is used to designate the number of cycles per second.

The human ear and that of most animals has a wide range of response. Humans can identify sounds with frequencies from about 16 Hz (Hertz) to 20,000 Hz. Because pure tones are relatively rare in real-life situations, most sounds consist instead of a complex mixture of many frequencies.

Time Pattern

The temporal nature of sound may be described in terms of its pattern of time and level: continuity, fluctuation, impulsiveness, intermittency. Continuous sounds are those produced for relatively long periods at a constant level, such as the noise of a waterfall. Intermittent sounds are those which are produced for short periods, such as the ringing of a telephone or aircraft take-offs and landings. Impulse noises are sounds which are produced in an extremely short span of time, such as a pistol shot or a hand clap. Fluctuating sounds vary in level over time, such as the loudness of traffic sounds at a busy intersection.

MEASUREMENT OF ENVIRONMENTAL NOISE: SOUND DESCRIPTORS

EPA has adopted a system of four "sound descriptors" to summarize how people hear sound and to determine the impact of environmental noise on public health and welfare. These four descriptors are: the A-weighted Sound Level, A-weighted Sound Exposure Level, Equivalent Sound Level, and Day-Night

Sound Level. They are related but each is most useful for a particular type of measurement. The descriptors and some examples of their uses are described below.

A-weighted Sound Level

One's ability to hear a sound depends greatly on the frequency composition of the sound. People hear sounds most readily when the predominant sound energy occurs at frequencies between 1000 and 6000 Hertz (cycles per second). Sounds at frequencies above 10,000 Hertz (such as high-pitched hissing) are much more difficult to hear, as are sounds at frequencies below about 100 Hz (such as a low rumble). To measure sound on a scale that approximates the way it is heard by people, more weight must be given to the frequencies that people hear more easily.

A method for weighting the frequency spectrum to mimic the human ear has been sought for years. Many different scales of sound measurement, including A-weighted sound level (and also B, C, D, and E-weighted sound levels) have evolved in this search. A-weighting was recommended by EPA to describe environmental noise because it is convenient to use, accurate for most purposes, and is used extensively throughout the world. Figure 1 shows the A-weighted levels of some environmental noises. Note that these ranges of measured values are the maximum sound levels.

The A-weighting of frequency also is used in the three descriptors discussed below. When used by itself, an A-weighted decibel value denotes either a sound level at a given instant, a maximum level, or a steady-state level. The following three descriptors are used to summarize those levels which vary over time.

Sound Exposure Level

Since the levels of many sounds change from moment to moment, this variation must also be accounted for when measuring environmental noise. One method for measuring the changing magnitude of sound levels is to trace a line on a sheet of moving paper, so that the movement of the pen is proportional to the sound level in decibels. Figure 2 illustrates such a recording, about which several features are noteworthy. First, the sound level varies with time over a range of about 30 dB. Second, the sound appears to be characterized by a fairly steady-state lower level, upon which are superimposed sound levels associated with individual events. This fairly constant lower level is often called the background ambient sound level.

Each single event in Figure 2 may be partially characterized by its maximum level. It may also be partially characterized by its time pattern. In the example, the sound level of the aircraft is above that of the background ambient level for about a minute, whereas the sound levels from cars are above the background level for much less time.

The duration of sounds with levels that vary from moment to moment is more difficult to characterize. One way is to combine the maximum sound level with the length of time during which the sound level is greater than a certain number of decibels below the maximum level — for example, the number of seconds that the sound rises from 10 dB below maximum, as in Figure 3.

Using this procedure one can measure the total energy of the sound by summing the intensity during the exposure duration. This procedure produces the second measurement descriptor, *sound exposure level* (L_s), referred to in the Levels Document as the single event noise exposure level (SENEL).

Equivalent Sound Level

Yet another method of quantifying the noise environment is to determine the value of a steady-state sound which has the same A-weighted sound energy as that contained in the time-varying sound. This is the third measurement descriptor, termed the *Equivalent Sound Level* (L_{eq}). The Equivalent Sound Level is a single value of sound level for any desired duration, which includes *all* of the time-varying sound energy in the measurement period. In Figure 2, for example, the L_{eq} equals about 58 dB, indicating that the amount of sound energy in all the peaks and valleys in the figure is equivalent to the energy in a continuous sound of 58 dB.

The major virtue of the Equivalent Sound Level is that it correlates reasonably well with the effects of noise on people, even for wide variations in environmental sound levels and time patterns. It is used when only the durations and levels of sound, and not their times of occurrence (day or night), are relevant. It is easily measurable by available equipment. It also is the basis of a fourth and final measurement descriptor of the total outdoor noise environment, the *Day-Night Sound Level* (L_{dn}).

5

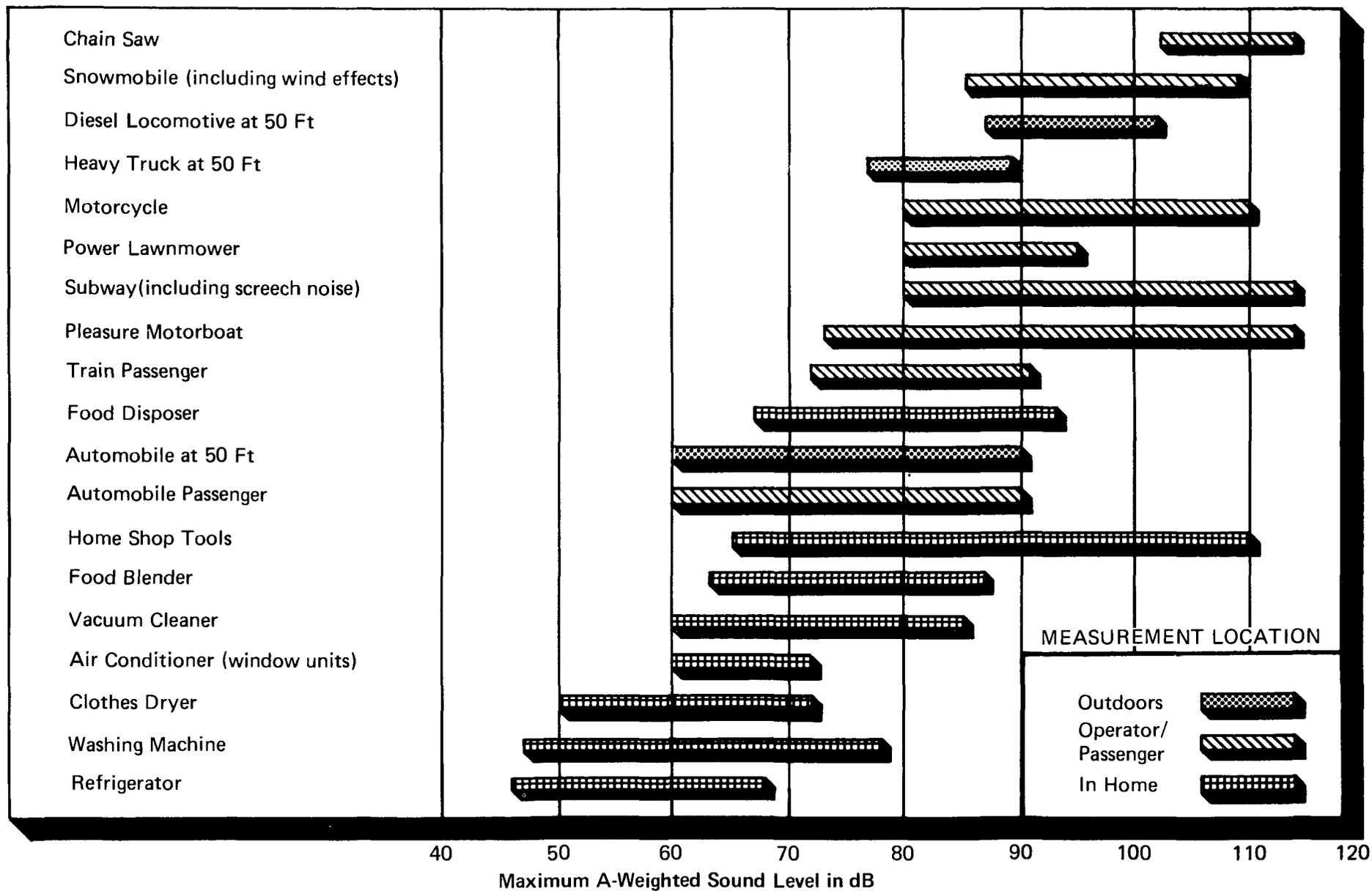


FIGURE 1. TYPICAL RANGE OF COMMON SOUNDS

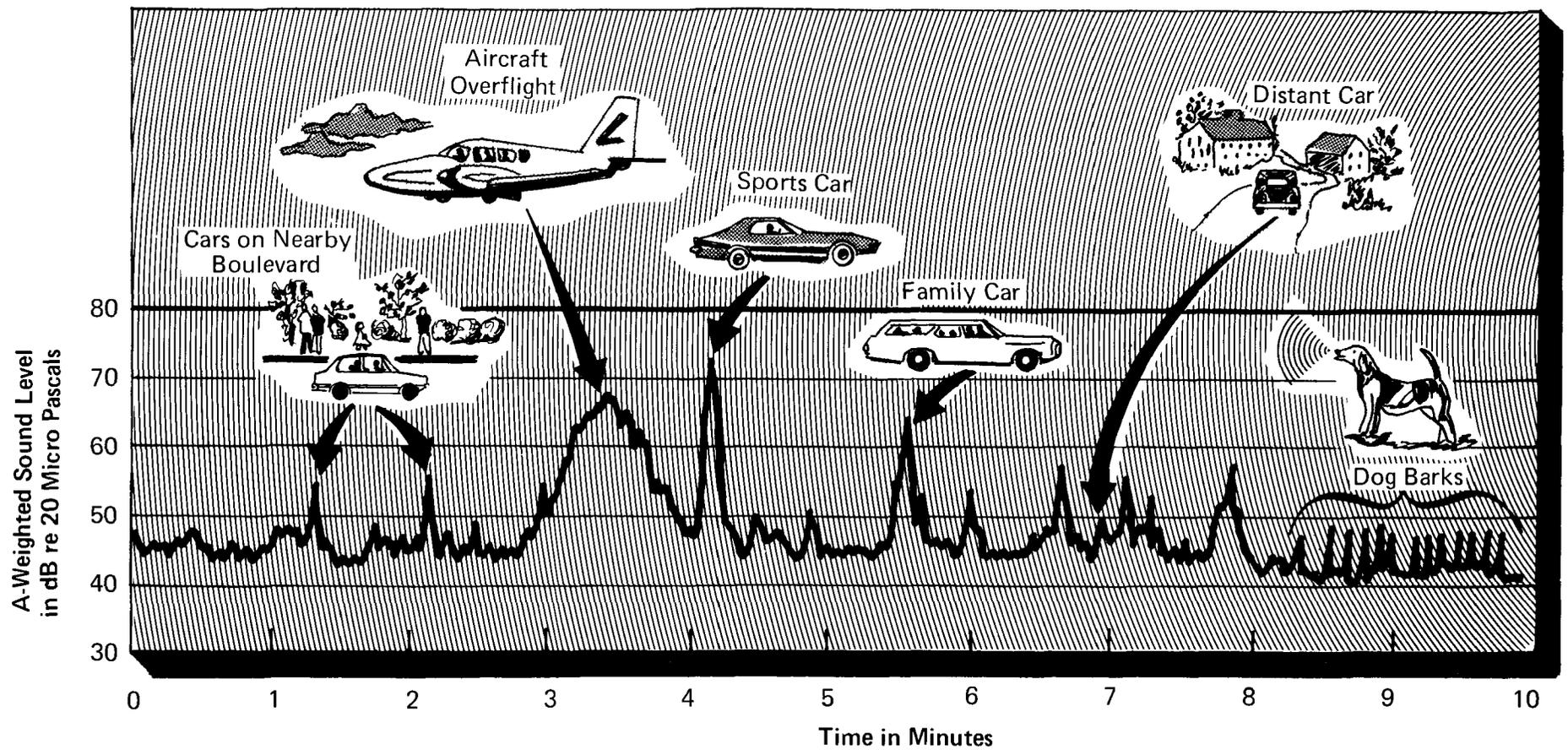


FIGURE 2. TYPICAL OUTDOOR SOUND MEASURED ON A QUIET SUBURBAN STREET

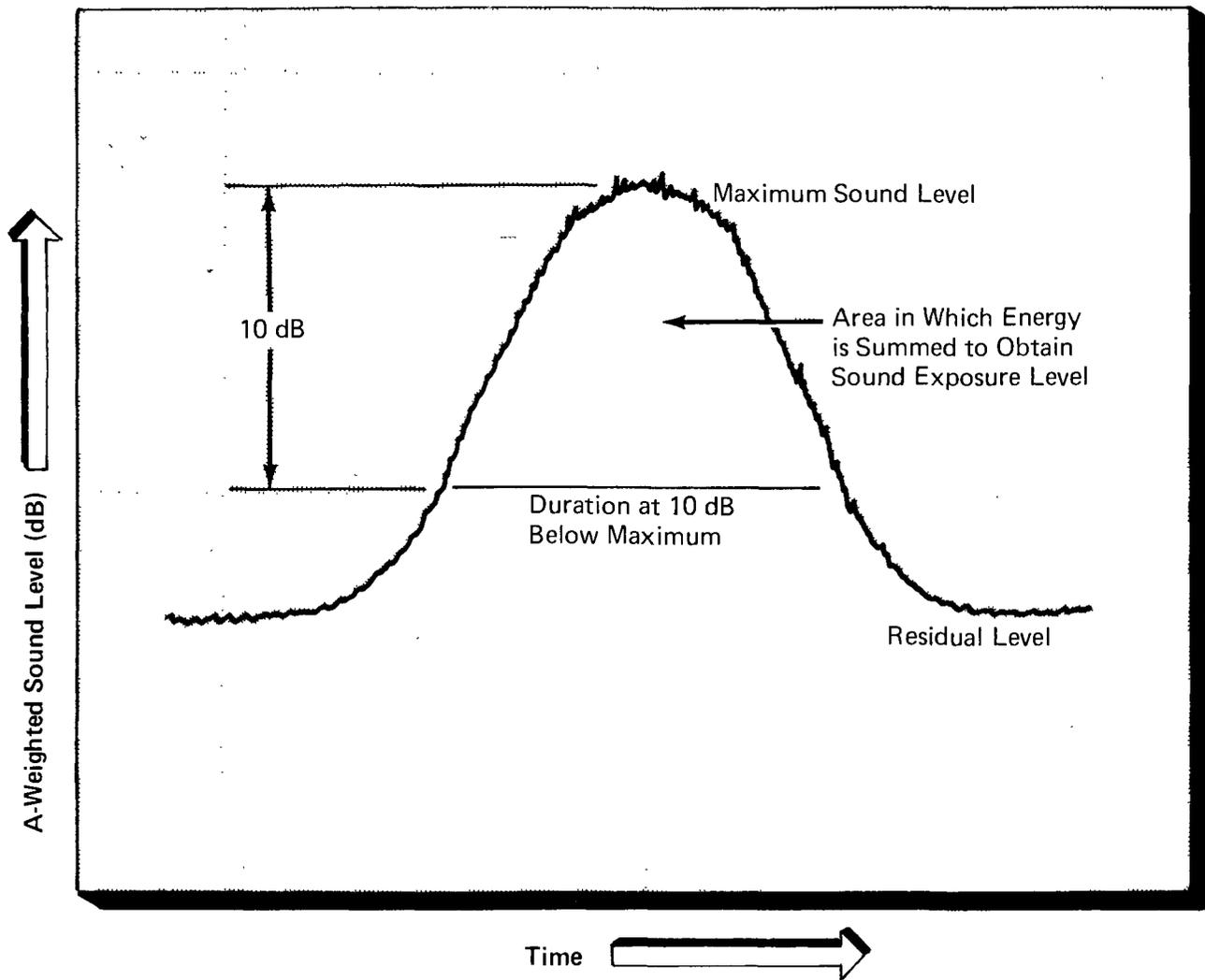


FIGURE 3. DESCRIPTION OF THE SOUND OF A SINGLE EVENT

L_{dn} in dB

Outdoor Location

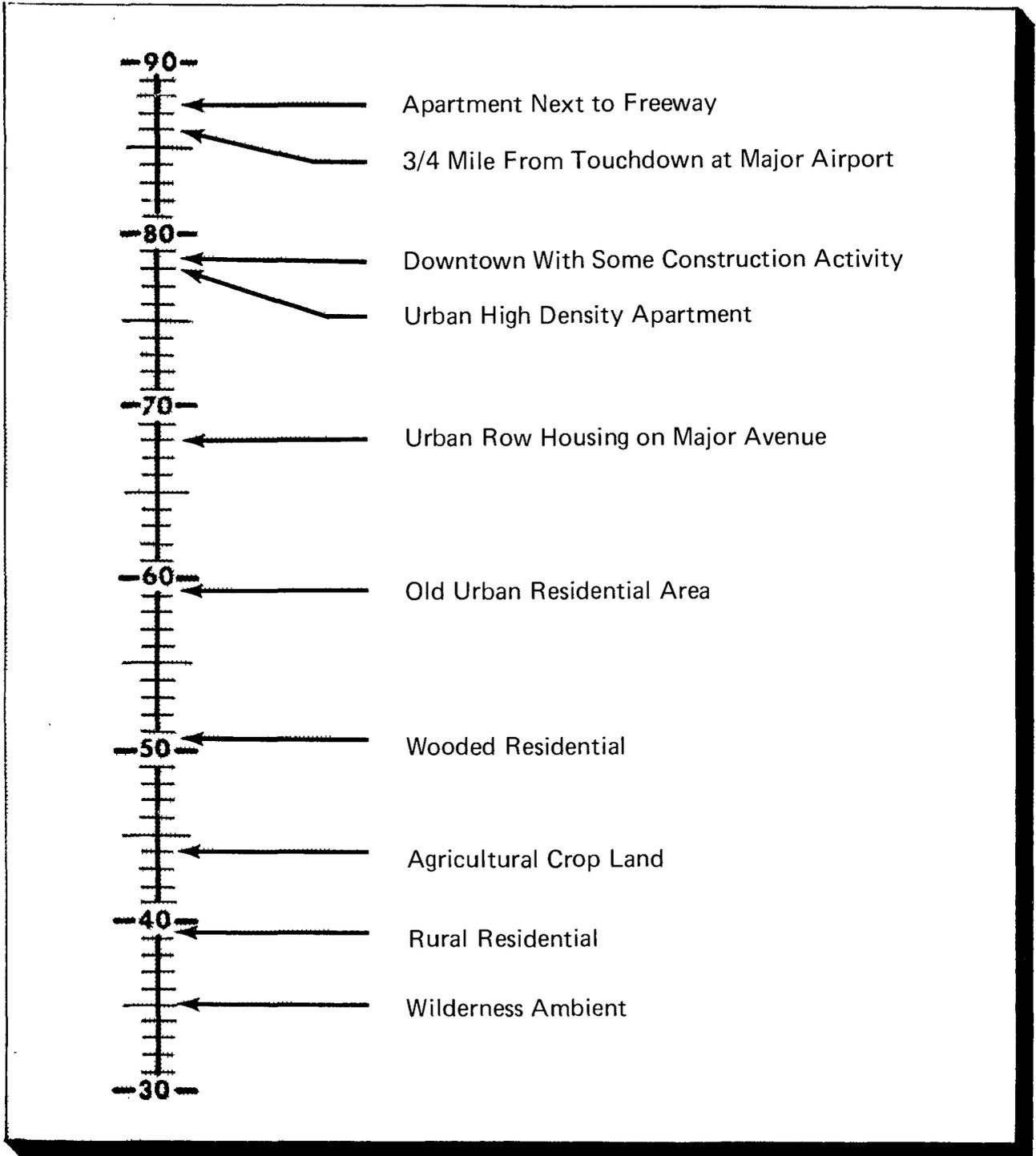


FIGURE 4. EXAMPLES OF OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS IN dB MEASURED AT VARIOUS LOCATIONS

Day-Night Sound Level

The Day-Night Sound Level is the A-weighted equivalent sound level for a 24-hour period with an additional 10 dB weighting imposed on the equivalent sound levels occurring during nighttime hours (10 pm to 7 am). Hence, an environment that has a measured daytime equivalent sound level of 60 dB and a measured nighttime equivalent sound level of 50 dB, can be said to have a weighted nighttime sound level of 60 dB (50 + 10) and an L_{dn} of 60 dB. Examples of measured L_{dn} values are shown in Figure 4. Table I summarizes the use of the four sound descriptors used by EPA.

Table I. Descriptors of Sound*

TYPICAL USE	NAME OF DESCRIPTOR	NATURE OF DESCRIPTOR
To describe steady airconditioning sound in a room or measure maximum sound level during a vehicle passby with a simple sound level meter.	A-weighted Sound Level	The momentary magnitude of sound weighted to approximate the ear's frequency sensitivity.
To describe noise from a moving source such as an airplane, train, or truck.	A-weighted Sound Exposure Level	A summation of the energy of the momentary magnitudes of sound associated with a single event to measure the total sound energy of the event.
To measure average environmental noise levels to which people are exposed.	Equivalent Sound Level	The A-weighted sound level that is "equivalent" to an actual time varying sound level, in the sense that it has the same total energy for the duration of the sound.
To characterize average sound levels in residential areas throughout the day and night.	Day-Night Sound Level	The A-weighted equivalent sound level for a 24-hour period with 10 decibels added to nighttime sounds (10 pm - 7 am).

*The unit for all descriptors is the decibel.

LEVELS OF ENVIRONMENTAL NOISE IN THE UNITED STATES

In residential areas of the United States, major contributions to outdoor noise come from transportation, industrial, construction, human and animal sources. Inside homes, appliances, radio and television, as well as people and animals, are predominant noise sources. On the job, workplace equipment can create moderate to extremely high levels of noise. The daily noise exposure of people depends on how much time they spend in different outdoor and indoor locations and on the noise environments in these places. Typical daily exposure patterns are discussed in this section, following short descriptions of outdoor and indoor levels of environmental noise throughout the United States.

Outdoor Levels

The noise environment outside residences in the United States can be highly variable. As seen in Figure 4, outdoor Day-Night Sound Levels in different areas vary over a range of 50 dB. Levels occur as low as $L_{dn} = 30$ to 40 dB in wilderness areas and as high as $L_{dn} = 85$ to 90 dB in urban areas.

Most Americans live in areas with a much smaller range of outdoor noise levels. Figure 5 shows that for urban dwellers (roughly 135 million people, more than half the U.S. population), 87% live in areas of $L_{dn} = 48$ and higher from traffic noise alone. Most of the other 13% of the urban population experience lower noise levels than those of Figure 5. Figure 5 also shows that nearly half of the urban population live in areas exposed to traffic sounds that range over only 5 dB ($L_{dn} = 55$ to 60 dB). Rural populations enjoy average outdoor sound levels generally lower than $L_{dn} = 50$ dB.

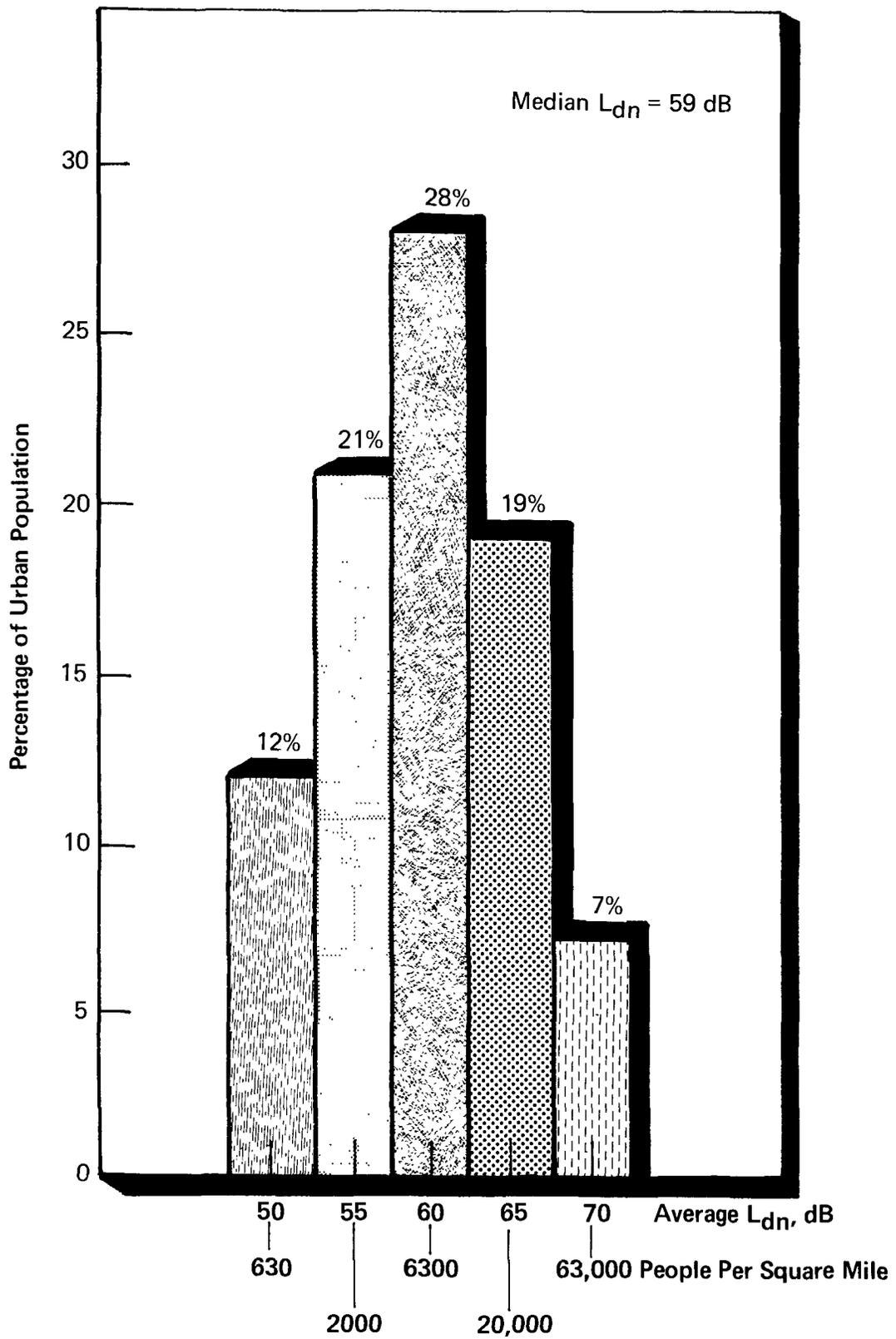


FIGURE 5. ESTIMATED PERCENTAGE OF URBAN POPULATION EXPOSED TO OUTDOOR DAY-NIGHT SOUND LEVELS DUE TO TRAFFIC

It is useful to know the number of people living in areas characterized by different levels of environmental noise. Figure 6 presents estimates for urban traffic, freeway traffic, and aircraft noise. The figure shows that urban traffic noise is much more widespread than either aircraft or freeway noise, but the figures are not strictly additive, because many of the people counted in one category are also exposed to another category of noise. Fifty-nine million people live in areas with urban traffic noise of $L_{dn} = 60$ dB or higher, in contrast to only 16 million and 3.1 million people who live in areas with outdoor levels of $L_{dn} = 60$ dB or higher for aircraft and freeway noise, respectively. On the other hand, more people are exposed to higher levels of noise from freeway and aircraft operations than from urban traffic: about 300,000 people live in areas exposed to levels of $L_{dn} = 80$ dB or higher from freeway traffic; 200,000 from aircraft operations; and 100,000 from urban traffic. Bear in mind, however, that there may be differences between individual at-ear exposure levels and outdoor levels, because people move from place to place for varying amounts of time.

Relationship Between Indoor and Outdoor Levels

The contribution of outdoor noise to indoor noise levels is usually small. That part of a sound level within a building caused by an outdoor source obviously depends on the source's intensity and the sound level reduction afforded by the building. Although the sound level reduction provided by different buildings differs greatly, dwellings can be categorized into two broad classes—those built in warm climates and those built in cold climates. Further, the sound level reduction of a building is largely determined by whether its windows are open or closed. Table II shows typical sound level reductions for these categories of buildings and window conditions, as well as an approximate national average sound level reduction.

Table II
Typical Sound Level Reductions of Buildings

	Windows Opened	Windows Closed
Warm Climate	12 dB	24 dB
Cold Climate	17 dB	27 dB
Approximate National Average	15 dB	25 dB

Sample measurements of outdoor and indoor noise levels during 24-hour periods are depicted in Figure 7. Despite the sound level reduction of buildings, indoor levels are often comparable to or higher than levels measured outside. Thus, indoor levels often are influenced primarily by internal noise sources such as appliances, radio and television, heating and ventilating equipment, and people. However, many outdoor noises may still annoy people in their homes more than indoor noises do. Indeed, people sometimes turn on indoor sources to mask the noise coming from outdoors.

An example of the range of hourly sound levels measured inside living areas is plotted for each hour of the day in Figure 8. The figure shows the median levels and the range of levels observed for 80% of the data. During late night hours the typical hourly sound level was approximately 36 dB. This level was probably dominated by outdoor noise. However, during the day, the hourly average levels ranged from about 40 to 70 dB, indicating the wide range of activities in which people engage.

INDIVIDUAL NOISE EXPOSURE PATTERNS

During a 24-hour period, people are exposed to a wide range of noises, including noise at home, work, school, places of recreation, shopping establishments, and while enroute to these or other locations. Clearly, no single exposure pattern can be typical of all people, or even of those people who follow a common life style. Figure 9 shows hypothetical exposure patterns for broad classes of people. From these levels and some assumptions about the hours spent at different daytime activities, 24-hour average sound levels can be estimated for factory and office workers, housewives, and preschool and school-age children. Estimates based on these assumptions are found in Table III.

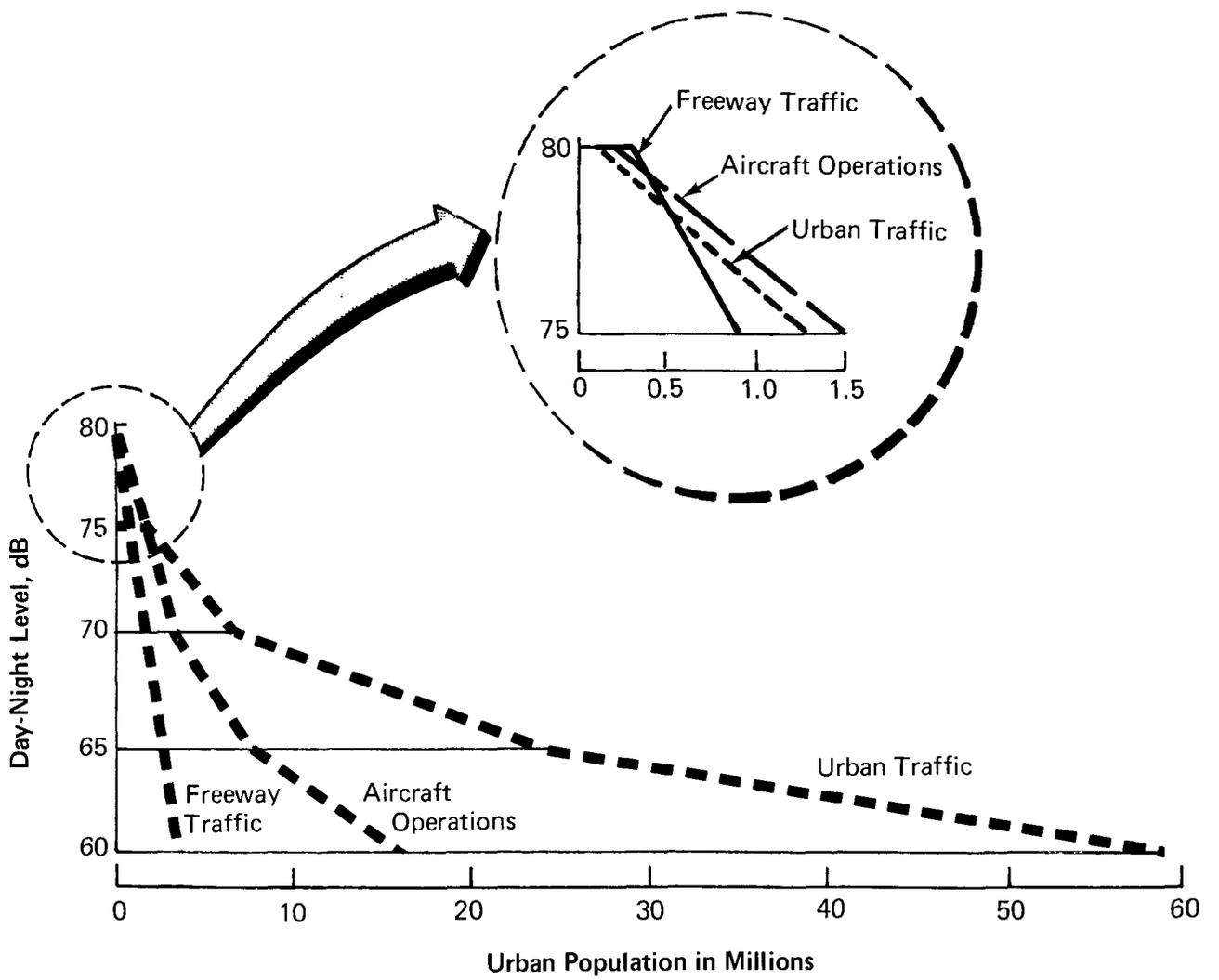


FIGURE 6. CUMULATIVE NUMBER OF PEOPLE IN URBAN AREAS EXPOSED TO OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS FROM DIFFERENT SOURCES

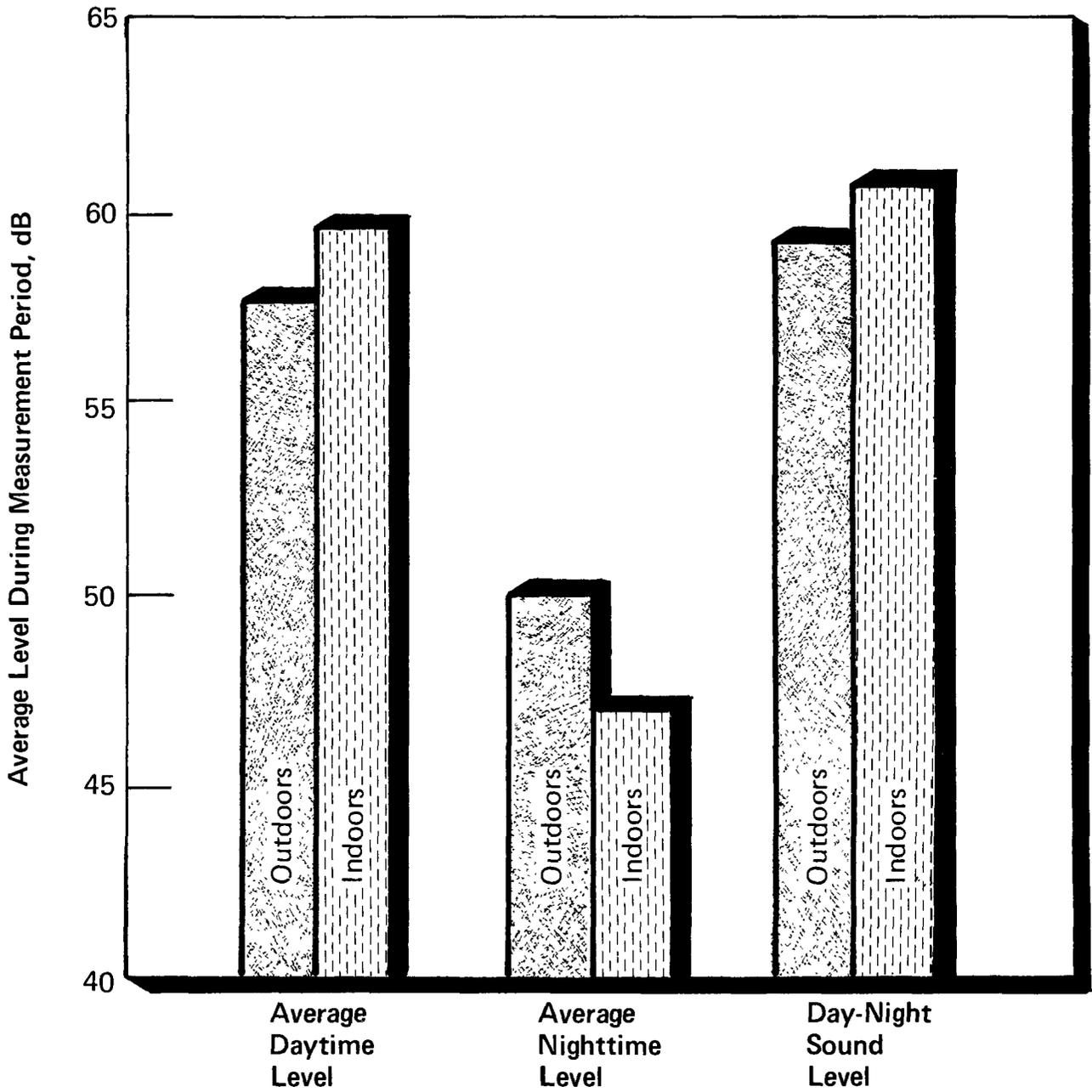


FIGURE 7. COMPARISON OF SAMPLE OUTDOOR AND INDOOR AVERAGE RESIDENTIAL SOUND LEVELS

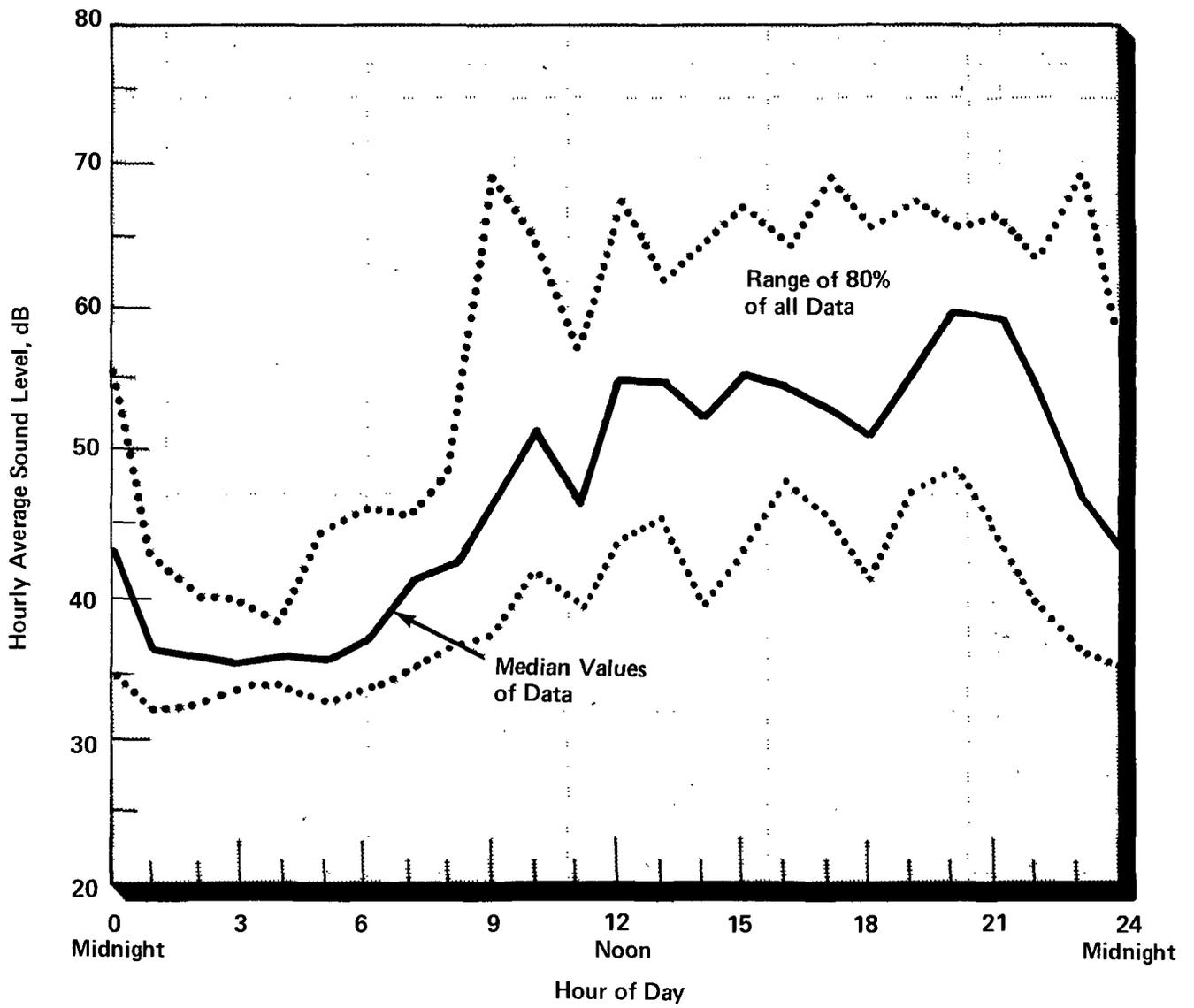


FIGURE 8. TIME PATTERN OF HOURLY INDOOR RESIDENTIAL SOUND LEVELS

For most people, nighttime noises do not contribute significantly to the 24-hour average. For many, the 24-hour average is determined primarily by the noise exposure of a single activity, frequently occurring for a short period of time.

Table III
Hypothetical Examples of Noise Exposures of Individuals

Individual	24-Hour Average Sound Level, dB	
	Suburban Environment	Urban Environment
Factory Worker	87	87
Office Worker	72	70
Housewife	64	67
School Child	77	77

HEARING DAMAGE FROM ENVIRONMENTAL NOISE

There is no question that exposure to certain levels of noise can damage hearing. However, determining exposure levels that protect hearing with an adequate margin of safety is a complicated matter.

This is because hearing is a complex ability that cannot be summarized by a single number in the way an individual's height or weight can be described. In fact, sizeable differences exist between individuals' hearing abilities. Hearing acuity tends to change progressively with age. Also, environmental noise exposure may vary considerably from moment to moment, so that specification of protective levels should include dynamic considerations. Further, relationships between hearing damage and noise exposure must be inferred, since available scientific information was gathered from groups of people who differed not only in noise exposure, but also in other important ways. Finally, individual and group noise exposures (especially over a working lifetime) are rarely known with precision.

In reaching conclusions about hearing loss, then, one must rely to a degree on assumptions, hypotheses, and extrapolations from existing data. Since complete agreement within the scientific community on these matters is lacking, an attempt was made in the Levels Document to consider alternative assumptions and hypotheses to ensure that the methods used to derive protective levels were based on the most defensible practice. As new data become available these levels may change slightly.

Basic Premises Involved in Determining Protective Levels

1. Changes in ability to hear in the region of 4000 Hz are the most important signs of irreversible hearing loss, indicating actual physiological destruction within the hearing mechanism. This frequency is usually the first frequency affected when the ear is damaged by exposure to noise. Furthermore, the protection of hearing acuity at this frequency is critical for understanding of speech and appreciation of music and other sounds.

2. Changes in individual hearing level, like changes in height or weight, are only significant if they are sizeable. Changes smaller than 5 dB are considered insignificant.

3. At all ages, it is assumed that hearing acuity cannot be damaged by sounds that cannot be heard. This may be important in that aging and other causes may produce appreciable shifts in hearing.

4. Because hearing ability varies from person to person, recommendations must be made in terms of a critical percentage of the population, ranked with superior hearing over the remainder. EPA's recommendations were based on the 96th percentile—that is, on providing protection for 96% of the people. It is assumed that people with poorer hearing than the 96th percentile are not affected by noise of typical levels (see 3 above), so that the recommendations protect virtually the entire population.

5. An individual's total noise exposure is evaluated by an "equal energy" rule: two noise exposures are expected to produce equal hearing loss if the product of exposure intensity and exposure time are equal. This rule allows a 3-dB decrease in sound pressure level (expressed in dB) for each doubling of the duration. Thus an exposure of 76 dB for one hour is equivalent to 73 dB for two hours, or 70 dB for four hours. This procedure is probably accurate for exposures of 30 minutes or more. It is also more protective for very short exposures and for noise that fluctuates greatly in level.

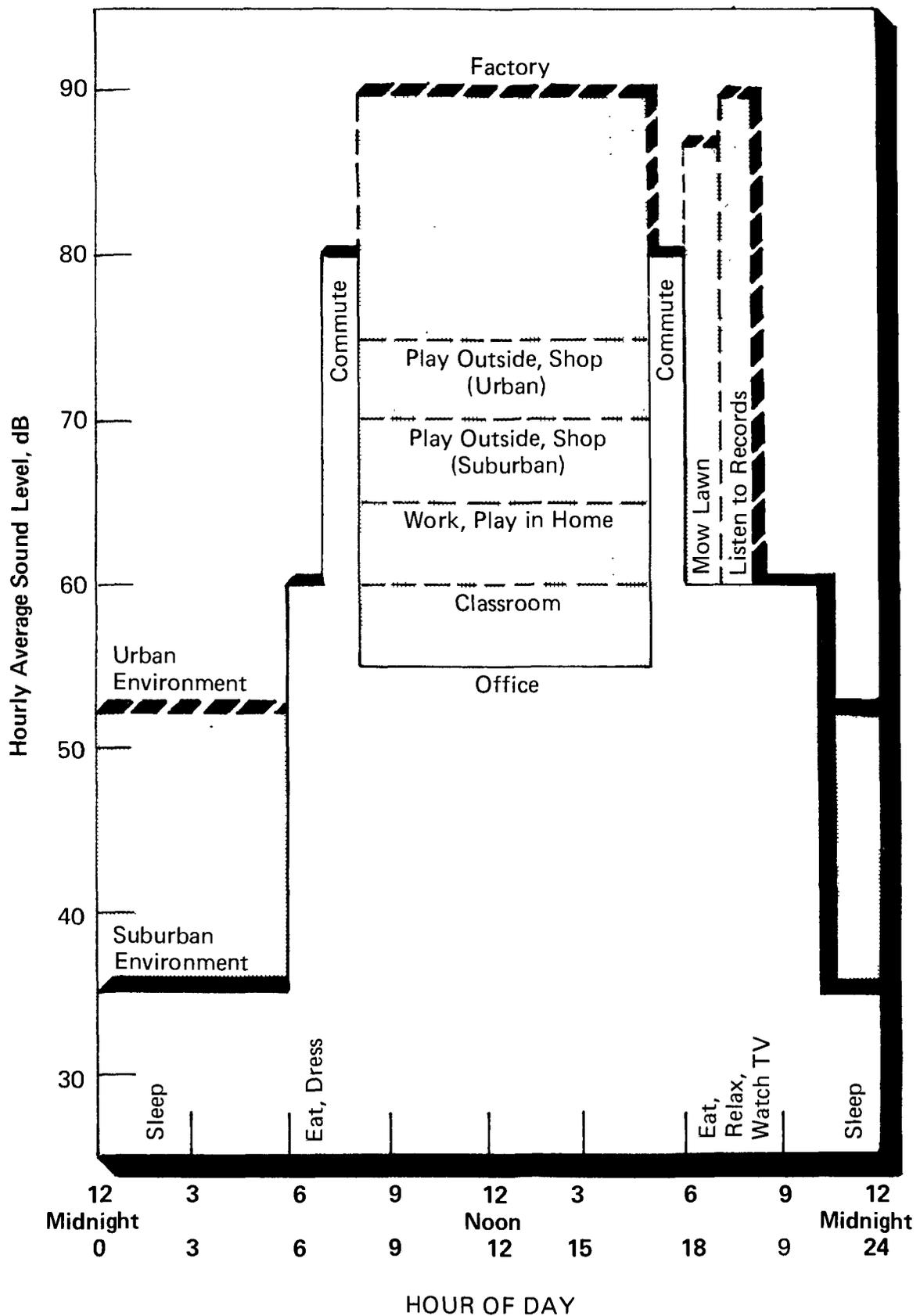


FIGURE 9. GENERALIZED INDIVIDUAL NOISE EXPOSURE PATTERNS

6. Intermittent noise produces less hearing damage than the "equal energy" rule would predict. To be considered intermittent for this purpose, a noise must fall below 65 dB for 10% of each hour and have peaks that exceed the background level by 5 to 15 dB. Intermittent noise is assumed to produce 5 dB less effect than does continuous noise of the same average level.

Calculation of the Maximum Allowable Noise Exposure

Three major scientific studies have attempted to assess hearing damage for various noise exposures. All are based on a comparison of groups of noise-exposed people and comparable non-exposed groups. All three studies attempted to predict hearing loss as a function of noise exposure of a certain percentage of people. Because these studies were of exposure to high-level noise, extrapolations of the data were necessary to estimate the protective exposure level that would produce minimal hearing loss: less than 5 dB at 4000 Hz for 96% of the people.

Forty years of exposure (250 working days per year) to a noise level of 73 dB for 8 hours per day was calculated to produce a hearing loss smaller than 5 dB for 96% of the people. This is the basic datum used to calculate hearing-protective levels of noise exposure. To use it in specific situations, certain corrections must be applied. One correction is to determine the yearly (rather than working day) level (250 to 365 days). This consideration amounts to a reduction 1.6 dB. Another correction, based on exposure on a 24-hour rather than 8-hour basis, produces an additional reduction of 5 dB.

Table IV contains at-ear noise exposure levels that produce negligible hearing losses for both 8-hour and 24-hour exposure on a yearly and working day basis. The 8-hour calculation assumes the remaining 16 hours of the day are spent in relative quiet.

Since an individual often experiences intense noise exposure outside of working hours (for example, while using noisy appliances or pursuing noisy recreation), protection on a 24-hour basis 365 days per year requires exposure of an intermittent variety at an equivalent level of less than 71.4 dB. This value is rounded to 70 dB to provide a slight margin of safety. Exposure to greater levels would produce more than 5 dB hearing loss in at least some of the population.

Table IV
(At-Ear) Exposure Levels that Produce No More Than
5 dB Noise-Induced Hearing Damage Over a 40-Year Period

		Steady (Continuous) Noise	Intermittent Noise	With Margin of Safety
L _{eq} , 8 hour	250 day/year	73	78	75
	365 day/year	71.4	76.4	
L _{eq} , 24 hour	250 day/year	68	73	70
	365 day/year	66.4	71.4	

Discussion of Assumptions

Several assumptions have been made in calculating the 24-hour yearly hearing-protective level of 70 dB. It is reasonable to ask how alternative assumptions would affect this level, and what the range of error might be.

- Q. How would the recommended level be affected by a change in the percentage of the population protected?
- A. Reducing the 96th percentile value to the 50th percentile (i.e., protecting half the population) would increase the protective level value from 70 dB to 77 dB.
- Q. Since agreement on the value of the intermittency correction is imperfect, what other values might be used?
- A. The estimated intermittency correction used in the Levels Document is 5 dB. The true intermittency correction is probably within the range 0 to 15 dB.
- Q. How accurate is the equal energy assumption?
- A. The equal energy assumption when applied to the long times (8 hours to 24, or 250 to 365 days) is fairly accurate. It may be subject to error when applied to short exposures of extreme level.

- Q. How meaningful are the basic studies of hearing damage risk?
- A. The probable errors of estimates in the three basic studies cannot be stated with absolute accuracy. There are a number of problems in extrapolating percentages of the population damaged from relatively high exposure levels to the protective level. Also, there is the problem of determining the amount of hearing damage when the control (non-exposed) population is subject to high levels of non-occupational noise. Thus, the 70 dB protective level is simply the best present estimate, subject to change if better data become available.

SPEECH COMMUNICATION

Communication is an essential element of human society, and speech is its most convenient form of expression. Interference with speech can degrade living directly, by disturbing normal social and work-related activities, and indirectly, by causing annoyance and stress. Sometimes the communications disturbed by noise are of vital importance, such as warning signals or cries for assistance. Prolonged speech interference and resulting annoyance are clearly not consistent with public health and welfare.

Speech interference from environmental noise can occur at home, at work, during recreation, inside vehicles, and in many other settings. Of chief concern for current purposes are the effects of noise on face-to-face conversations (indoors and outdoors), telephone conversations, and radio or television use.

The degree to which noise disturbs speech depends not only on physical factors (such as noise levels, vocal effort, distances between talkers and listeners, and room acoustics), but also on non-physical factors. The latter include the speaker's enunciation, the familiarity of the listener with the speaker's vocabulary and accent, the topic of conversation, the listener's motivation, and the hearing acuity of the listener. Years of research on speech intelligibility have produced considerable information about how these factors interact. Accurate predictions of speech intelligibility can be based on average noise levels and distances between speakers and listeners.

Speech Interference Indoors

The solid line in Figure 10 shows the effects of steady masking noise on sentence intelligibility for persons with normal hearing in a typical living room. At distances greater than about one meter from the speaker, the level of speech is fairly constant throughout the room.

The highest noise level that permits relaxed conversation with 100% sentence intelligibility throughout the room is 45 dB. People tend to raise their voices when the background noise exceeds 45-50 dB.

Speech Interference Outdoors

The sound level of speech outdoors decreases with increasing distance between speaker and listener. Table V shows distances between speaker and listener for satisfactory outdoor speech intelligibility at two levels of vocal effort in steady background noise levels.

The levels for normal and raised-voice "satisfactory conversation" shown in Table V permit sentence intelligibility of 95% at each distance. Ninety-five percent sentence intelligibility usually permits reliable communication because of the redundancy in normal conversation.

If the noise levels in Table V are exceeded, the speaker and listener must either move closer together or expect reduced intelligibility. For example, consider a conversation at normal vocal effort at a distance of three meters in a steady background noise of 56 dB. If the background level increases to 66 dB, the speakers either will have to move closer (to one meter apart) to maintain the same intelligibility, or alternatively, raise their voices appreciably. If they remain three meters apart without raising their voices, speech intelligibility would drop considerably.

Table V
Steady A-weighted Sound Levels That Allow Communication with
95 Percent Sentence Intelligibility Over Various Distances
Outdoors for Different Voice Levels

VOICE LEVEL	COMMUNICATION DISTANCE (meters)					
	0.5	1	2	3	4	5
Normal Voice (dB)	72	66	60	56	54	52
Raised Voice (dB)	78	72	66	62	60	58

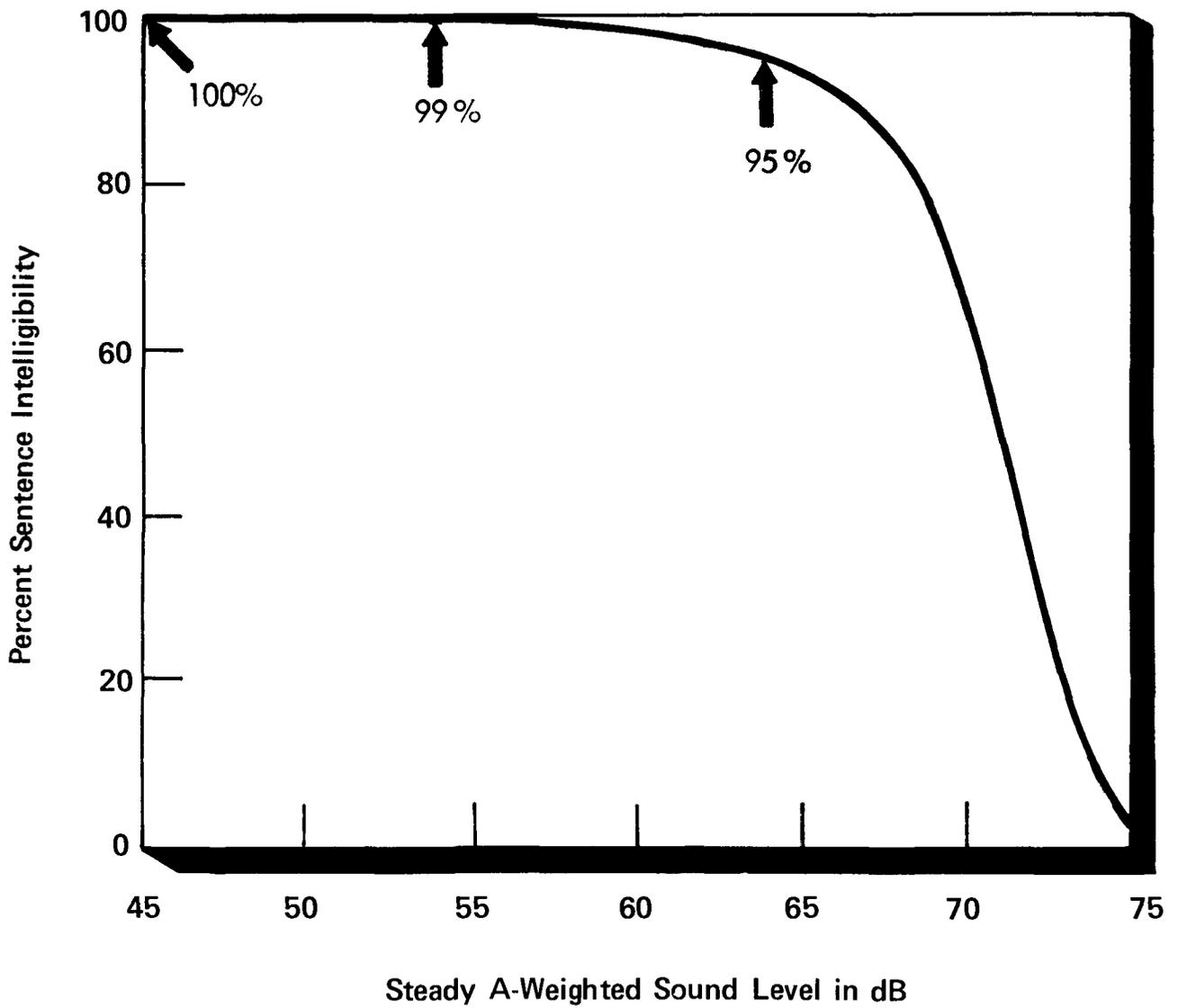


FIGURE 10. INDOOR SENTENCE INTELLIGIBILITY

Discussion

In summary, an L_{dn} of 45 dB permits virtually 100% intelligibility inside buildings. Assuming that a typical home reduces outdoor noise by 15 dB, the outdoor noise level should be no greater than $L_{dn} = 60$ dB to permit 100% intelligible speech indoors. Allowing a 5 dB margin of safety, the outdoor level should be $L_{dn} = 55$ dB. This outdoor level would also guarantee sentence intelligibility of 95% outdoors with normal voice levels at a distance of three meters.

- Q. What do percentages of sentence intelligibility signify?
- A. A given percentage of sentence intelligibility, such as 95% or 99%, indicates the proportion of key words (in a group of sentences) which are correctly heard by normal-hearing listeners.
- Q. How are the speech criteria affected by the fact that people tend to raise their voices in noise?
- A. The speech criteria are based on the principle that an adequate communication environment does not necessitate raised voices.
- Q. How do the identified continuous equivalent levels relate to the fact that, in everyday life, noise fluctuates and is intermittent in nature?
- A. The Levels Document tabulated speech interferences for different combinations of levels and durations to test the limits of certain L_{eq} values under intermittent conditions. It is acknowledged that, given equal L_{eq} values, fluctuating noise may reduce less total speech interference than continuous noise on average. On the other hand, during those times when the higher level noises occur, the speech interference will be greater than its average value.

ACTIVITY INTERFERENCE AND ANNOYANCE

Noise interferes with human activities to varying degrees. Intruding noises can interfere with human activities by distracting attention and by making activities more difficult to perform, especially when concentration is needed. Interference from noise can even make some activities (such as communication or sleep) virtually impossible. Except in the case of speech interference, however, the degree of interference is hard to specify and difficult to relate to the level of noise exposure.

Because people's reactions to time-varying noise differ from moment to moment, and because people's reactions differ in general, protective levels for annoyance and activity interference are determined from data collected from groups of people, rather than from individuals. Fortunately, considerable data from social surveys of community reactions to noise exposure are available for this purpose. Although there are some shortcomings in practically all such data, sufficient agreement exists to allow confident predictions of the noise levels that lead to certain degrees of activity interference and annoyance.

Activity Interference

Social surveys most often have been used to assess community reaction to noise exposure around airports. Table VI shows the percentage of people who reported noise interference with activities among a larger group which was extremely disturbed by aircraft noise.

It is hardly surprising that four of the nine activities in Table VI involve listening. Aircraft noise may also be found annoying because it may startle people, cause houses to shake, or elicit fear of a crash.

Another widely studied source of community noise exposure is vehicular traffic. Activity interference produced by traffic noise closely resembles that of aircraft noise, since interference with conversation, radio, television, and telephone use are all high on the list of activities disturbed.

Table VI
Percentage of Those People Who Were Highly
Disturbed by Aircraft Noise, by Activity Disturbed

ACTIVITY	PERCENT
TV-Radio Reception	20.6
Conversation	14.5
Telephone	13.8
Relaxing Outside	12.5
Relaxing Inside	10.7
Listening to Records/Tapes	9.1
Sleep	7.7
Reading	6.3
Eating	3.5

Community Reactions to Noise

Two major indices of the cumulative effects of environmental noise on people are (A) specific actions taken by individuals or groups (such as complaints), and (B) responses to social survey questionnaires. Over the last 25 years, numerous studies have been conducted to increase understanding of the relationship between noise exposure and its effects on people in communities.

Several factors beyond the magnitude of exposure have been found to influence community reaction. These factors include:

1. Duration of intruding noises and frequency of occurrence
2. Time of year (windows open or closed)
3. Time of day of noise exposure
4. Outdoor noise level in community when intruding noises are not present
5. History of prior exposure to the noise source
6. Attitude toward the noise source
7. Presence of pure tones or impulses.

Since each of these factors may affect community reactions to noise exposure, adjustments for each have been developed to improve the predictability of community reactions beyond that available from a simple measure of exposure level. Figure 11 shows the results of several different case studies, relating L_{dn} (in dB) to community response with various correction factors added. The addition of the correction factors makes it possible to predict community reaction to within ± 5 dB. As is common with annoyance and interference caused by noise, the effects of context and situation may be almost as important as the magnitude or intensity of the source. Caution is also needed in applying these relationships to communities that are significantly quieter than average urban areas.

Social Surveys

Extensive social surveys have been conducted around Heathrow Airport near London and at eight major airports in the United States. The relationship found in these surveys between noise exposure levels and the percentage of respondents who were considered annoyed by noise is summarized in Figure 12.

Discussion

- Q. Is annoyance simply a "welfare" effect?
- A. Annoyance is a reflection of adverse effects which cannot be ascribed solely to "health" or "welfare." "Public health and welfare" in the context of the Noise Control Act is an indivisible term; there are no separate "health" effects or "welfare" effects. "Public health and welfare" includes personal comfort and well-being, and the absence of mental anguish, disturbances and annoyance as well as the absence of clinical symptoms such as hearing loss or demonstrable physiological injury.
- Q. What is annoyance due to noise?
- A. Noise annoyance may be viewed as any negative subjective reaction to noise on the part of an individual or group. It is not an indication of weakness or inability to cope with stress on the part of the annoyed. More likely it signifies transient (or possibly lasting) stress beyond the control of the conscious individual. This is often expressed on social surveys as the percentage of people who express differing degrees of disturbance or dissatisfaction due to the noisiness of their environments. For the purpose of identifying protective noise levels, annoyance is quantified by using the percentage of people who are annoyed by noise. This is felt to be the best estimate of the average general adverse response of people, and in turn, is viewed as reflecting activity interference and the overall desire for quiet.
- Q. Are people annoyed at levels below an L_{dn} of 45 or 55 dB?
- A. Individuals, or even groups, may be annoyed by noise at low levels—the dripping faucet or humming fluorescent bulb are good examples. Annoyance depends very much on the situation, and on individual differences and noise durations.
- Q. What do complaints represent?
- A. Complaints are used by officials as an indication that a noise problem exists (although a noise problem may well exist in the absence of specific complaints). However, they do not necessarily represent the magnitude of a noise problem. The number of people who file complaints is only a very small percentage of those who are annoyed.

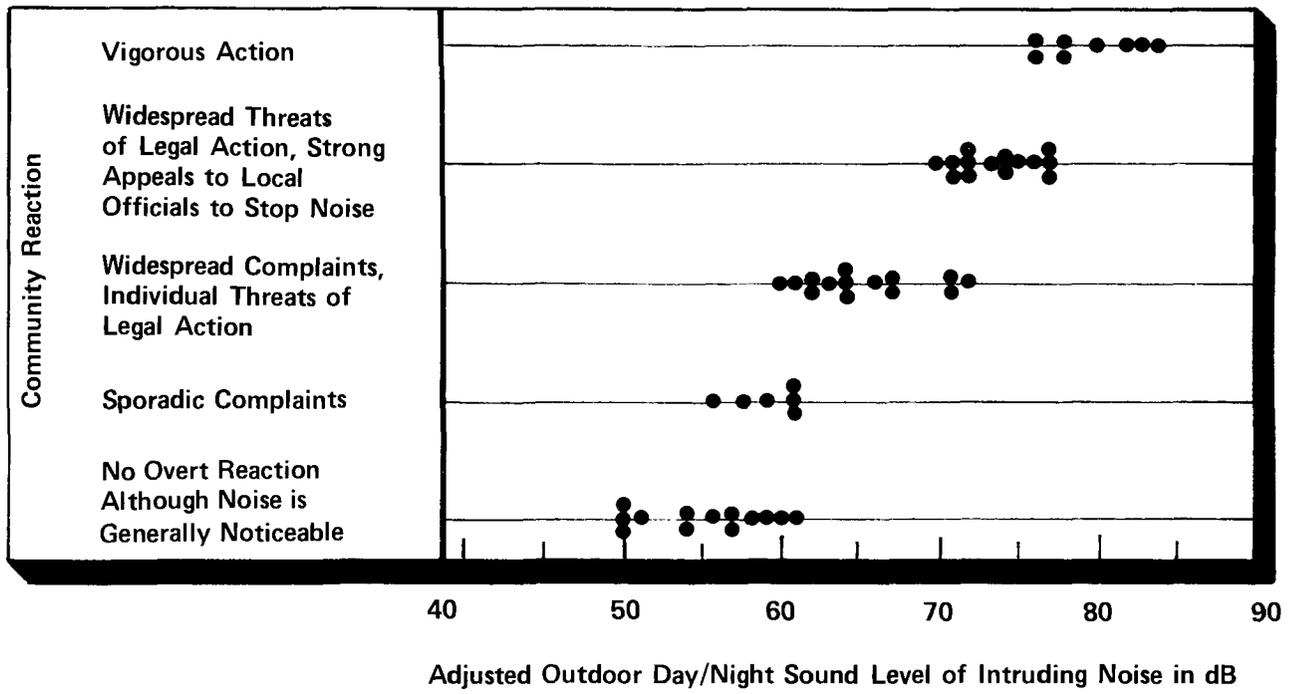


FIGURE 11. COMBINED DATA FROM COMMUNITY CASE STUDIES ADJUSTED FOR CONDITIONS OF EXPOSURE

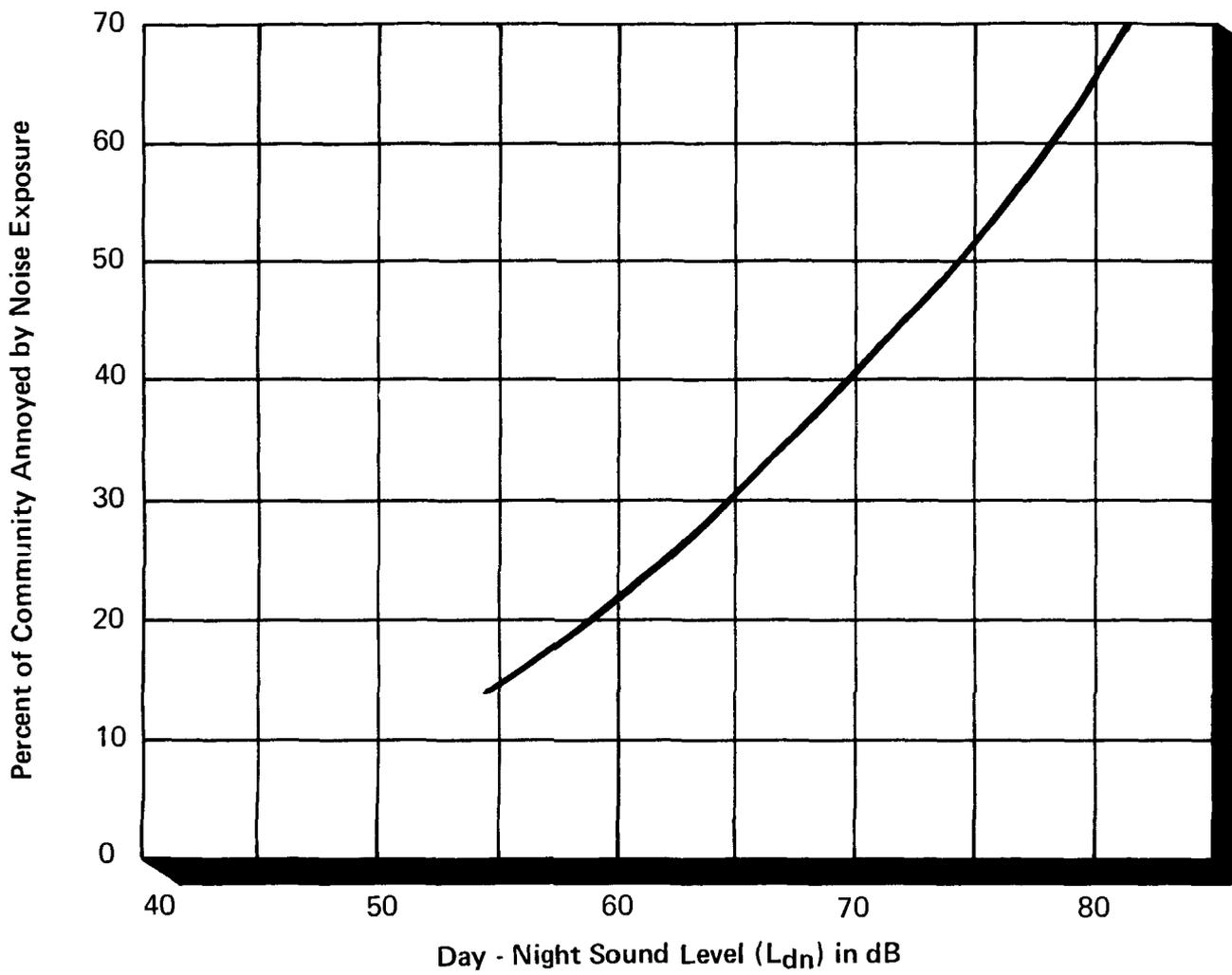


FIGURE 12. PERCENTAGE OF POPULATION ANNOYED BY COMMUNITY NOISE (HEATHROW AIRPORT STUDY)

- Q. How is the margin of safety for annoyance applied?
- A. The identified indoor level of $L_{dn} = 45$ incorporates a margin of safety for 100% protection of speech perception which is used as a surrogate for annoyance. The outdoor identified level of 55 L_{dn} protects speech outdoors to a level of 95% intelligibility at up to 2 meters, while incorporating a 5 dB margin of safety for speech, and giving added weight to the range of adverse effects.
- Q. Why is the nighttime penalty 10 decibels?
- A. The 10 dB nighttime weighting had two bases: first, this weighting value has been applied successfully here and in other countries; secondly, in quiet environments, the natural drop in level from day to night is about 10 dB.

SUMMARY

On the basis of its interpretation of available scientific information, EPA has identified a range of yearly Day-Night Sound Levels sufficient to protect public health and welfare from the effects of environmental noise. It is very important that these noise levels, summarized in Table VIII, not be misconstrued. Since the protective levels were derived without concern for technical or economic feasibility, and contain a margin of safety to insure their protective value, they must not be viewed as standards, criteria, regulations, or goals. Rather, they should be viewed as levels below which there is no reason to suspect that the general population will be at risk from any of the identified effects of noise.

Table VIII
Yearly L_{dn} Values That Protect Public Health
and Welfare with a Margin of Safety

EFFECT	LEVEL	AREA
Hearing	$L_{eq(24)} \leq 70$ dB	All areas (at the ear)
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

Outdoor yearly levels on the L_{dn} scale are sufficient to protect public health and welfare if they do not exceed 55 dB in sensitive areas (residences, schools, and hospitals). Inside buildings, yearly levels on the L_{dn} scale are sufficient to protect public health and welfare if they do not exceed 45 dB. Maintaining 55 L_{dn} outdoors should ensure adequate protection for indoor living. To protect against hearing damage, one's 24-hour noise exposure at the ear should not exceed 70 dB.

MISUSES, MISUNDERSTANDINGS, AND QUESTIONS

Perhaps the most fundamental misuse of the Levels Document is treatment of the identified levels as regulatory goals. They are *not* regulatory goals; they are levels defined by a negotiated scientific consensus. These levels were developed without concern for economic and technological feasibility, are intentionally conservative to protect the most sensitive portion of the American population, and include an additional margin of safety. In short, the levels in Table VIII are neither more nor less than what Congress re-

quired them to be: levels of environmental noise requisite to protect the public health and welfare with an adequate margin of safety.

- Q. Why doesn't the Levels Document explicitly say how much noise is too much noise?
- A. Decisions about how much noise is too much noise for whom, for how long, and under what conditions demand consideration of economic, political, and technological matters far beyond the intent of the Levels Document. Such decisions are properly embodied in formal regulations, not informational publications such as the Levels Document.
- Q. How do I use this information for local purposes?
- A. This question reflects the need to reconcile local economic and political realities with scientific information. People who formulate local noise abatement programs cannot escape the responsibility of making such economic and political compromises for their constituencies. The Levels Document does not impose arbitrary Federal decisions about the appropriateness of noise environments upon any level of government, nor is it a source of prescriptions for solving local noise problems. It is best viewed as a technical aid to local decision makers who seek to balance scientific information about effects of noise on people with other considerations, such as cost and technical feasibility.
- Q. If the identified noise levels are indeed sufficient to protect public health and welfare, shouldn't they be considered to be long-range regulatory goals?
- A. Attainment of the identified levels of environmental noise can only be considered idealized goals. Pragmatically, it is unlikely that local, state, or Federal regulatory strategies will seek to attain such levels for all situations in the near future.
- Q. Why isn't the Levels Document more definite about specific effects associated with various noise exposure conditions?
- A. Available knowledge about the effects of noise would not support more precise statements. Increasingly specific statements will be incorporated in future informational publications as they are justified by increasing knowledge of human response to noise exposure.

TECHNICAL REPORT DATA <i>(Please read Instructions on the reverse before completing)</i>		
1. REPORT NO. EPA 550/9-79-100	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Protective Noise Levels Condensed Version of EPA Levels Document	5. REPORT DATE November 1978	6. PERFORMING ORGANIZATION CODE ONAC
	8. PERFORMING ORGANIZATION REPORT NO.	
7. AUTHOR(S) EPA Office of Scientific Assistant to DAA/Noise	10. PROGRAM ELEMENT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS EPA/ONAC	11. CONTRACT/GRANT NO.	
	13. TYPE OF REPORT AND PERIOD COVERED	
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Protection Agency Office of Noise Abatement & Control (ANR-471) 401 M Street, S.W. Washington, D.C. 20460	14. SPONSORING AGENCY CODE EPA/ONAC	
	15. SUPPLEMENTARY NOTES	
16. ABSTRACT This publication is intended to promote understanding of EPA's findings about levels of environmental noise that protect public health and welfare. It seeks to clarify the proper use of the 1974 "Levels Document" by interpreting its contents in less technical terms. The manual deals with measurement descriptors of environmental noise. Also addressed are the best understood effects of noise on people (hearing damage, speech interference and annoyance). Protective levels are summarized.		
17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Environmental noise levels, indoor and outdoor levels, measurement descriptors, noise exposure patterns, hearing damage, speech interference, annoyance, protective noise exposures		
18. DISTRIBUTION STATEMENT Limited supply available at EPA/ONAC or NTIS, Springfield, VA 22151	19. SECURITY CLASS (<i>This Report</i>) Unclassified	21. NO. OF PAGES 25
	20. SECURITY CLASS (<i>This page</i>)	22. PRICE

REVISED WAIVER REQUEST LIST



February 6, 2025
Revised: March 25, 2025

Mr. Gregory Rondeau, Chairman
Franklin Planning Board
355 East Central Street
Franklin, MA 02038

***RE: Revised Waiver Request List from Site Plan and Design Review Bylaw
Site Plan Approval Submittal
Solar Canopy and Ground Mount Project
50 Constitution Boulevard – Franklin, MA (Parcel ID 319-015-000-000)***

Dear Board Members:

We respectfully request on behalf of the applicant, EMC Corporation, the following list of waivers to the submission and design requirements of the Town of Franklin Site Plan and Design Review Bylaw for Site Plan Approval:

1. *Section §185-31.C(3)(i) – provide outdoor lighting, open space areas, snow storage and parking areas.*

The property is already fully developed and currently functions as a Dell manufacturing facility. Since the site is already fully developed with adequate infrastructure in place, the project will not require additional lighting, open space, snow management, or parking needs.

2. *Section §185-31.C(3)(k) – provide a complete landscaping plans, including existing vegetation and proposed plantings.*

Since the site is already fully developed, the project will not significantly impact existing landscaping or require new plantings. Existing trees to be disturbed by the project will be replaced/replanted along the perimeter of the parking lot as indicated on the Site Development Plans.

If you have any questions or require further information, please do not hesitate to contact me at (508) 888-9282.

Sincerely,

ATLANTIC DESIGN ENGINEERS, INC.



Richard J. Tabaczynski, P.E.
Vice President

*REVISED POST-CONSTRUCTION LONG TERM STORMWATER
OPERATION & MAINTENANCE PLAN*

Solar Canopy and Ground Mount Project
At
50 Constitution Boulevard – Franklin, MA
Post-Construction Long Term Stormwater Operation & Maintenance Plan
February 5, 2025 Revised: March 25, 2025
ADE Job #3402.00

A. GENERAL NOTES

1. Upon completion of construction, the operation and maintenance of all components of the stormwater management system will be the responsibility (financially and otherwise) of the system owner (responsible party):

EMC Corporation
176 South Street
Hopkinton, MA 01748


Signature


Date

2. The responsible party shall file an inspection report with the Town of Franklin DPW following each site inspection as recommended in the Operation & Maintenance (O&M) Schedule. The inspection report shall identify the date of inspection, name, and contact number of responsible party, specific structures inspected, specific maintenance and/or repairs required and general observations. Any deficiencies noted in the inspection report shall be corrected to the Town of Franklin's DPW's satisfaction.
3. Disposal of accumulated sediment and hydrocarbons to be in accordance with the applicable local, state, and federal guidelines and regulations.
4. There shall be no illicit discharge of any waste or waste water into the stormwater management system. The maintenance of the facility shall be undertaken in such a manner as to prevent any discharge of waste or waste water into the stormwater management system. Any waste oil or other waste products generated during the maintenance shall be properly disposed of offsite.

EMC Corporation
176 South Street
Hopkinton, MA 01748


Signature


Date



5. The Town will be notified of changes in project ownership or assignment of operation and maintenance financial responsibility.
6. The maintenance schedule in this operation and maintenance (O&M) Plan will only be amended by mutual agreement of the Town and the responsible party. Amendments will be made in writing and signed by the responsible party.

B. STORMWATER SYSTEM/BMPS

Stone Infiltration Trench:

Inspect after every major storm event (2" or greater) for the first few months after construction and at least twice per year thereafter during wet weather to ensure the system is working properly. Check for accumulation of sediment, debris, weed growth and leaf litter and clean out as required, including replacement of top layer of stone.

C. ESTIMATED ANNUAL BUDGET

The estimated annual budget for the activities required in this Post-Construction Long Term Stormwater Operation and Maintenance Plan is \$1,000.00.

D. SAMPLE OPERATION AND MAINTENANCE LOG (next page)

E. BMP Locations (Attached)



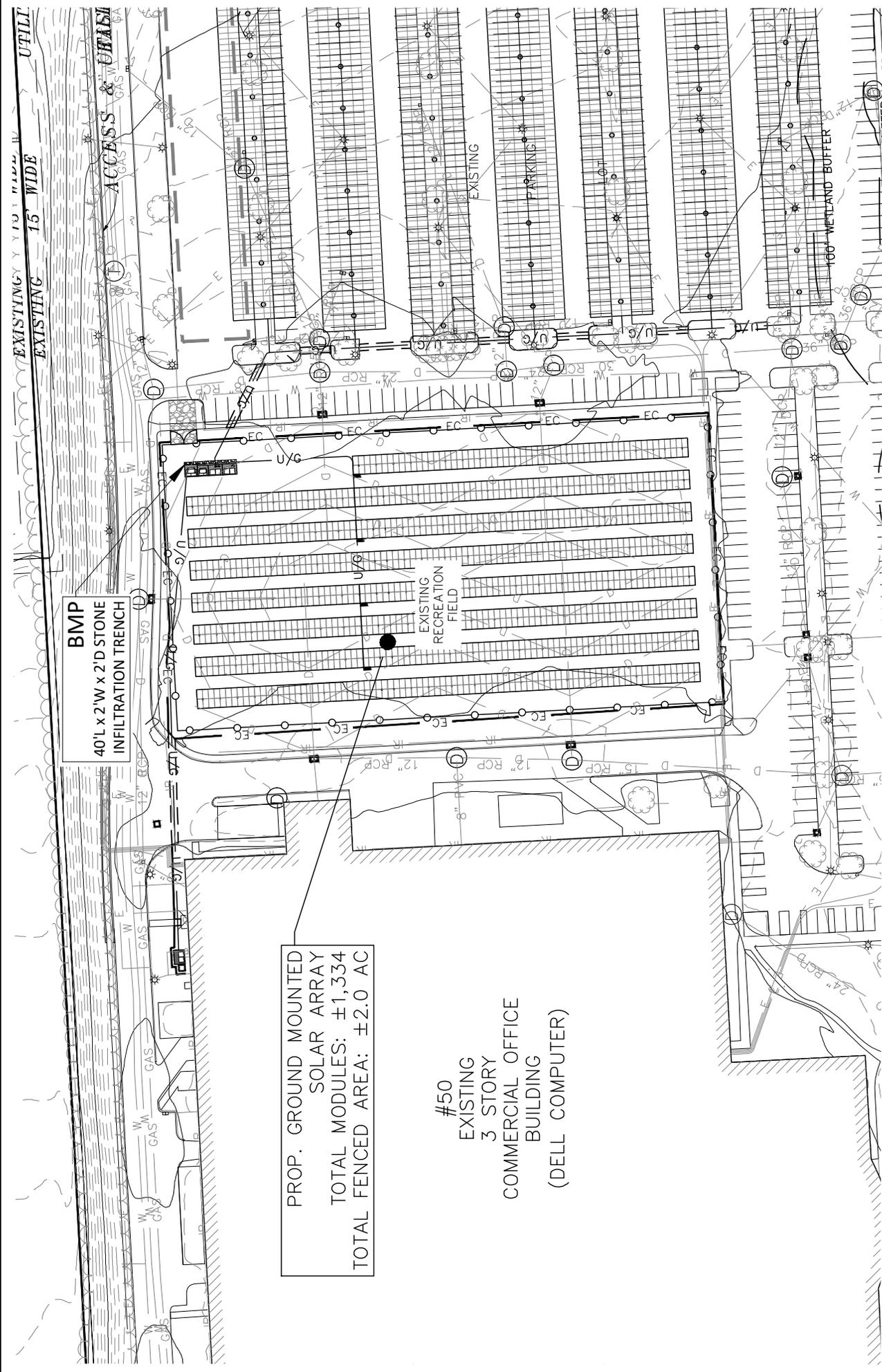
SAMPLE OPERATION AND MAINTENANCE LOG

**SOLAR CANOPY AND GROUND MOUNT PROJECT - FRANKLIN,
 MASSACHUSETTS**

POST-CONSTRUCTION

LONG TERM STORMWATER OPERATION & MAINTENANCE PLAN

Date: _____ Personnel Present: _____ _____	
Inspectors Name: _____ Inspectors Contact Information: _____ _____ _____	
Signature: _____ _____	
O&M ITEM:	COMMENTS, CORRECTIVE ACTION NEEDED, AND NOTES:
Stone Infiltration Trench	



BMP
 40'L x 2'W x 2'D STONE
 INFILTRATION TRENCH

PROP. GROUND MOUNTED
 SOLAR ARRAY
 TOTAL MODULES: ±1,334
 TOTAL FENCED AREA: ±2.0 AC

#50
 EXISTING
 3 STORY
 COMMERCIAL OFFICE
 BUILDING
 (DELL COMPUTER)

BMP Locations
 SOLAR CANOPY & GROUND MOUNT PROJECT
 DELL CAMPUS - 50 CONSTITUTION BLVD, FRANKLIN, MA
 MARCH 25, 2025
 Scale: 1"=100'



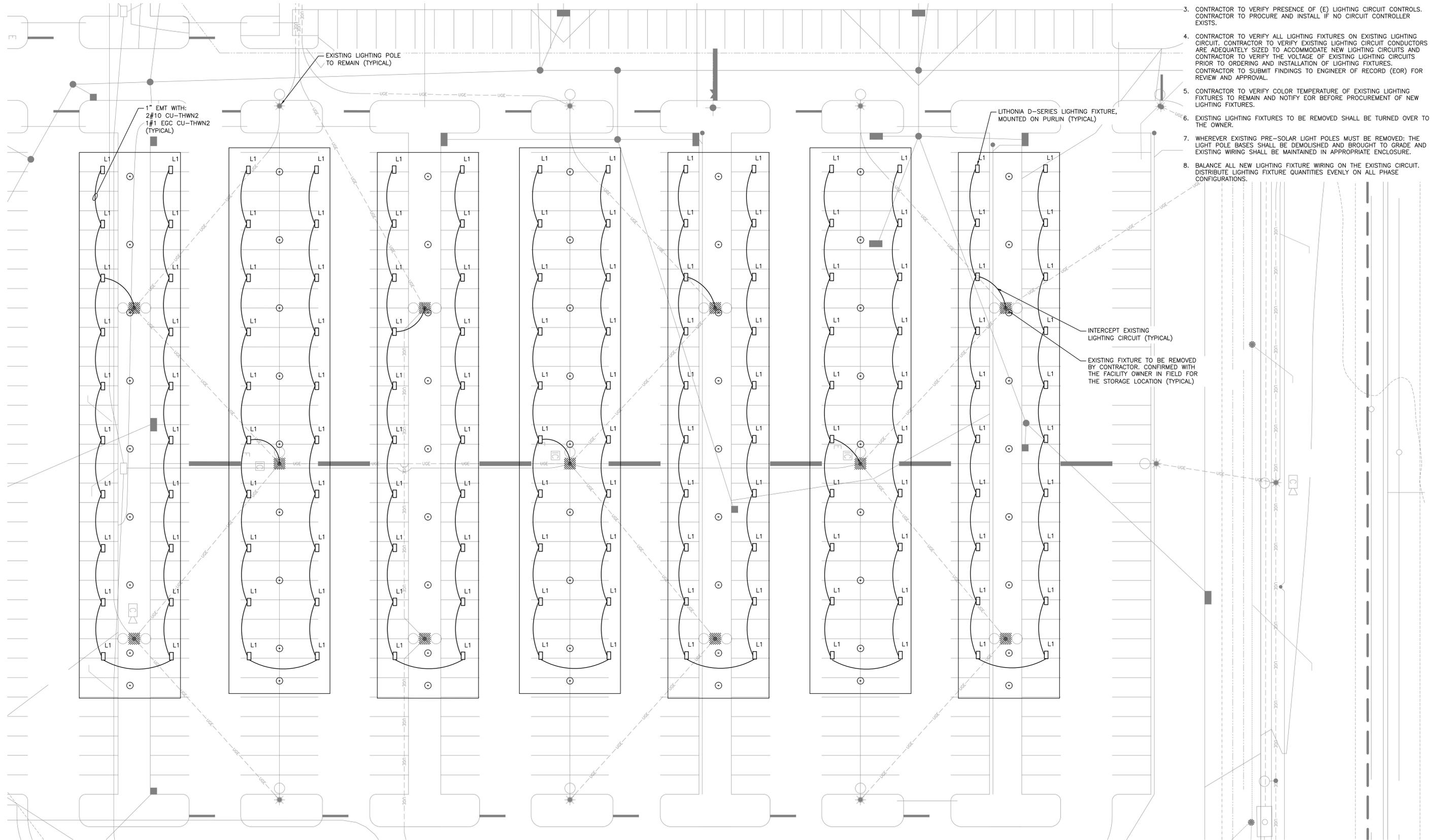
Atlantic
 DESIGN ENGINEERS, INC.

P.O. Box 1051 Sandwich, MA 02563 tel. (508) 888-9282 fax. (508) 888-5859

LIGHTING & PHOTOMETRIC PLANS - 90% SET

RULER IN INCHES: 0 1/2 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

PLOT DATE: 3/17/2025 5:53 PM



LIGHTING LEGEND:

- NEW FIXTURE TO BE INSTALLED UNDERNEATH SOLAR CARPORT
- ▨ EXISTING FIXTURE TO BE REMOVED
- ⊛ EXISTING FIXTURE TO REMAIN
- UGE — EXISTING LIGHTING CONDUITS

LIGHTING GENERAL NOTES:

1. CONDUIT RUN PATHS SHOWN ARE APPROXIMATE. CONTRACTOR SHALL FIELD VERIFY LOCATION, ROUTE OF CONDUIT RUNS AND ALL EXISTING UNDERGROUND UTILITIES AND CIRCUITRY AS REQUIRED, PRIOR TO STARTING WORK.
2. PROVIDE IN-GRADE TRAFFIC-RATED BOX LOCATIONS FOR DEMOLISHED LIGHT POLES IF REQUIRED TO MAINTAIN CONTINUITY TO ANY EXISTING LIGHTING REQUIREMENTS WITH EXISTING PARKING LOT LIGHTING INFRASTRUCTURE. NEW LIGHTING MUST BE TIED INTO EXISTING CIRCUIT. AT THE CONCLUSION OF PROJECT, PROVIDE AS-BUILT DRAWINGS SHOWING THE REVISED CIRCUITING AND BOX LOCATIONS TO OWNER.
3. CONTRACTOR TO VERIFY PRESENCE OF (E) LIGHTING CIRCUIT CONTROLS. CONTRACTOR TO PROCURE AND INSTALL IF NO CIRCUIT CONTROLLER EXISTS.
4. CONTRACTOR TO VERIFY ALL LIGHTING FIXTURES ON EXISTING LIGHTING CIRCUIT. CONTRACTOR TO VERIFY EXISTING LIGHTING CIRCUIT CONDUCTORS ARE ADEQUATELY SIZED TO ACCOMMODATE NEW LIGHTING CIRCUITS AND CONTRACTOR TO VERIFY THE VOLTAGE OF EXISTING LIGHTING CIRCUITS PRIOR TO ORDERING AND INSTALLATION OF LIGHTING FIXTURES. CONTRACTOR TO SUBMIT FINDINGS TO ENGINEER OF RECORD (EOR) FOR REVIEW AND APPROVAL.
5. CONTRACTOR TO VERIFY COLOR TEMPERATURE OF EXISTING LIGHTING FIXTURES TO REMAIN AND NOTIFY EOR BEFORE PROCUREMENT OF NEW LIGHTING FIXTURES.
6. EXISTING LIGHTING FIXTURES TO BE REMOVED SHALL BE TURNED OVER TO THE OWNER.
7. WHEREVER EXISTING PRE-SOLAR LIGHT POLES MUST BE REMOVED: THE LIGHT POLE BASES SHALL BE DEMOLISHED AND BROUGHT TO GRADE AND EXISTING WIRING SHALL BE MAINTAINED IN APPROPRIATE ENCLOSURE.
8. BALANCE ALL NEW LIGHTING FIXTURE WIRING ON THE EXISTING CIRCUIT. DISTRIBUTE LIGHTING FIXTURE QUANTITIES EVENLY ON ALL PHASE CONFIGURATIONS.

1 LIGHTING PLAN
SCALE: 1" = 20'



DRAWING TITLE
LIGHTING POWER PLAN

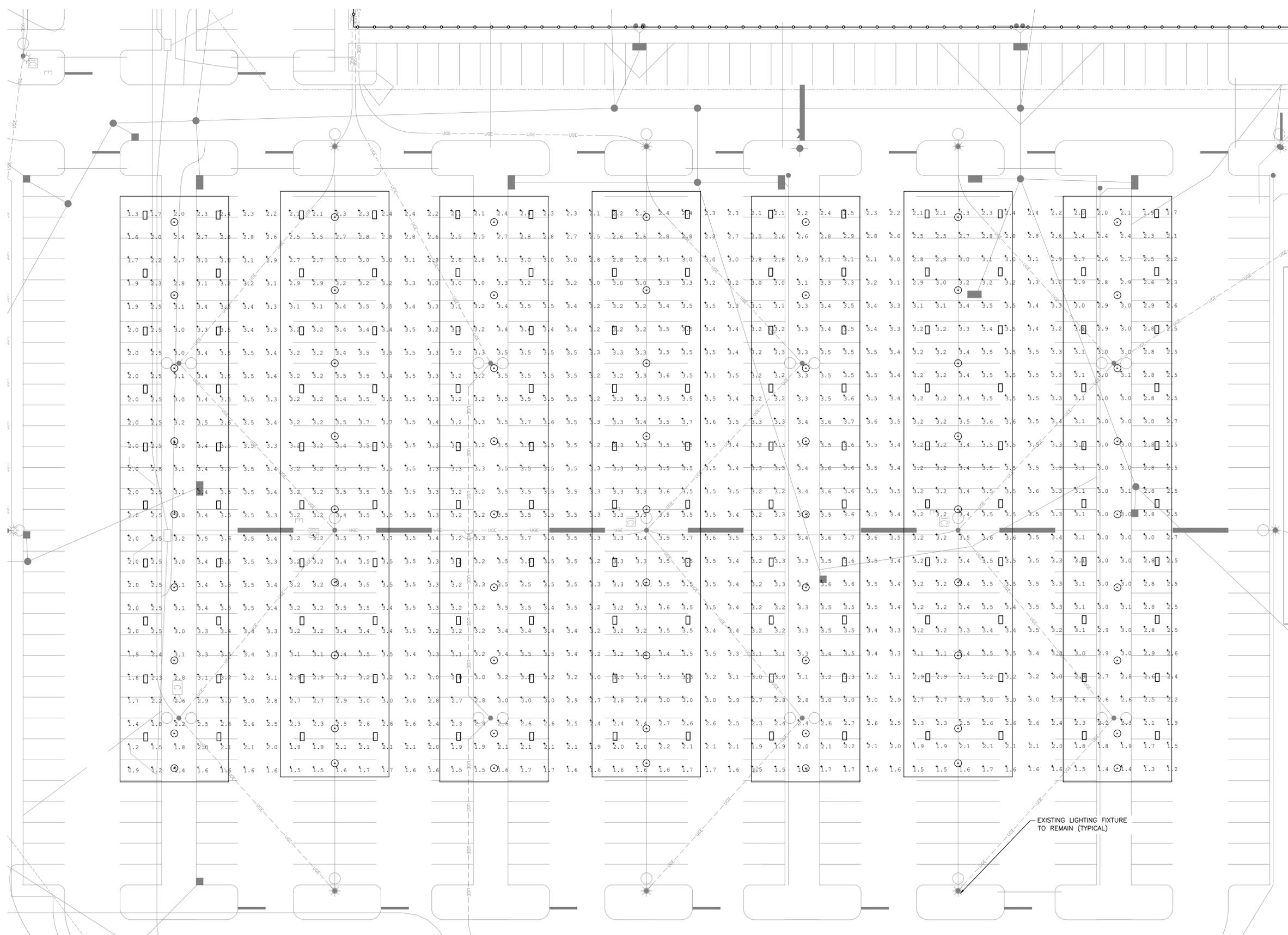
DRAWING #
E150

<p>PROJECT: SOLAR ROOFTOP, CARPORT, AND GROUND MOUNT SYSTEM AT FRANKLIN 50 SOLAR PROJECT 50 CONSTITUTION BLVD, FRANKLIN, MA 02038</p>	<p>DC SYSTEM SIZE: 4,615.13 kWDC AC SYSTEM SIZE: 3,935.00 kWAC MODULE TYPE: TRINA 655W BIFACIAL MODULE QUANTITY: 7,046 ORIENTATION: TILT & AZIMUTH VARY</p>
<p>DEVELOPER: Sunnova™</p>	<p>GENERAL CONTRACTOR: Honeywell</p>
<p>PAGE SIZE: 36" x 24" PROJECT #: 07929</p>	<p>REVISION CHECK: PM ENG CHK BX RA RI BX SZ RI BX MB RI BX SZ RI</p>
<p>DATE: 03/17/2025 02/28/2025 02/21/2025</p>	<p>REVISION DESCRIPTION: 90% SET 90% SET - SLD CONCEPTUAL DESIGN - REV 2 CONCEPTUAL DESIGN - REV 1</p>

RULER IN INCHES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

LUMINAIRE SCHEDULE									
SYMBOL	QUANTITY	LABEL	DESCRIPTION	VOLTAGE	COLOR TEMP.	MOUNTING HEIGHT	WATTS	LUMENS	BUG RATING
	140	L1	DSXSC LED 20C 350 40K T5W MVOLT DWHXD	120-277	4000K	14' - 17'10"	25	2969	B2-U0-G1

PHOTOMETRIC CALCULATION SUMMARY				
LABEL	AVG	MAX	MIN	MAX/MIN
CARPORT LIGHTING	2.99 (Fc)	3.7 (Fc)	0.9 (Fc)	4.11 (Fc)



- EXISTING FIXTURE NOTES:**
1. THE EXISTING LIGHTING FIXTURES TO REMAIN WILL PROVIDE LIGHT TO THE AREAS OUTSIDE THE CANOPY FOOTPRINT. THE FOOTCANDLE LEVELS IN THESE AREAS OUTSIDE THE CALCULATION ZONE WILL NOT BE NEGATIVELY AFFECTED.
 2. CONTRACTOR TO VERIFY ALL FIXTURES ON EXISTING 480V, 3-POLE LIGHTING CIRCUIT. CONTRACTOR TO MAINTAIN CONNECTION TO EXISTING FIXTURES TO REMAIN.
 3. EXTEND OR REROUTE CIRCUIT TO MAINTAIN CONNECTION.
 4. ALL EXISTING CONTROLS SHALL REMAIN UNLESS OTHERWISE NOTED.
- NEW FIXTURE NOTES:**
1. EXTEND AND REROUTE EXISTING 480V, 3-POLE CIRCUIT TO NEW FIXTURES.
 2. CONTINUE CIRCUIT FROM NEW FIXTURES TO EXISTING FIXTURES TO REMAIN AS REQUIRED.
 3. ALL EXISTING CONTROLS SHALL REMAIN UNLESS OTHERWISE NOTED.
 4. BALANCE ALL NEW FIXTURE WIRING ON THE EXISTING 480V, 3-POLE CIRCUIT AS SHOWN BELOW. DISTRIBUTE FIXTURE QUANTITIES EVENLY ON ALL PHASE CONFIGURATIONS.

D-Series LED Surface Canopy

Specifications

Length: 17.34" (441mm)
 Width: 8.27" (210mm)
 Height: 3.21" (82mm)
 (max) 5.51" (140mm)

Ordering Information

Series	LED	Color Temp.	Beam Angle	Mounting	Notes
DSXSC	10 LED (per module)	3000K	30°	SRM	Standard
DSXSC	20 LED (per module)	4000K	30°	SRM	Standard
DSXSC	30 LED (per module)	5000K	30°	SRM	Standard

Accessories

DSXSC-1: 10 LED (per module) with 3000K or 4000K
 DSXSC-2: 20 LED (per module) with 4000K or 5000K
 DSXSC-3: 30 LED (per module) with 5000K or 6000K

LIGHTING LEGEND:

- NEW FIXTURE TO BE INSTALLED UNDERNEATH SOLAR CARPORT
- EXISTING FIXTURE TO BE REMOVED
- EXISTING FIXTURE TO REMAIN

1 PHOTOMETRICS PLAN
 SCALE: 1" = 20'

DRAWING TITLE: **PHOTOMETRICS PLAN**
 DRAWING #: **E151**

PROJECT: SOLAR ROOFTOP, CARPORT, AND GROUND MOUNT SYSTEM AT FRANKLIN 50 SOLAR PROJECT
 50 CONSTITUTION BLVD, FRANKLIN, MA 02038
 DRAWING # E151
 PROJECT # 07929
 DEVELOPER: Sunnova
 GENERAL CONTRACTOR: Honeywell
 ENGINEER: RICHARD A. WINIS
 MA LICENSE NO. 49515
 PURE POWER
 111 RICHARD A. WINIS
 WWW.PUREPOWER.COM
 MA LICENSE NO. 49515
 REVISION DESCRIPTION: 9/17/2025 90% SET - SLD, 9/28/2025 90% SET - SLD, 10/21/2025 CONCEPTUAL DESIGN - REV. 2, 10/21/2025 CONCEPTUAL DESIGN - REV. 1