



November 29, 2023

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

**Re: Proposed Upper Union Solar Project
Site Plan Peer Review**

Dear Mr. Rondeau:

BETA Group, Inc. is pleased to provide updated engineering peer review services for the proposed project entitled **Upper Union Solar Project** in Franklin, Massachusetts. This letter is provided to outline findings, comments, and recommendations.

BASIS OF REVIEW

The following documents were received by BETA in response to our comments from August 04,2023 and formed the basis of the review:

- Plans (10 sheets) entitled: **Site Development Plans for Upper Union Solar Project. Franklin Massachusetts** dated June 30, 2023, revised November 10,2023, prepared by Atlantic Design Engineers stamped by Richard J. Tabacynski, PE No. 33746 and Edwin H. Gless, PLS No. 39045
- Stormwater Addendum #1 for Upper Union Solar Project, dated November 10,2023.
- Letter from Atlantic Design Engineers to the Planning Board dated November 10,2023 **RE: Noise Attenuation Analysis, Upper Union Solar Project-Franklin, MA** , signed by Simon B. Thomas, P.E.
- Letter from Atlantic Design Engineers to the Planning Board dated November 10,2023, **RE: Response to BETA Site Plan Peer Review Comments, August 03,2023, Upper Union Solar Project-Franklin, MA** , signed by Richard J. Tabacynski, PE No. 33746
- Letter from Atlantic Design Engineers to the Planning Board dated November 10,2023, **RE: Waiver Request List from Site Plan and Design Review Bylaw Site Plan Approval Submittal, Upper Union Solar Project, 9 Upper Union Street-Franklin, MA (Parcel ID 319-009-000-000)**, signed by Richard J. Tabacynski, PE No. 33746
- **Construction Sequence & Schedule**, Upper Union Solar Project, Franklin, Massachusetts, November 10,2023.

Review by BETA will include the above items along with the following, as applicable:

- Site Visit
- **Zoning Chapter 185 From the Code of the Town of Franklin**, current through March 01, 2016
- **Zoning Map of the Town of Franklin, Massachusetts**, amended July 13, 2016
- **Stormwater Management Chapter 153 From the Code of the Town of Franklin**, Adopted May 02, 2007
- **Wetlands Protection Chapter 181 From the Code of the Town of Franklin**, current through August 20, 1997
- **Subdivision Regulations Chapter 300 From the Code of the Town of Franklin**, current through January 01, 2016

- MassDEP Wetlands Program Policy 17-1: Photovoltaic System Solar Array Review, dated September 23, 2017

INTRODUCTION

The project site is a 6.2±-acre parcel on the east side of Upper Union Street, just north of Ribero Drive at 0 Upper Union Street, (Parcel 009 on the Town of Franklin Assessor Map 319). The property is comprised of partially cleared areas and undeveloped woodland with a 325' wide New England Power Easement running through the center of the site. Access to the site will come from frontage along Upper Union Street along a 20' wide paved driveway. The driveway will run east approximately 550' directly behind the existing abutting residential dwellings along Ribero Street.

The proposed development is a ground mounted Photovoltaic Power System. The limit of work for this system will be approximately 3.4 acres. Except for the Easement area, the entirety of the site is wooded currently. The site is located within the Industrial Zoning District. The southerly property line of the parcel forms the Zone line between the Industrial Zone and Rural Residential 1 Zone. The land to the north of the site is within the Industrial Zone. The project is not located within a FEMA mapped flood zone (area of 1% chance flood). NRCS soil maps indicate the soils at the site are of Charlton-Hollis -Rock outcrop complex, (fine sandy loam,) and Woodbridge fine sandy loam. The Charlton-Hollis-Outcrop complex is rated in Hydrologic Soil Group (HSG) A (high Infiltration potential), while the Woodbridge is rated C (low infiltration potential).

The project proposes to develop the site with approximately 2.5 acres of ground mounted solar modules, a separate equipment area at the entrance composed of inverters, cabinets, and transformers, 7' high security fencing, and a 20' wide gravel access driveway from Upper Union Street across the easement up to the solar modules. All the modules will be mounted on the east side of the Easement.

Except for the entrance driveway, there are no impervious surfaces proposed within the limits of the proposed development except those surfaces associated with the accessory equipment. Stormwater management will deal primarily with conformance with Standard 2 for peak flow rate attenuation. Stormwater management features proposed include the construction of a stormwater detention basin along the northerly edge of the access driveway at the western edge of the easement, a second detention basin at the far easterly edge of the parcel and an infiltration trench and deep sump catch basin at the entrance. The project as currently depicted will disturb more than one acre of land and is required to prepare a Stormwater Pollution Prevention Plan (SWPPP) and file a Notice of Intent with EPA. As currently shown, the wetlands on site are located on the southern portion of the site inside the easement which are supported by a stormwater discharge culvert from the roadway surface at Ribero Drive. The access driveway and the lower southeast portion of the array project area will be located within the limits of the buffers to these existing wetland resource areas. A Notice of Intent has been filed with the Franklin Conservation Commission.

FINDINGS, COMMENTS, AND RECOMMENDATIONS

GENERAL

- G1. The existing grade across the proposed panel array area ranges from 10-20%. The array area as proposed will cover 2.29± acres, with runoff travel paths exceeding 300' across the disturbance area. BETA recommends that interim erosion control measures be implemented to reduce the travel paths to less than 200'.

ADE: An additional interim row of erosion control barriers are proposed within the array

field on the revised site plans.

BETA: No further comments

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.

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

As shown on the schedule on the Zoning table on Sheet 5 of 9, the Site meets the requirements for lot area, depth, frontage, building height, and impervious area coverage. The lot width does not conform, however as noted in the bylaws, any lot created prior to May 20, 1998, is exempt from the current definition. The design engineer has indicated that the lot was created in 1995 prior to the bylaw and is therefor grandfathered.

- S.1 BETA recommends that a copy of the recorded plan be submitted to confirm the grandfather status of the lot regarding lot width.

ADE: *A copy of the recorded plan #624 of 1995 is enclosed.*

BETA: Comment addressed, no further comments

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

The project proposes to construct a 20' wide access driveway from Upper Union Street to the gate at the entrance to the array area. A hammerhead turn around will be provided in front of the gate. The driveway will have a 50' long paved apron at the entrance and be gravel the remainder of the way to the gate which will measure approximately 900'. The driveway will be located directly behind the existing residential lots on Ribero Drive and proceed east for approximately 600' until it turns northeast across the easement to the array. The driveway will follow an existing 20' wide right of way easement that extends from Upper Union Street to an existing gravel roadway in the easement.

The project does not propose a residential or nonresidential building; therefore, no parking is required. BETA anticipates that there is adequate space along at turnaround areas for maintenance vehicles to temporarily park without disrupting access.

- P1. BETA recommends the Applicant consult with the Town of Franklin Fire Department to determine required driveway width, grade, and alignment.

ADE: *The applicant has reviewed the driveway design with the Deputy Fire Chief Joseph Barbieri and has received a sign-off email (see attached).*

BETA: No further comments

- P2. Around the perimeter of the array, the grade will range from 12-20%. BETA recommends that the applicant coordinate with the Fire Department to confirm that the perimeter access is acceptable.

ADE: *The Deputy Fire Chief has indicated that he only requires access up to the break in panels in the middle of the array.*

BETA: BETA will defer this to the Fire Chief. No Further comments.

- P3. The proposed access gate is located at the end of a 900+ foot long driveway with little opportunity for turnaround until they reach the gate. BETA recommends providing another turnaround area near the proposed detention basin 450' in.

***ADE:** An additional turnaround area is provided on the revised site plans near the southwest detention basin.*

***BETA:** Turn around provided approximately 420' from the entrance. No further comments.*

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.

- I1. 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 property line and the lack of a vegetative buffer, the noise from the invertors will be heard within the setbacks noted in the bylaws. BETA recommends that the applicant provide a noise barrier design which will comply with this section of the bylaws.

***ADE:** Refer to the Noise Attenuation Analysis dated 11/10/2023 by Atlantic Design Engineers, which addresses noise impacts from the invertors and shows compliance with this section of the bylaws.*

***BETA:** The invertors have been moved and the noise levels at the residential zone line have been reduced but will remain perceptible. The abutters are greater than 400' from the source and should not be impacted by the noise. No further comments.*

EARTH REMOVAL REGULATIONS (§185-23)

The project includes significant disturbance which may result in earth removal greater than 15 cubic yards.

- E1. Indicate approximate earth removal volume to determine compliance with this section.

***ADE:** The limited amount of excavation required for the project will allow the excavated material to remain and be re-used as fill on the site. No earth removal is anticipated.*

***BETA:** BETA recommends that Construction Note 20 on Sheet 8 of 10 be expanded to note that no earth will be removed from the site.*

SIDEWALKS (§185-28) AND CURBING (§185-29)

No sidewalks are proposed under this project. As a solar facility, pedestrian access to the Site is not required. The project proposes to provide a 50' long paved apron in the proposed driveway entrance. A cape cod berm is proposed on the northerly edge of the driveway. BETA will defer to the Planning Board whether vertical granite or precast concrete curbing should be provided at the entrance.

ADE: *A Cape Cod berm at the short, paved apron at the entrance is sufficient to convey any stormwater from the paved area into the proposed catch basin and infiltration chamber. Curbing is not required.*

BETA: *BETA will defer to the Planning Board on this matter.*

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.

STORMWATER MANAGEMENT

The stormwater management design proposes two detention basins to capture stormwater runoff from the arrays and the gravel roadway. A catch basin is proposed at the entrance which will discharge to a subsurface infiltration trench beneath the driveway. Outfalls from this basin are proposed to convey captured stormwater runoff to the east. The remainder of the Site will generally follow pre-development flow patterns with no stormwater BMPs proposed.

- G1. The grading for the embankment that forms the detention basin at the northwest corner of the parcel is incorrect. The top width is shown incorrectly. Since the crest elevation is 405.5 with 3h:1v side slopes, the distance between the elevation 405 contours should be 9'. It is depicted on the plans as 4'.

ADE: *The basin berm has been regraded on the revised site plans and the basin detail has been revised to clarify the crest elevation.*

BETA: *The grading for the crest width has been corrected, however, the slope of the embankment at the down gradient edge of the basin has been increased to 2.5h:1v. Where this basin has been converted to an infiltration basin, BETA recommends that the slope be reduced to 3h:1v in accordance with Volume 2, Chapter 2 of the handbook.*

- G2. The grading for the embankment that forms the detention basin at the north of the entrance driveway 450' from Upper Union Street is also incorrect. The top width is shown incorrectly. Since the crest elevation is 459.5 with 3h:1v side slopes, the distance between the elevation 459 contours should be 9'. It is depicted on the plans as 5'.

ADE: *The basin berm has been regraded on the revised site plans and the basin detail has been revised to clarify the crest elevation.*

BETA: *The grading has been corrected, no further comments*

- G3. the nature of the flow onto the abutting parcel. Specifically, because of the proximity to the property line, the flow will not have the opportunity to replicate natural flow patterns. BETA recommends that the outfall be setback a sufficient distance for a natural flow pattern to develop or obtain an easement.

ADE: *The basin has been converted to an infiltration basin, based upon the favorable soil and groundwater conditions found in the test pits. The outlet pipe has been eliminated from the design. Therefore, any flow off the site will occur only under emergency overflow conditions. The toe of the basin has been shifted 20-feet away from the property line. A 50-foot long level*

spreader is provided at the base of the emergency spillway to replicate natural flow patterns in the unlikely event of an emergency overflow.

BETA: As noted, the basin will not discharge on to the abutting parcel except during a rainfall event greater than a 100-year frequency rainfall. Therefore, the issues with the discharge onto the abutting parcel are no longer an issue. However, because the basin serves both purposes of recharge and peak flow rate attenuation, a mounding analysis is required (Chapter 3, Volume 1)

STORMWATER MANAGEMENT REGULATIONS (CHAPTER 153)

The project proposes to 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. Provide test pit data in the area of the proposed basins to determine Estimated Seasonal High Groundwater levels (§153-15.A(9)).

ADE: Refer to the soil evaluated test pit logs provided in the Stormwater Addendum. These logs are also provided on the revised detail sheets and the test pit locations are shown on the revised site plans.

BETA: Test pits provided, no further comments.

SW2. Proposed seed mix for all disturbed areas should include native vegetation to the maximum extent practicable and should be specified on the plans. (BDPG Pg 6).

ADE: The seed mix for all disturbed areas is shown on the revised plans.

BETA: No further comments.

SUBDIVISION REGULATIONS - STORMWATER MANAGEMENT REGULATIONS (§300-11)

Additional requirements for stormwater management are outlined in §300-11 of the Town of Franklin Subdivision Regulations.

SW3. Provide the design elevations for the catch basin at the entrance including the piping from the proposed catch basin into the Cul-tec chamber system. This piping should be identified as reinforced concrete pipe as required by the subdivision standards. (§300-11.B(2.a)).

ADE: The rim, inverts, pipe sizes and slopes are provided on Sheet 6 of the revised site plans. The pipe has been identified as Class V RCP.

BETA: No further comments

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 two infiltration basins and a Cul-tec 100 HD Chamber system at the entrance.

SW4. The paved driveway section which flows toward Upper Union Street must be treated in accordance with the standards. Provide calculations that document compliance with the standards.

ADE: Refer to the Water Quality, Recharge and TSS removal calculations for the 1,137 SF asphalt area in the Miscellaneous Calculations section of the Drainage Addendum.

BETA: Since the infiltration rate qualifies as a higher rate, pretreatment must be 44% and should be documented.

SW5. Construction details for the proposed infiltration trench at the entrance should also be included on the plans including design elevations and layout dimensions.

BETA: There are no design elevations provided for the proposed Cul-tec system at the entrance. In addition, it appears that the system will be less than 4' above ESHGW and a mounding analysis will be required.

SW6. The runoff from the proposed equipment pad should be treated in accordance with the standards. Provide calculations which document that the treatment and pretreatment requirements for this impervious surface is being met.

ADE: Refer to the Water Quality and Recharge calculations for the 640 SF of equipment pad in the Miscellaneous Calculations section of the Stormwater Addendum. The equipment pad is subject to foot traffic only so TSS removal is not required.

BETA: In accordance with Volume 1, Chapter 1 of the handbook, the equipment pad is subject to the Maximum Extent Possible. The infiltration basin at the northwest corner of the site will certainly provide the treatment and recharge required for this small area. Document TSS Removal based upon all the measures provided.

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. The project proposes changes to site hydrology and ground cover which will impact stormwater flow to the analyzed design points. Stormwater runoff will be mitigated via the 2 proposed detention basins. Calculations indicate a decrease in peak discharge rates.

SW7. The CN values for the Woodbridge soils should be based upon HSG C conditions not HSG D.

ADE: The CN values have been revised in the Stormwater Addendum.

BETA: No further comments

SW8. In watershed 1S, the Tc for the proposed conditions is incorrectly reported greater than existing conditions. The slope on the final leg of the calculation for the existing conditions analysis is incorrect.

ADE: The Tc calculations for watershed 1S have been revised in the Stormwater Addendum.

BETA: BETA recommends that the designer review the Tc calculations since the Tc for proposed is greater than existing. In addition, the hydrograph should be routed through the cul-tec trench.

SW9. In watershed 4S, the Tc for the proposed conditions is incorrectly reported greater than existing conditions. The watershed where the Tc is calculated for proposed conditions is unchanged and therefore should be the same for existing conditions.

ADE: The Tc calculations for watershed 4S have been revised in the Stormwater Addendum.

BETA: No further comments.

SW10. The CN Values for the Hollis-Charlton-Rock Complex should be based upon HSG A conditions not HSG D. There are no conditions on site that would indicate that runoff characteristics associated with the soil conditions are this extreme. The 400 square feet of ledge outcrop reported by the surveyor is not sufficient to justify the assumed HSG condition.

ADE: The CN values have been revised in the Stormwater Addendum.

BETA: No further comments.

SW11. In the proposed conditions, the watershed delineation between areas 4S and 6A is incorrect. The grading shown around the equipment pads is not sufficient to completely modify the delineation. (See SW5 above)

ADE: The grading and watershed plans have been revised to clarify the watershed delineation at the equipment pad.

BETA: No further comments.

SW12. The Tc calculation for watershed 5S & 6S in the existing conditions are incorrect. The slopes for the sheet flow should be 0.02 for each watershed and should be corrected.

ADE: The Tc calculations for watershed 5S & 6S have been revised in the Stormwater Addendum.

BETA: No further comments.

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 of Charlton-Hollis -Rock outcrop complex, (fine sandy loam,) and Woodbridge fine sandy loam. The Charlton-Hollis-Outcrop complex is rated in Hydrologic Soil Group (HSG) A (high Infiltration potential), while the Woodbridge is rated HSG-C (low infiltration potential).

The project proposes new impervious surfaces on the site which must be treated in accordance with the requirements of the standards and the bylaw.

SW13. At the rear of the site, the soils are HSG A and the recharge volume should be 0.6" of runoff from the impervious surfaces. Correct the analysis.

ADE: The Recharge Calculations have been revised in the Stormwater Addendum.

BETA: No further comments.

SW14. In accordance with §153-16.A. of the bylaws, control of stormwater runoff must comply with §300-11,(3) which reads "Post-development conditions may not increase the peak rate and volume of stormwater flow, or increase the contaminant burden from stormwater flows." Provide the information needed to document compliance with this section of the bylaws.

ADE: *The Pre & Post-development volume comparisons have been added to the tables in the Stormwater Addendum.*

BETA: *No further comments.*

SW15. Provide a minimum of 2 test pits in the area of each of the proposed detention basins and the infiltration measures required for the proposed impervious surfaces to establish Estimated Seasonal High Groundwater.

ADE: *Refer to the soil evaluated test pit logs provided in the Stormwater Addendum. These logs are also provided on the revised detail sheets and the test pit locations are shown on the revised site plans.*

BETA: *No further comments.*

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.*

SW16. For a new development Site, meet one of the following criteria (§153-16.B(1))

- a. Retain the volume of runoff equivalent to, or greater than, 1.0 inch multiplied by the total post-construction impervious surface area on the Site; and/or
- b. Remove 90% of the average annual post-construction load of TSS and 60% of the average annual load of total phosphorus.

ADE: *Calculations are provided in the Miscellaneous Calculations section of the Stormwater Addendum that show that greater than 1" times the impervious areas on the site is being retained/infiltrated on the site.*

BETA: *Calculated water quality volumes do not include runoff from the roof areas on the adjacent residential lots which are tributary to the infiltration measures which should be included unless they qualify for LID Credits. It should also be noted that because of the higher infiltration rate, the required pretreatment for all the impervious surface runoff should be 44% and documented accordingly.*

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.*

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.*

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– not applicable.*

EROSION AND SEDIMENT CONTROLS (STANDARD NUMBER 8): *Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities. As the project*

proposes to disturb greater than one acre of land, it will be required to file a Notice of Intent with EPA and develop a Stormwater Pollution Prevention Plan (SWPPP). Erosion control measures are depicted on the plans include compost sock, silt fence, hay bales, inlet protection, stabilized construction entrance, dust control, erosion control blankets, filter bags for dewatering, and stockpile controls. A construction sequencing plan is included on Sheet C-608.

SW17. Provide expected date clearing will begin and estimate duration of exposure of cleared areas (§153-12.M).

ADE: See attached Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

BETA: No further comments.

SW18. Remove hay bales from the proposed erosion control plan (BDPG Pg. 11)

ADE: The hay bale detail has been removed from the revised site plans.

BETA: No further comments.

SW19. Provide construction scheduling plan (BDPG Pg. 11)

ADE: See attached Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

BETA: No further comments.

SW20. Provide dust control plan (BDPG Pg. 11)

ADE: Dust control notes are provided on Sheet 8 of the revised site plans.

BETA: No further comments.

SW21. Based upon the steep grades on site, BETA recommends that special conditions be identified for stabilization of disturbed areas prior to placement of the panels.

ADE: Additional interim rows of erosion control barriers are proposed within the array field, particularly in the steeper areas. In addition, erosion control notes have been added to limit the time of exposed soil prior to stabilization.

BETA: Additional rows added, no further comments.

SW22. Indicate if existing topsoil is to be retained and/or stockpiled and screened for re-use.

ADE: A note indicating that the existing topsoil is to be retained and/or stockpiled and screened for re-use is provided on the revised site plans.

BETA: No further comments.

SW23. The applicant is reminded that a Stormwater permit from the Franklin DPW is required based upon the size of the disturbance.

ADE: The Stormwater Permit request was included in the original Planning Board submittal.

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.

SW20. Provide owner's signature (§153-18.B(5)).

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

BETA: No further comments.

SW21. Indicate the stormwater system owner(s) for the stormwater management system following construction.

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

BETA: No further comments.

SW22. Indicate the party or parties responsible for maintenance.

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

BETA: No further comments.

SW23. Provide BMP location map.

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

BETA: No further comments.

SW24. Catch basins should be inspected four times a year. Change schedule noted in plan.

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum and the note on the site plans has been revised accordingly as well.

BETA: No further comments.

SW25. Based upon the grades on site, BETA recommends that regular inspection and maintenance of drip edges to mitigate creation of rills and gullies be added to the O & M Plan.

ADE: The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

BETA: No further comments.

ILLICIT DISCHARGES (STANDARD NUMBER 10): *All illicit discharges to the stormwater management system are prohibited. An Illicit Discharge Compliance Statement was provided with the submission.*

SW26. Provide signature of owner on the illicit discharge compliance statement.

ADE: The Applicant's signature is provided in the illicit discharge statement in the revised Post-Construction Long Term O & M Plan.

BETA: No further comments.

Mr. Gregory Rondeau, Chairman

November 29, 2023

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WETLANDS PROTECTION

The Project proposes work within Areas Subject to Protection and Jurisdiction of the Franklin Conservation Commission, including the 100-foot Buffer Zones to a vegetated wetland. Work within these areas includes portions of the solar array, fencing, gravel access drives, grading, tree clearing, and equipment pad. Therefore, the Applicant is required to submit an NOI to the Town of Franklin Conservation Commission and must obtain an Order of Conditions to complete the proposed work.

If we can be of any further assistance regarding this matter, please contact us at our office.

Very truly yours,

BETA Group, Inc.



Gary D. James, P.E.

Senior Project Engineer

cc: Amy Love, Town Planner



TOWN OF FRANKLIN

DEPARTMENT OF PUBLIC WORKS

Franklin Municipal Building
257 Fisher Street
Franklin, MA 02038-3026

November 28, 2023

Mr. Greg Rondeau, Chairman
Members of the Franklin Planning Board
355 East Central Street
Franklin, MA 02038

RE: Site Plan – Upper Union Solar Project

Dear Mr. Chairman and Members:

We have reviewed the revised materials for the subject project and our previous comments have been addressed.

Should you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,

Michael Maglio, P.E.
Town Engineer

Town of Franklin

355 East Central Street
Franklin, Massachusetts 02038-1352



Phone: (508) 520-4907
www.franklinma.gov

DEPARTMENT OF PLANNING AND COMMUNITY DEVELOPMENT

DATE: November 29, 2023
TO: Franklin Planning Board
FROM: Department of Planning and Community Development
RE: Upper Union St Solar
Site Plan

The DPCD has reviewed the above referenced Site Plan Modification application for the Monday, December 4, 2023 Planning Board meeting and offers the following commentary:

General:

1. The site is on Upper Union Street, and located in the Industrial Zoning District.
2. The proposed project includes the construction solar panels, along with drainage.
3. The Applicant has filed a NOI with the Conservation Commission.
4. Review letters will be provided from BETA, DPW and Fire.

Comments:

1. Per section §185-31.C(3)(i) – provide outdoor lighting, open space areas, snow storage and parking areas.
2. Per section §185-31.C(3)(j) – provide location, size and sketch of all proposed signs.
3. Per section §185-31.C(3)(k) – provide a complete landscaping plans, including existing vegetation and proposed plantings.
4. Per section §185-31.C(3)(l) – provide a photometric plan.
5. Applicant is proposing cape cod berm along the roadway.

Comments from August 7, 2023:

1. Provide screening around the transformer to block noise
2. Provide additional plantings throughout the site, along with a landscaping plan
3. Provide a decommissioning bond and replanting schedule



RECEIVED

NOV 17 2023

PLANNING DEPT.

November 10, 2023

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

RE: *Response to BETA Site Plan Peer Review Comments, August 3, 2023*
Upper Union Solar Project – Franklin, MA
ADE Job #3328.00

Dear Mr. Rondeau:

This response letter addresses the comments made in the BETA Site Plan Peer Review Letter dated August 3, 2023, for above-referenced project. Please note the peer review comments are italicized, and our responses follow in bold text:

GENERAL

G1. The existing grade across the proposed panel array area ranges from 10-20%. The array area as proposed will cover 2.29± acres, with runoff travel paths exceeding 300' across the disturbance area. BETA recommends that interim erosion control measures be implemented to reduce the travel paths to less than 200'.

An additional interim row of erosion control barriers are proposed within the array field on the revised site plans.

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 necessary



Mr. Gregory Rondeau, Chairman
Franklin Planning Board
Response to BETA Site Plan Peer Review Comments, August 3, 2023
Upper Union Solar Project – Franklin, MA (ADE Project #3328.00)
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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 5 of 9, the Site meets the requirements for lot area, depth, frontage, building height, and impervious area coverage. The lot width does not conform, however as noted in the bylaws, any lot created prior to May 20, 1998, is exempt from the current definition. The design engineer has indicated that the lot was created in 1995 prior to the bylaw and is therefor grandfathered.

S.1 BETA recommends that a copy of the recorded plan be submitted to confirm the grandfather status of the lot regarding lot width.

A copy of the recorded plan #624 of 1995 is enclosed.

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

The project proposes to construct a 20' wide access driveway from Upper Union Street to the gate at the entrance to the array area. A hammerhead turn around will be provided in front of the gate. The driveway will have a 50' long paved apron at the entrance and be gravel the remainder of the way to the gate which will measure approximately 900'. The driveway will be located directly behind the existing residential lots on Ribero Drive and proceed east for approximately 600' until it turns northeast across the easement to the array. The driveway will follow an existing 20' wide right of way easement that extends from Upper Union Street to an existing gravel roadway in the easement.

The project does not propose a residential or nonresidential building; therefore, no parking is required. BETA anticipates that there is adequate space along at turnaround areas for maintenance vehicles to temporarily park without disrupting access.

P1. BETA recommends the Applicant consult with the Town of Franklin Fire Department to determine required driveway width, grade, and alignment.

The applicant has reviewed the driveway design with the Deputy Fire Chief Joseph Barbieri and has received a sign-off email (see attached).



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Franklin Planning Board
Response to BETA Site Plan Peer Review Comments, August 3, 2023
Upper Union Solar Project – Franklin, MA (ADE Project #3328.00)
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P2. *Around the perimeter of the array, the grade will range from 12-20%. BETA recommends that the applicant coordinate with the Fire Department to confirm that the perimeter access is acceptable.*

The Deputy Fire Chief has indicated that he only requires access up to the break in panels in the middle of the array.

P3. *The proposed access gate is located at the end of a 900+ foot long driveway with little opportunity for turnaround until they reach the gate. BETA recommends providing another turnaround area near the proposed detention basin 450' in.*

An additional turnaround area is provided on the revised site plans near the southwest detention basin.

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 property line and the lack of a vegetative buffer, the noise from the invertors will be heard within the setbacks noted in the bylaws. BETA recommends that the applicant provide a noise barrier design which will comply with this section of the bylaws.

Refer to the Noise Attenuation Analysis dated 11/10/2023 by Atlantic Design Engineers, which addresses noise impacts from the invertors and shows compliance with this section of the bylaws.



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EARTH REMOVAL REGULATIONS (§185-23)

The project includes significant disturbance which may result in earth removal greater than 15 cubic yards.

E1. Indicate approximate earth removal volume to determine compliance with this section.

The limited amount of excavation required for the project will allow the excavated material to remain and be re-used as fill on the site. No earth removal is anticipated.

SIDEWALKS (§185-28) AND CURBING (§185-29)

No sidewalks are proposed under this project. As a solar facility, pedestrian access to the Site is not required. The project proposes to provide a 50' long paved apron in the proposed driveway entrance. A cape cod berm is proposed on the northerly edge of the driveway. BETA will defer to the Planning Board whether vertical granite or precast concrete curbing should be provided at the entrance.

A Cape Cod berm at the short, paved apron at the entrance is sufficient to convey any stormwater from the paved area into the proposed catch basin and infiltration chamber. Curbing is not required.

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 attached Fire Department email signoff.

STORMWATER MANAGEMENT

The stormwater management design proposes two detention basins to capture stormwater runoff from the arrays and the gravel roadway. A catch basin is proposed at the entrance which will discharge to a subsurface infiltration trench beneath the driveway. Outfalls from this basin are proposed to convey captured stormwater runoff to the east. The remainder of the Site will generally follow pre-development flow patterns with no stormwater BMPs proposed.



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Franklin Planning Board
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- G1. *The grading for the embankment that forms the detention basin at the northwest corner of the parcel is incorrect. The top width is shown incorrectly. Since the crest elevation is 405.5 with 3h:1v side slopes, the distance between the elevation 405 contours should be 9'. It is depicted on the plans as 4'.*

The basin berm has been regraded on the revised site plans and the basin detail has been revised to clarify the crest elevation.

- G2. *The grading for the embankment that forms the detention basin at the north of the entrance driveway 450' from Upper Union Street is also incorrect. The top width is shown incorrectly. Since the crest elevation is 459.5 with 3h:1v side slopes, the distance between the elevation 459 contours should be 9'. It is depicted on the plans as 5'.*

The basin berm has been regraded on the revised site plans and the basin detail has been revised to clarify the crest elevation.

- G3. *The discharge point from the northeast detention basin will change the nature of the flow onto the abutting parcel. Specifically, because of the proximity to the property line, the flow will not have the opportunity to replicate natural flow patterns. BETA recommends that the outfall be setback a sufficient distance for a natural flow pattern to develop or obtain an easement.*

The basin has been converted to an infiltration basin, based upon the favorable soil and groundwater conditions found in the test pits. The outlet pipe has been eliminated from the design. Therefore any flow off the site will occur only under emergency overflow conditions. The toe of the basin has been shifted 20-feet away from the property line. A 50-foot long level spreader is provided at the base of the emergency spillway to replicate natural flow patterns in the unlikely event of an emergency overflow.

STORMWATER MANAGEMENT REGULATIONS (CHAPTER 153)

The project proposes to 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.



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Response to BETA Site Plan Peer Review Comments, August 3, 2023
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SW1. Provide test pit data in the area of the proposed basins to determine Estimated Seasonal High Groundwater levels (§153-15.A(9)).

Refer to the soil evaluated test pit logs provided in the Stormwater Addendum. These logs are also provided on the revised detail sheets and the test pit locations are shown on the revised site plans.

SW2. Proposed seed mix for all disturbed areas should include native vegetation to the maximum extent practicable and should be specified on the plans. (BDPG Pg 6).

The seed mix for all disturbed areas is shown on the revised plans.

SUBDIVISION REGULATIONS - STORMWATER MANAGEMENT REGULATIONS (§300-11)

Additional requirements for stormwater management are outlined in §300-11 of the Town of Franklin Subdivision Regulations.

SW3. Provide the design elevations for the catch basin at the entrance including the piping from the proposed catch basin into the Cul-tec chamber system. This piping should be identified as reinforced concrete pipe as required by the subdivision standards. (§300-11.B(2.a)).

The rim, inverts, pipe sizes and slopes are provided on Sheet 6 of the revised site plans. The pipe has been identified as Class V RCP.

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 two detention basins.

SW4. The paved driveway section which flows toward Upper Union Street must be treated in accordance with the standards. Provide calculations that document compliance with the standards.

Refer to the Water Quality, Recharge and TSS removal calculations for the 1,137 SF asphalt area in the Miscellaneous Calculations section of the Drainage Addendum.



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- SW5. *Construction details for the proposed infiltration trench at the entrance should also be included on the plans including design elevations and layout dimensions.*
- SW6. *The runoff from the proposed equipment pad should be treated in accordance with the standards. Provide calculations which document that the treatment and pretreatment requirements for this impervious surface is being met.*

Refer to the Water Quality and Recharge calculations for the 640 SF of equipment pad in the Miscellaneous Calculations section of the Stormwater Addendum. The equipment pad is subject to foot traffic only so TSS removal is not required.

*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. The project proposes changes to site hydrology and ground cover which will impact stormwater flow to the analyzed design points. Stormwater runoff will be mitigated via the 2 proposed detention basins. Calculations indicate a decrease in peak discharge rates.*

- SW7. *The CN values for the Woodbridge soils should be based upon HSG C conditions not HSG D.*

The CN values have been revised in the Stormwater Addendum.

- SW8. *In watershed 1S, the Tc for the proposed conditions is incorrectly reported greater than existing conditions. The slope on the final leg of the calculation for the existing conditions analysis is incorrect.*

The Tc calculations for watershed 1S have been revised in the Stormwater Addendum.

- SW9. *In watershed 4S, the Tc for the proposed conditions is incorrectly reported greater than existing conditions. The watershed where the Tc is calculated for proposed conditions is unchanged and therefore should be the same for existing conditions.*

The Tc calculations for watershed 4S have been revised in the Stormwater Addendum.

- SW10. *The CN Values for the Hollis-Charlton-Rock Complex should be based upon HSG A conditions not HSG D. There are no conditions on site that would indicate that runoff characteristics associated with the soil conditions are this extreme. The 400 square feet*



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of ledge outcrop reported by the surveyor is not sufficient to justify the assumed HSG condition.

The CN values have been revised in the Stormwater Addendum.

SW11. In the proposed conditions, the watershed delineation between areas 4S and 6A is incorrect. The grading shown around the equipment pads is not sufficient to completely modify the delineation. (See SW5 above)

The grading and watershed plans have been revised to clarify the watershed delineation at the equipment pad.

SW12. The Tc calculation for watershed 5S & 6S in the existing conditions are incorrect. The slopes for the sheet flow should be 0.02 for each watershed and should be corrected.

The Tc calculations for watershed 5S and 6S have been revised in the Stormwater Addendum.

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 of Charlton-Hollis -Rock outcrop complex, (fine sandy loam,) and Woodbridge fine sandy loam. The Charlton-Hollis-Outcrop complex is rated in Hydrologic Soil Group (HSG) A (high Infiltration potential), while the Woodbridge is rated HSG-C (low infiltration potential).

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

Refer to the soil evaluated test pit logs provided in the Stormwater Addendum. These logs are also provided on the revised detail sheets and the test pit locations are shown on the revised site plans.

The project proposes new impervious surfaces on the site which must be treated in accordance with the requirements of the standards and the bylaw.

SW13. At the rear of the site, the soils are HSG A and the recharge volume should be 0.6" of runoff from the impervious surfaces. Correct the analysis.

The Recharge Calculations have been revised in the Stormwater Addendum.



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SW14. *In accordance with §153-16.A. of the bylaws, control of stormwater runoff must comply with §300-11,(3) which reads “Post-development conditions may not increase the peak rate and volume of stormwater flow, or increase the contaminant burden from stormwater flows.” Provide the information needed to document compliance with this section of the bylaws.*

The pre and post-development volume comparisons have been added to the tables in the Stormwater Addendum.

SW15. *Provide a minimum of 2 test pits in the area of each of the proposed detention basins and the infiltration measures required for the proposed impervious surfaces to establish Estimated Seasonal High Groundwater.*

Refer to the soil evaluated test pit logs provided in the Stormwater Addendum. These logs are also provided on the revised detail sheets and the test pit locations are shown on the revised site plans.

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.

SW16. *For a new development Site, meet one of the following criteria (§153-16.B(1))*

- a. *Retain the volume of runoff equivalent to, or greater than, 1.0 inch multiplied by the total post-construction impervious surface area on the Site; and/or*
- b. *Remove 90% of the average annual post-construction load of TSS and 60% of the average annual load of total phosphorus.*

Calculations are provided in the Miscellaneous Calculations section of the Stormwater Addendum that show that greater than 1” times the impervious areas on the site is being retained/infiltrated on the site.

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 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 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– not applicable.

No response necessary

EROSION AND SEDIMENT CONTROLS (STANDARD NUMBER 8): Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities. As the project proposes to disturb greater than one acre of land, it will be required to file a Notice of Intent with EPA and develop a Stormwater Pollution Prevention Plan (SWPPP). Erosion control measures are depicted on the plans include compost sock, silt fence, hay bales, inlet protection, stabilized construction entrance, dust control, erosion control blankets, filter bags for dewatering, and stockpile controls. A construction sequencing plan is included on Sheet C-608.

SW17. Provide expected date clearing will begin and estimate duration of exposure of cleared areas (§153-12.M).

See attached Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

SW18. Remove hay bales from the proposed erosion control plan (BDPG Pg. 11)

The hay bale detail has been removed from the revised site plans.

SW19. Provide construction scheduling plan (BDPG Pg. 11)

See attached Construction Sequence and Schedule by Atlantic Design Engineers, Inc. dated 11/10/2023.

SW20. Provide dust control plan (BDPG Pg. 11)

Dust control notes are provided on Sheet 8 of the revised site plans.



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SW21. *Based upon the steep grades on site, BETA recommends that special conditions be identified for stabilization of disturbed areas prior to placement of the panels.*

Additional interim rows of erosion control barriers are proposed within the array field, particularly in the steeper areas. In addition, erosion control notes have been added to limit the time of exposed soil prior to stabilization.

SW22. *Indicate if existing topsoil is to be retained and/or stockpiled and screened for re-use.*

A note indicating that the existing topsoil is to be retained and/or stockpiled and screened for re-use is provided on the revised site plans.

SW23. *The applicant is reminded that a Stormwater permit from the Franklin DPW is required based upon the size of the disturbance.*

The Stormwater Permit request was included in the original Planning Board submittal.

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.

SW20. *Provide owner's signature (§153-18.B(5)).*

The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

SW21. *Indicate the stormwater system owner(s) for the stormwater management system following construction.*

The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

SW22. *Indicate the party or parties responsible for maintenance. SW23. Provide BMP location map.*

The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.



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Franklin Planning Board
Response to BETA Site Plan Peer Review Comments, August 3, 2023
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SW24. *Catch basins should be inspected four times a year. Change schedule noted in plan.*

The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum and the note on the site plans has been revised accordingly as well.

SW25. *Based upon the grades on site, BETA recommends that regular inspection and maintenance of drip edges to mitigate creation of rills and gullies be added to the O & M Plan.*

The Post-Construction Long Term Stormwater O&M Plan has been revised accordingly in the Stormwater Addendum.

ILLICIT DISCHARGES (STANDARD NUMBER 10): All illicit discharges to the stormwater management system are prohibited. An Illicit Discharge Compliance Statement was provided with the submission.

SW26. *Provide signature of owner on the illicit discharge compliance statement.*

The applicant's signature is provided in the illicit discharge statement in the revised Post-Construction Long Term O&M Plan.

WETLANDS PROTECTION

The Project proposes work within Areas Subject to Protection and Jurisdiction of the Franklin Conservation Commission, including the 100-foot Buffer Zones to a vegetated wetland. Work within these areas includes portions of the solar array, fencing, gravel access drives, grading, tree clearing, and equipment pad. Therefore, the Applicant is required to submit an NOI to the Town of Franklin Conservation Commission and must obtain an Order of Conditions to complete the proposed work.

Acknowledged. A Notice of Intent was filed concurrently with the Conservation Commission. Public hearings are underway.



*Mr. Gregory Rondeau, Chairman
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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'.

Richard J. Tabaczynski, P.E.
Vice President

CC: VS Union Solar Smart, LLC



November 10, 2023

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

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PLANNING DEPT.

RE: *Response to Town Engineer's Site Plan Comments, August 7, 2023*
Upper Union Solar Project – Franklin, MA
ADE Job #3328.00

Dear Mr. Rondeau:

This response letter addresses the comments made in the Town Engineer's Site Plan Letter dated August 7, 2023 for above-referenced project. Please note the Town Engineer's comments are italicized, and our responses follow in bold text:

1. *Applications that will need to be filed with the Franklin Department of Public Works may include, but are not necessarily limited to a Right-of-Way Excavation Permit, a Public Way Access Permit, a Trench Permit, and a Soil Erosion and Sediment Control Plan Permit.*

Acknowledged. The contractor or applicant will be applying for these permits, as applicable, upon commencement of construction.

2. *A separate Scenic Road permit from the Planning Board may also be required.*

A Scenic Road permit has been approved. See attached.

3. *In addition to not increasing the peak rate of stormwater runoff from the site, the proposal must also not increase the peak volume of runoff from a site. The applicant should include a table in the stormwater report comparing the pre- vs. post- runoff volumes to go along with the comparison of runoff flow rates.*

The tables have been revised in the Stormwater Addendum to include a comparison of pre- vs. post-development volumes.

4. *There is a proposed grassed swale along the gravel access road with proposed hay bale check dams. We're concerned with the ability of the hay bales to function as designed over the long term.*

The hay bale check dams have been replaced with stone check dams, and the detail has been revised accordingly.

P.O. Box 1051
Sandwich, MA 02563
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email: ade@atlanticcompanies.com
www.atlanticcompanies.com



Mr. Gregory Rondeau, Chairman
Franklin Planning Board

Response to Town Engineer's Site Plan Peer Review Comments, August 7, 2023
Upper Union Solar Project – Franklin, MA (ADE Project #3328.00)
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5. *A section of the gravel access road is designed at over 9% slope. This section is directly upstream of the wetland resource areas and is expected to be susceptible to erosion.*

This section of gravel access road has been regraded to be $\pm 7\%$ maximum.

6. *Stormwater discharge at the rear of the site is through an 8" HDPE pipe and a 10 foot wide spillway, both of which are adjacent to the property line. During the 100-year storm event, the discharges from these two outfalls are 3 cfs and 4 cfs respectively. The 8" discharge pipe is also designed to have an outflow at all design storms. Our concern is that although the adjacent property is wooded in this area, there is potential for erosion and damage due to excessive flows.*

The basin has been converted to an infiltration basin, based upon the favorable soil and groundwater conditions found in the test pits. The outlet pipe has been eliminated from the design. Therefore any flow off the site will occur only under emergency overflow conditions. The toe of the basin has been shifted 20-feet away from the property line. A 50-foot long level spreader is provided at the base of the emergency spillway to replicate natural flow patterns in the unlikely event of an emergency overflow.


7. *The stormwater model does not appear to coincide with the details shown on the drawings, regarding the Cultec chambers and outfall pipe.*

The Cultec chambers are provided at the site entrance only for water quality and recharge purposes in order to comply with the water quality requirements of the Town's Stormwater Management Bylaw. They are not required to meet pre- vs. post-development runoff or volume rates so they are not included in the Hydrocad Analysis. Sizing, water quality and recharge calculations for the Cultec chambers are provided only in the Miscellaneous Calculations section of the Drainage Report.

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

Sincerely,

ATLANTIC DESIGN ENGINEERS, INC.


Richard J. Tabaczynski, P.E.
Vice President

CC: VS Union Solar Smart, LLC



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PLANNING DEPT.

November 10, 2023

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

RE: *Response to Planning Board's Site Plan Comments, August 2, 2023*
Upper Union Solar Project – Franklin, MA
ADE Job #3328.00

Dear Mr. Rondeau:

This response letter addresses the comments made in the Planning Board's Site Plan Memo dated August 2, 2023 for above-referenced project. Please note the Planning Board's comments are italicized, and our responses follow in bold text:

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

No lighting is proposed. A waiver is requested.

2. *Per section §185-31.C(3)(j) – provide location, size and sketch of all proposed signs.*

The revised site plans show locations and details of proposed signs.

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

No landscaping is proposed. A waiver is requested. Mitigation and wetland replication planting plans by Goddard Associates have been provided separately to the Conservation Commission.

4. *Per section §185-31.C(3)(l) – provide a photometric plan.*

No lighting is proposed. A waiver is requested.



*Mr. Gregory Rondeau, Chairman
Franklin Planning Board
Response to Town Engineer's Site Plan Comments, August 2, 2023
Upper Union Solar Project – Franklin, MA (ADE Project #3328.00)
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5. *Applicant is proposing cape cod berm along the roadway.*

A Cape Cod berm at the short, paved apron at the entrance is sufficient to convey any stormwater from the paved area into the proposed catch basin and infiltration chamber. In addition, the plans have been clarified that this is a private driveway only, not a “roadway”. Curbing is not required.

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', is written over the typed name.

Richard J. Tabaczynski, P.E.
Vice President

CC: VS Union Solar Smart, LLC



November 10, 2023

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

**RE: *Waiver Request List from Site Plan and Design Review Bylaw
Site Plan Approval Submittal
Upper Union Solar Project
0 Upper Union Street – Franklin, MA (Parcel ID 319-009-000-000)***

Dear Board Members:

We respectfully request on behalf of the applicant, VS Union Solar Smart, LLC, 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.*
2. *Section §185-31.C(3)(k) – provide a complete landscaping plans, including existing vegetation and proposed plantings.*
3. *Section §185-31.C(3)(l) – provide a photometric plan.*

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



CONSTRUCTION SEQUENCE & SCHEDULE

**Upper Union Solar Project
Franklin, Massachusetts
November 10, 2023
ADE Job #3328.00**

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PLANNING DEPT.

Construction Overview & Schedule

Construction activities at the Site are expected to take approximately four (4) to six (6) months and will commence approximately four (4) months after receipt of necessary permits and approvals.

Construction of the solar project will not be initiated until erosion controls are in place. Construction activities shall adhere to any design/management plans as well as conditions set forth in the following documents:

- Stormwater and Operation & Maintenance Plan
- Stormwater Pollution Prevention Plan (SWPPP) per current EPA Construction General Permit
- Approval Conditions set by the Planning Board
- Order of Conditions from the Conservation Commission
- Any other documents or design plans pertaining to local, state or federal approvals

Construction Sequence

In conjunction with any sequence to be provided within a Stormwater Pollution Prevention Plan (SWPPP), the following general sequence of construction for the site work is as follows:

- 1) Stake limit of work/clearing to define the limit of work for the access roads, solar field, underground utility lines, and stormwater facilities.
- 2) Notify Dig-Safe to demarcate all underground utilities prior to the start of construction.
- 3) Install erosion control barriers at down gradient limits of work as shown on the site plans.
- 4) Begin clearing and chipping of vegetation. A temporary access road will be cleared/installed to access proposed basin locations. Clearing will be limited to a manageable acreage while temporary sediment basins are installed to prevent siltation of permanent stormwater basins.



- 5) Stockpile wood chips as needed in piles for further use in erosion control and soil stabilization.
- 6) At the end of each day of clearing operations, walk site perimeter to repair any damaged erosion controls or perform any necessary maintenance.
- 7) At the end of each day, inspect all temporary stormwater facilities and repair any damage and perform any necessary maintenance.
- 8) Install Construction Entrance pad and subsurface drainage system as shown on the site plans. Maintain silt sac in catch basin to prevent siltation of the underground chamber during construction.
- 9) Complete final grading of stormwater swales, wetland replication areas and stormwater basins.
- 10) Install check dams and rip-rap aprons/spillways.
- 11) Stabilize all stormwater facilities and slopes with loam and seed and erosion control measures as required.
- 12) Install and compact gravel access road and interior site access roads.
- 13) Prepare contractor staging/laydown area for temporary parking, storage, wheel wash area, concrete wash-out, and mobile fueling areas.
- 14) Stumps are to be ground where necessary and used for wood chip berms.
- 15) Grading activities should be avoided during extremely wet conditions to minimize soil compaction, deep rutting, and soil smearing.
- 16) If necessary, provide temporary protective measures, which may include barriers and/or silt sacks until site is stabilized and vegetated. Intermediate erosion controls should be installed prior to the installation of the solar array racking system.
- 17) Use disks, tillers, or harrows to break up the surface where soil has become compacted during construction activities in order to create viable seed beds.
- 18) Initiate the installation of stabilization measures immediately in any areas of exposed soil more than five acres where construction activities have permanently ceased or will be temporarily inactive for 14 or more calendar days. Complete the installation of measures as soon as practicable, but no later than (7) calendar days after stabilization has been initiated. Oats will be used for a spring or summer seeding, winter wheat for a fall seeding. This cover crop will establish quickly, providing additional erosion control throughout construction, along with protection of final native vegetation during its establishment period.



- 19) Work involving foundation pile driving and trenching shall be staged to concentrate work in phases, to reduce site disturbance. Seed and mulch any disturbed areas as they are completed.
- 20) Once site construction is complete, permanent seeding will be applied by broadcasting.
- 21) To assure rapid stabilization, supplement seeding for areas where coverage is less than 70% uniform cover of vegetation.
- 22) Unless directed otherwise by the Franklin Conservation Commission, once the site is permanently stabilized at 70% uniform cover of vegetation or more, remove all temporary erosion and sediment control devices.
- 23) Stake out pier location for racking system driven piers.
- 24) Install underground utilities (electric) in the area of the solar field and equipment pads leading to the first customer owned pole location.
- 25) Install solar field array and electrical facilities on site including above-ground utility poles and wiring.
- 26) Complete paving and berm at entrance to site.
- 27) Stabilize all disturbed areas with loam and seed.
- 28) Install plantings for wetland replication and mitigation areas as required per the Goddard Consulting Inc. Wetland Replication Plan and Habitat Restoration Plan.
- 29) After completion of construction the site will be inspected for any remaining debris and, if found, will be cleaned and disposed of off-site.
- 30) Install perimeter fencing, signs, and gates.



November 10, 2023

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

***RE: Waiver Request List from Site Plan and Design Review Bylaw
Site Plan Approval Submittal
Upper Union Solar Project
0 Upper Union Street – Franklin, MA (Parcel ID 319-009-000-000)***

Dear Board Members:

We respectfully request on behalf of the applicant, VS Union Solar Smart, LLC, 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.*
- 2. Section §185-31.C(3)(k) – provide a complete landscaping plans, including existing vegetation and proposed plantings.*
- 3. Section §185-31.C(3)(l) – provide a photometric plan.*

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



November 10, 2023

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

Re: *Noise Attenuation Analysis*
 Upper Union Solar Project – Franklin MA
 ADE Project #3328.00

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 VS Union Smart, LLC (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 ground mounted solar photovoltaic installation off Upper Union Street 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 009 (the Site). The Site is ±6.21-acres and is located within in the Industrial Zoning District and abuts the Residential I zoning district to the south and east.

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 Upper Union Solar 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 Upper Union Solar project proposes to use approximately two (2) pad mounted SolarEdge SE120KUS central three phase inverters. According to the specification data sheet provided by SolarEdge the average sound emitted by the SE120KUS inverter is ±67 dBA at an assumed distance of 1-foot from the equipment. The Applicant indicated the average sound emitted by the transformer was ±56 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 when compared to the sound produced by the transformer (56 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:

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

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 directly West of the equipment pad where the inverters will be located. The impact from the sound levels were also measured at two of the nearest residential abutter’s property lines adhering to the 100-foot buffer from Section 185-22 *Industrial District performance controls* in the Town of Franklin’s Bylaws. This means that the noise measurement was taken 100 feet from the property boundary into the residential zone.

The input parameters for *Equation 1.0* utilizing the closest property boundary located to the West of the equipment pad and proposed SolarEdge SE120KUS inverter noise ratings, are as follows: (L_1) 70 dBA, (r_1) 1-foot, and (r_2) 65 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{65} \right| && \text{Eq. 1.1} \\ L_2 &= 70 - |20 \times -1.8| \\ L_2 &= 70 - |-36| \\ L_2 &= 70 - 36 \\ L_2 &\cong 34 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L_2) from the Equipment Pad at the nearest property boundary generated by the SE120KUS inverter is estimated to be 34 dBA during operation (i.e. daytime hours). For comparison, the typical refrigerator produces a sound level of 40 dBA while in operation and 20 dBA is a silent study room.

The input parameters for *Equation 1.0* utilizing the closest residential property to the South of the equipment pad distance including the 100-foot buffer and proposed SolarEdge SE120KUS inverter, are as follows: (L_1) 70 dBA, (r_1) 1-foot, and (r_2) 352 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{352} \right| && \text{Eq. 1.2} \\ L_2 &= 70 - |20 \times -2.5| \\ L_2 &= 70 - |-50| \\ L_2 &= 70 - 50 \\ L_2 &\cong 20 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L_2) from the Equipment Pad at the nearest residential property boundary located South of the equipment pad generated by the SE120KUS inverter is estimated to be 20 dBA during operation (i.e. daytime hours).



The input parameters for *Equation 1.0* utilizing the closest residential property to the East of the equipment pad distance including the 100-foot buffer and proposed SolarEdge SE120KUS inverter, are as follows: (L_1) 70 dBA, (r_1) 1-foot, and (r_2) 219 feet. The equation result is:

$$\begin{aligned} L_2 &= 70 - \left| 20 \times \log \frac{1}{219} \right| && \text{Eq. 1.3} \\ L_2 &= 70 - |20 \times -2.3| \\ L_2 &= 70 - |-46| \\ L_2 &= 70 - 46 \\ L_2 &\cong 24 \text{ dBA} \end{aligned}$$

Per the above calculation, the noise level (L_2) from the Equipment Pad at the nearest residential property boundary located East of the equipment pad generated by the SE120KUS inverter is estimated to be 24 dBA during operation (i.e. daytime hours).

As previously mentioned, 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 per Section 185-22 in the Town of Franklin’s Bylaws.

As shown in *Equation 1.1*, *Equation 1.2*, and *Equation 1.3* above, the sound level generated by the project at the closest property boundary (34 dBA) and the sound level generated at the nearest residential property boundaries including the 100-foot buffer (20 dBA & 24 dBA) are at a permissible levels, and abide by the Town of Franklin’s Industrial District Performance Controls Bylaw (Section 185-22). Please note that per the EPA Protective Noise Levels Condensed Version of EPA Levels Document dated November 1978, the outdoor day-night average sound level for rural residential/wooded residential ranges approximately between 39 and 51 dB (See **Exhibit B**).



*Noise Attenuation Analysis
VS Union Smart, LLC
Upper Union Solar Project – Franklin, MA
ADE Project #3328.00
November 10, 2023– Page 5*

In practice, the noise generated by the SE120KUS inverter will often be deflected by 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 Upper Union Solar project will be negligible at abutting residential properties and, in our opinion, will have no negative noise impact at the abutting residential properties.

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

Very truly yours,

Sincerely,
ATLANTIC DESIGN ENGINEERS, INC.

A handwritten signature in blue ink that reads 'Simon B. Thomas'.

Simon B. Thomas, P.E.
President

cc: Valta Energy

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	+/-0.2 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		Aac
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	EC 2014, 2017 and 2020, 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				
DC SAFETY SWITCH					
DC Disconnect	Built-in				
STANDARD COMPLIANCE					
Safety	UL1699B, UL1741, UL1741 SA, UL1741 SB, UL1998, CSA C22.2#107.1, Canadian AFCI according to T.I.L. M-07				
Grid Connection Standards	IEEE 1547-2018, Rule 21, Rule 14 (HI)				
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 [Resource Library](#) to download the relevant product datasheet.

/ 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	8 / 4 pairs; 6-12 AWG	12 / 4 pairs; 6-12 AWG		
	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			

(4) For power de-rating information refer to the [Temperature De-rating - Technical Note \(North America\)](#).

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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Cautionary Note Regarding Market Data and Industry Forecasts: This brochure may contain market data and industry forecasts from certain third-party sources. This information is based on industry surveys and the preparer's expertise in the industry and there can be no assurance that any such market data is accurate or that any such industry forecasts will be achieved. Although we have not independently verified the accuracy of such market data and industry forecasts, we believe that the market data is reliable and that the industry forecasts are reasonable.



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	Available in Δ or Y configuration
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

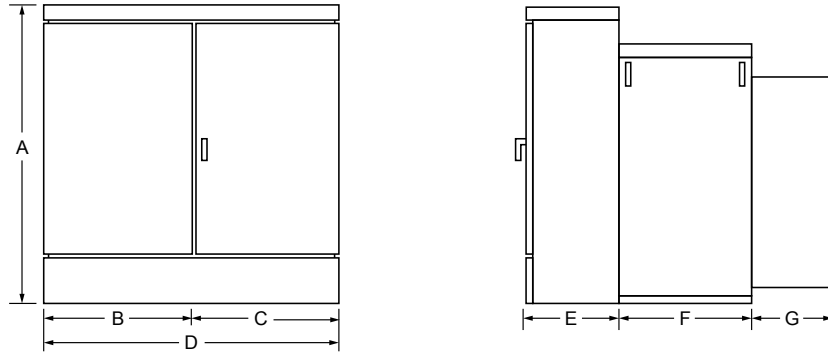


Table 2. Approximate Transformer Dimensions

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

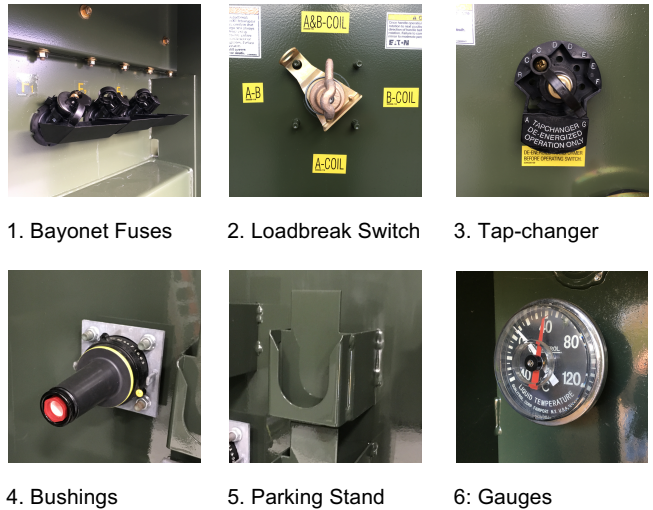


EXHIBIT B

*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}).

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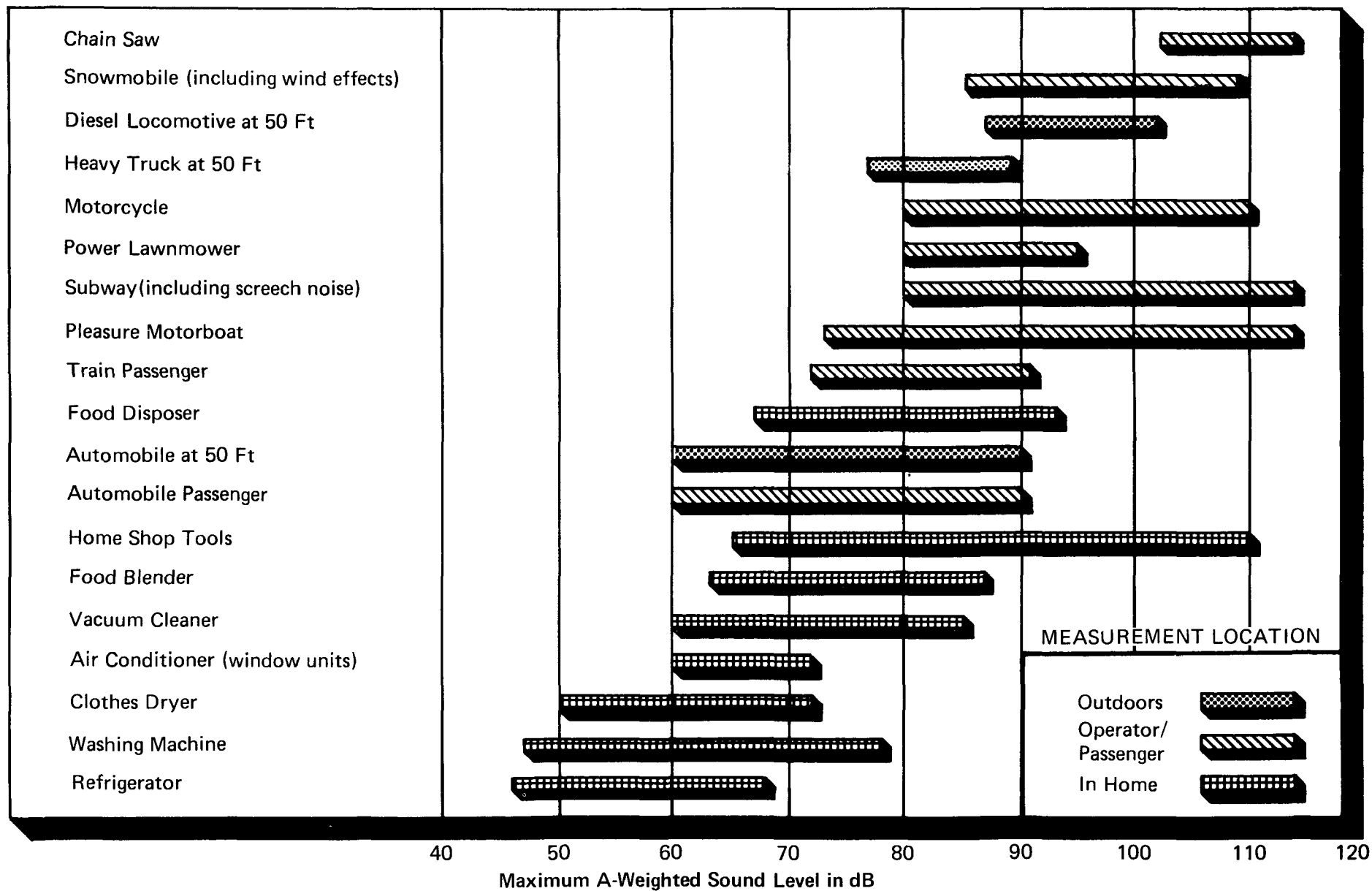


FIGURE 1. TYPICAL RANGE OF COMMON SOUNDS

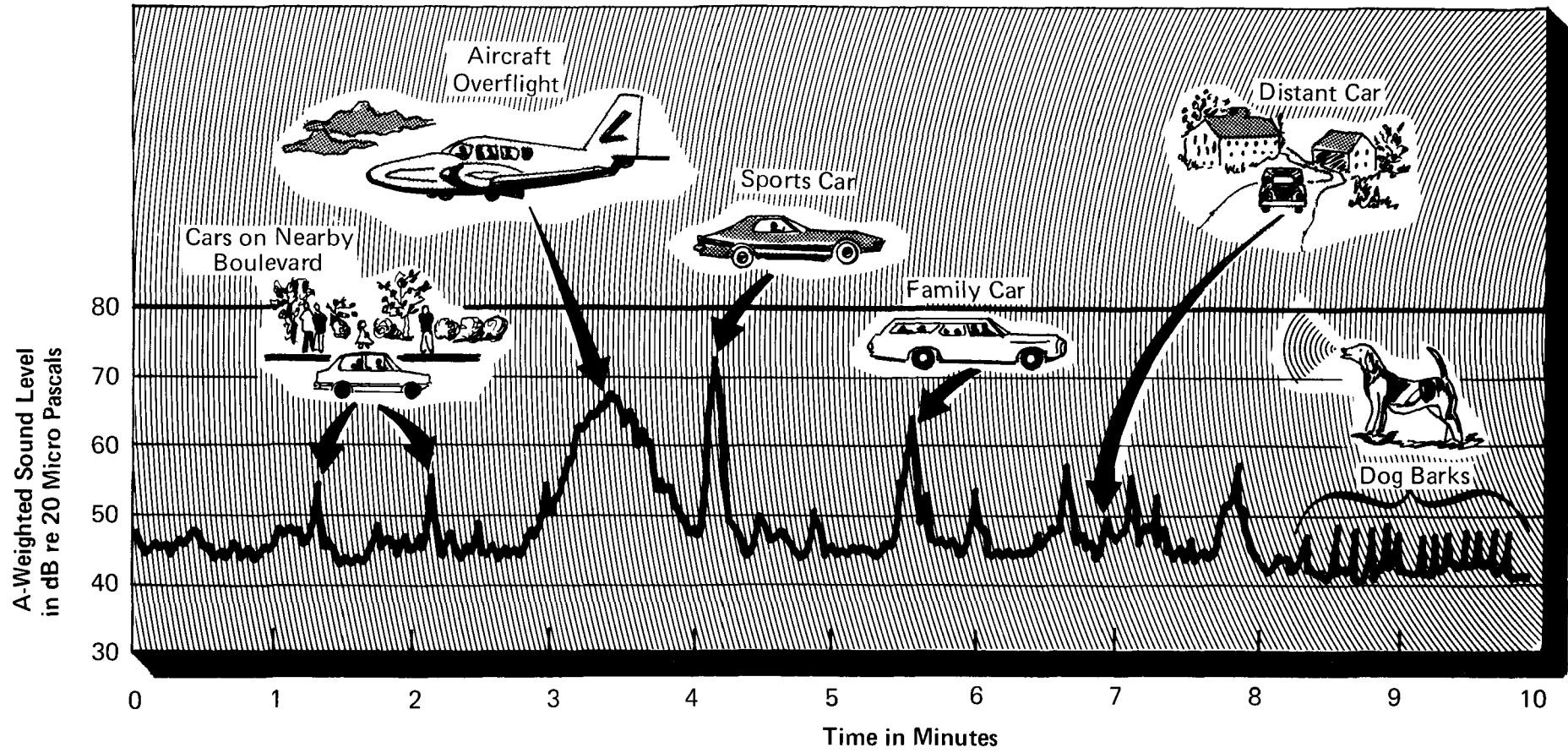


FIGURE 2. TYPICAL OUTDOOR SOUND MEASURED ON A QUIET SUBURBAN STREET

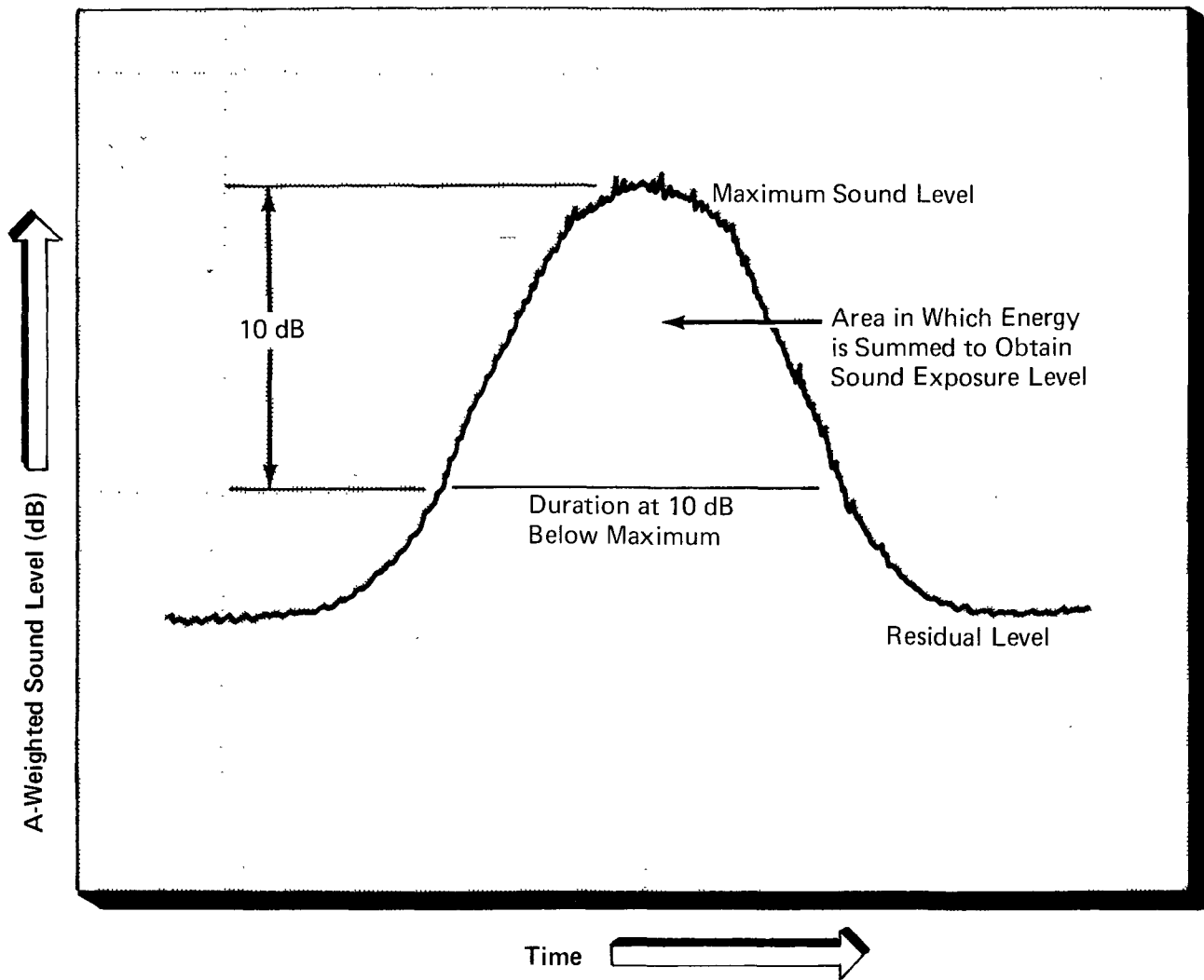


FIGURE 3. DESCRIPTION OF THE SOUND OF A SINGLE EVENT

L_{dn} in dB

Outdoor Location

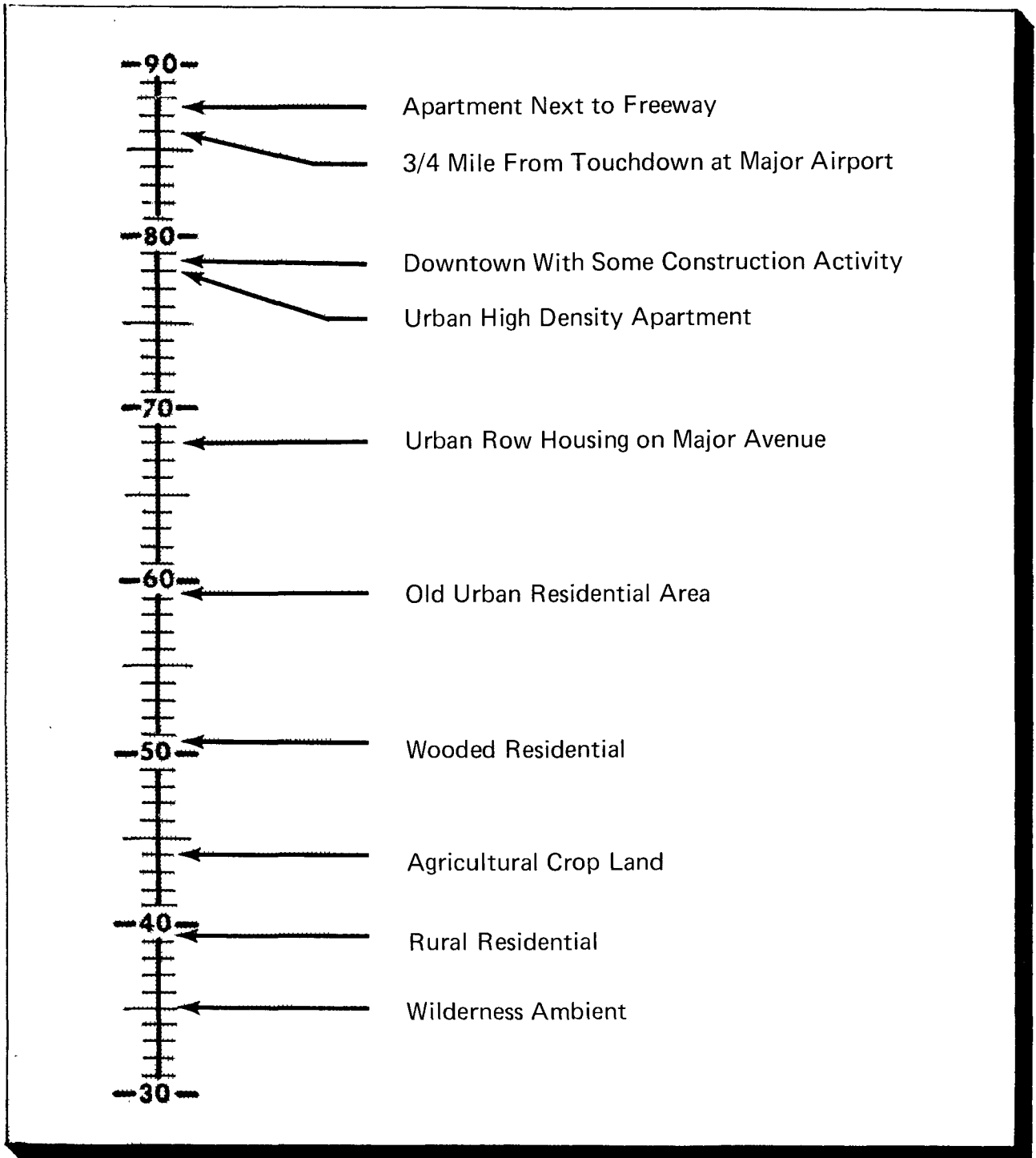


FIGURE 4. EXAMPLES OF OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS IN dB MEASURED AT VARIOUS LOCATIONS

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.

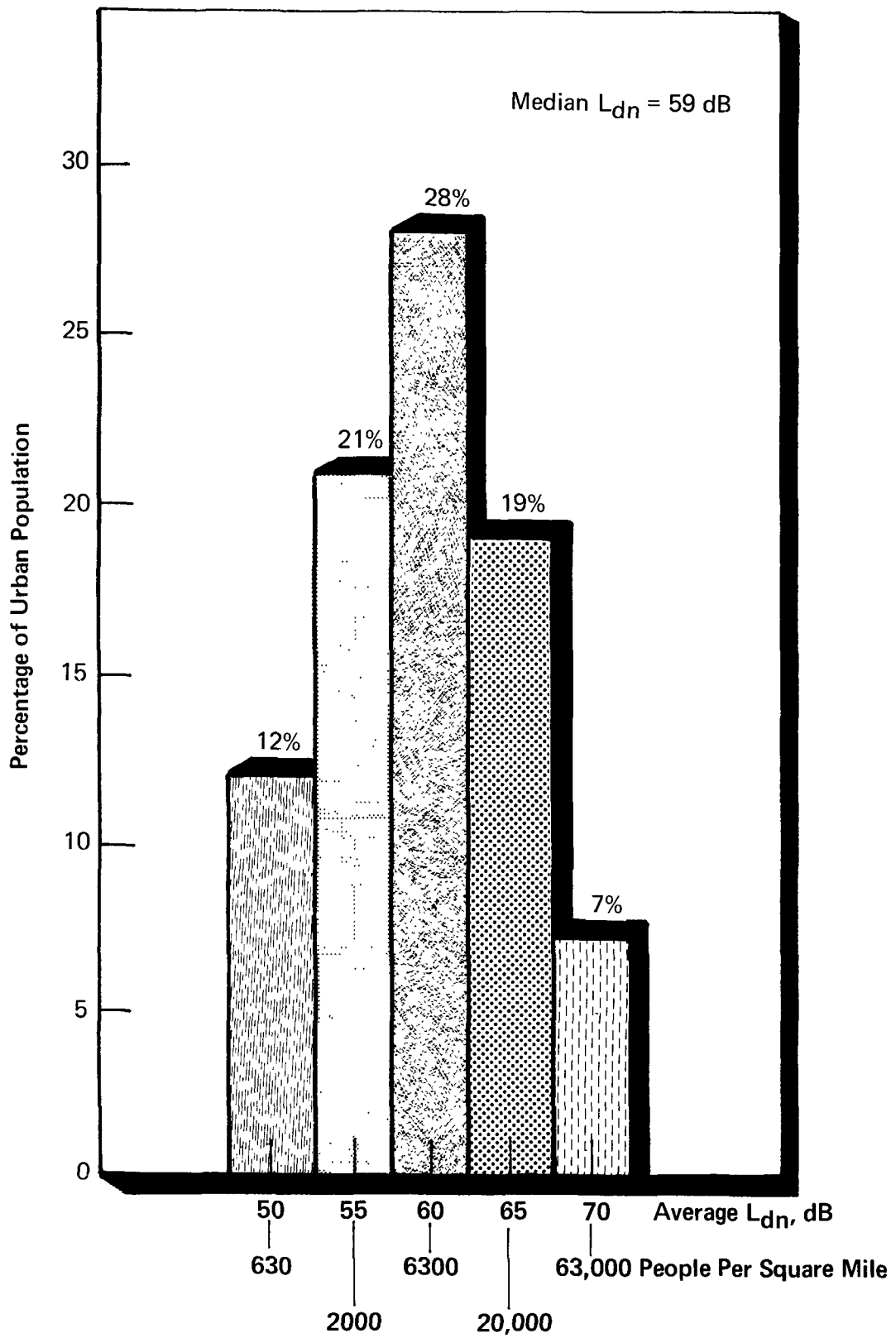


FIGURE 5. ESTIMATED PERCENTAGE OF URBAN POPULATION EXPOSED TO OUTDOOR DAY-NIGHT SOUND LEVELS DUE TO TRAFFIC

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.

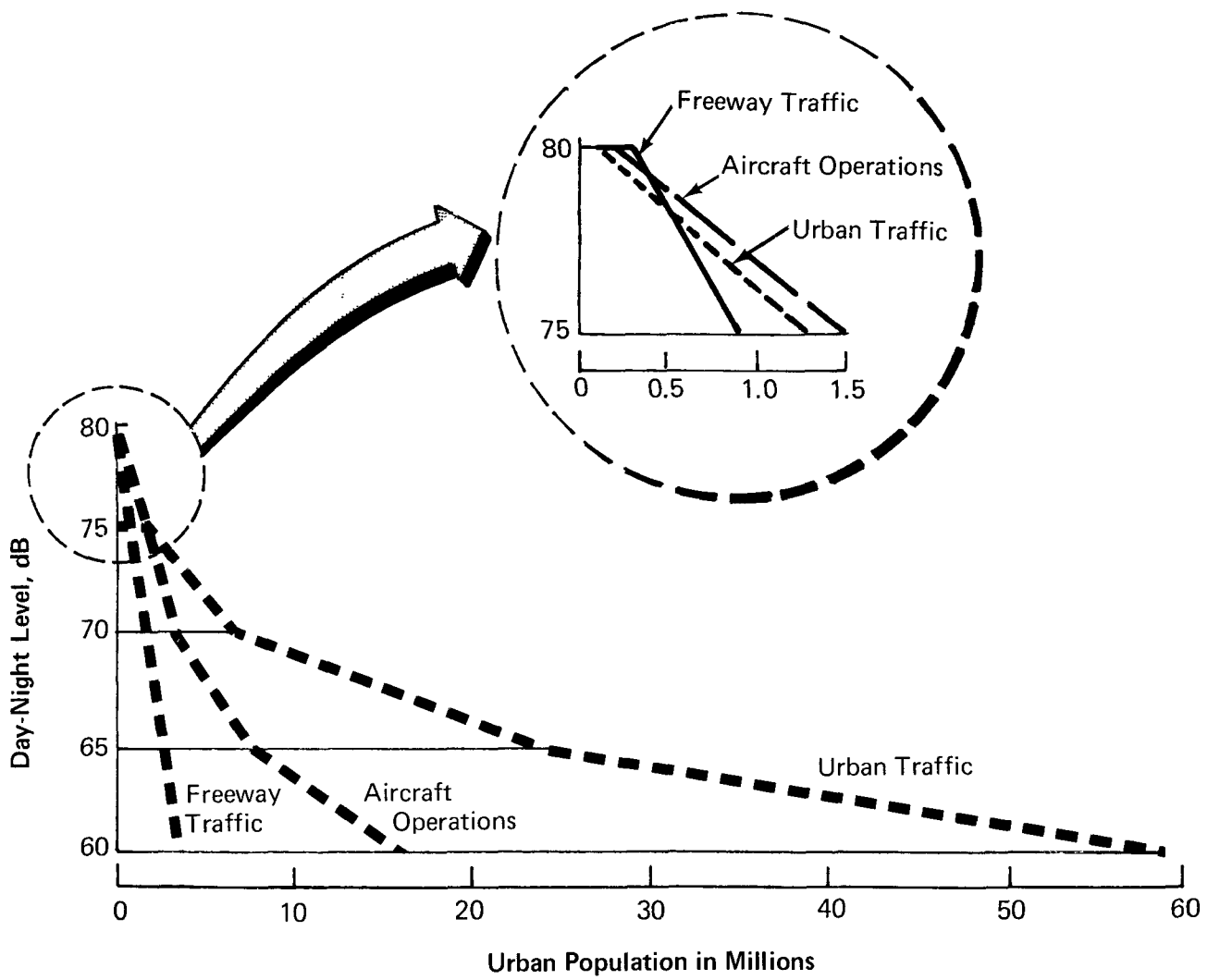


FIGURE 6. CUMULATIVE NUMBER OF PEOPLE IN URBAN AREAS EXPOSED TO OUTDOOR DAY-NIGHT AVERAGE SOUND LEVELS FROM DIFFERENT SOURCES

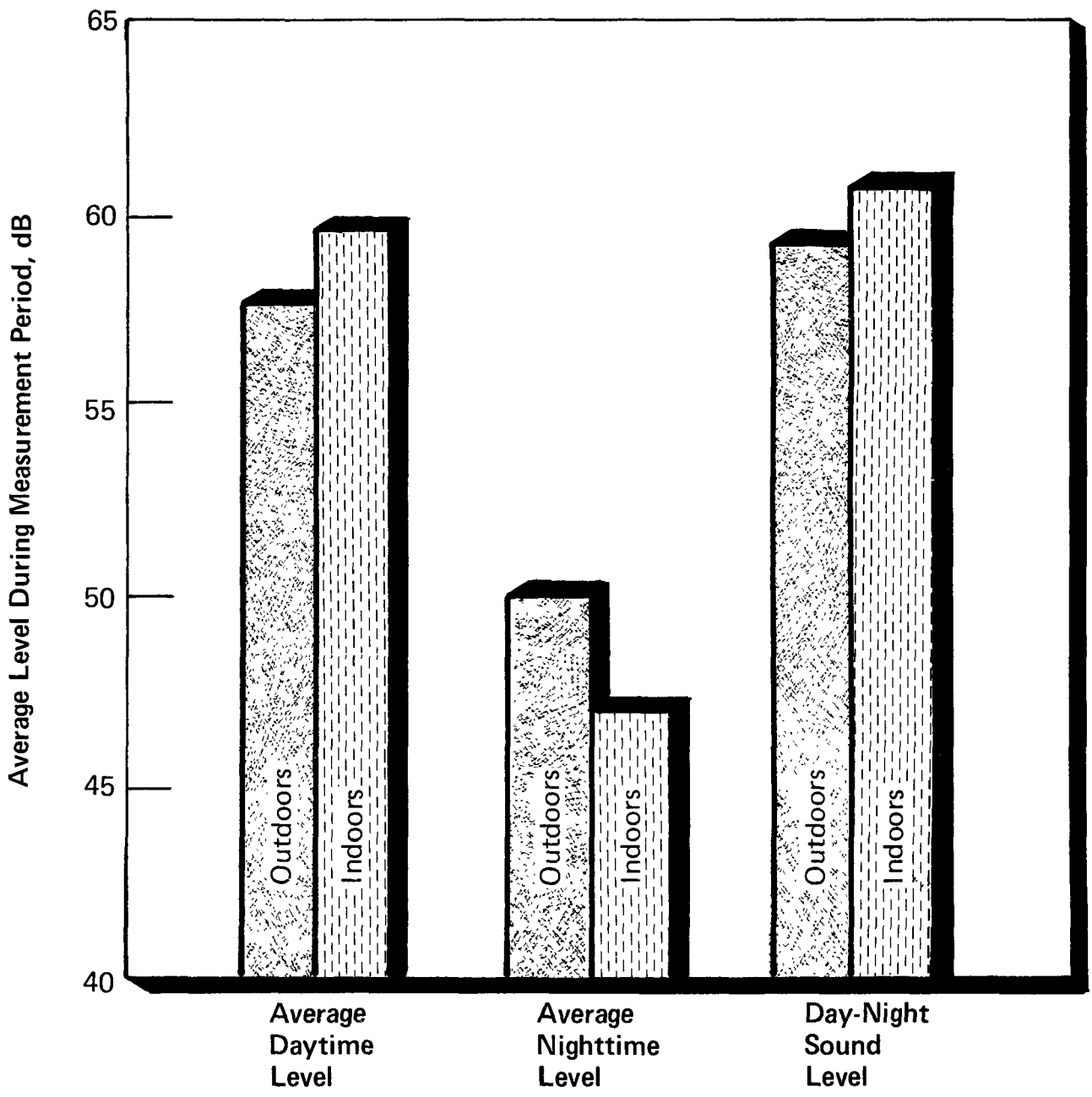


FIGURE 7. COMPARISON OF SAMPLE OUTDOOR AND INDOOR AVERAGE RESIDENTIAL SOUND LEVELS

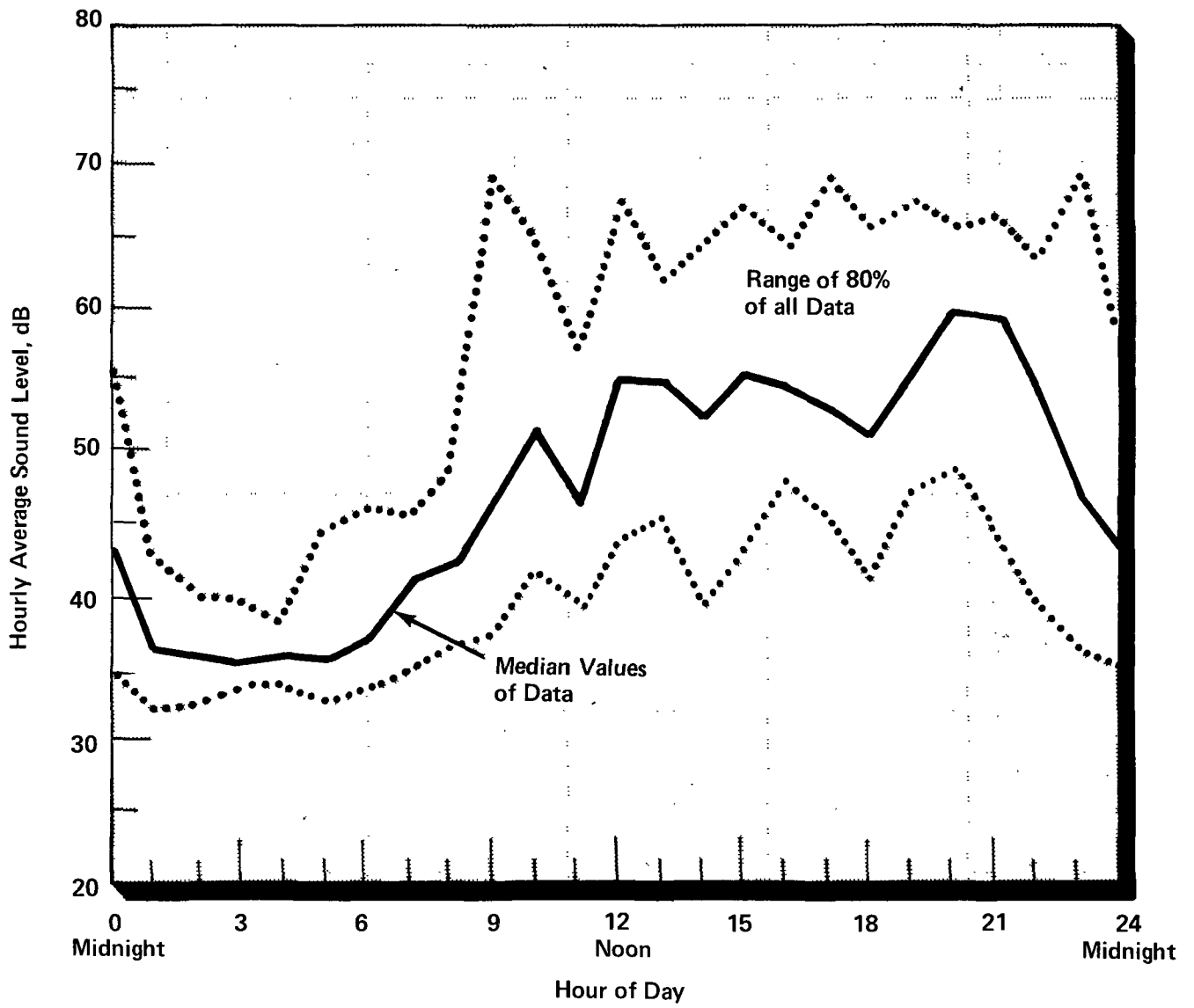


FIGURE 8. TIME PATTERN OF HOURLY INDOOR RESIDENTIAL SOUND LEVELS

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.

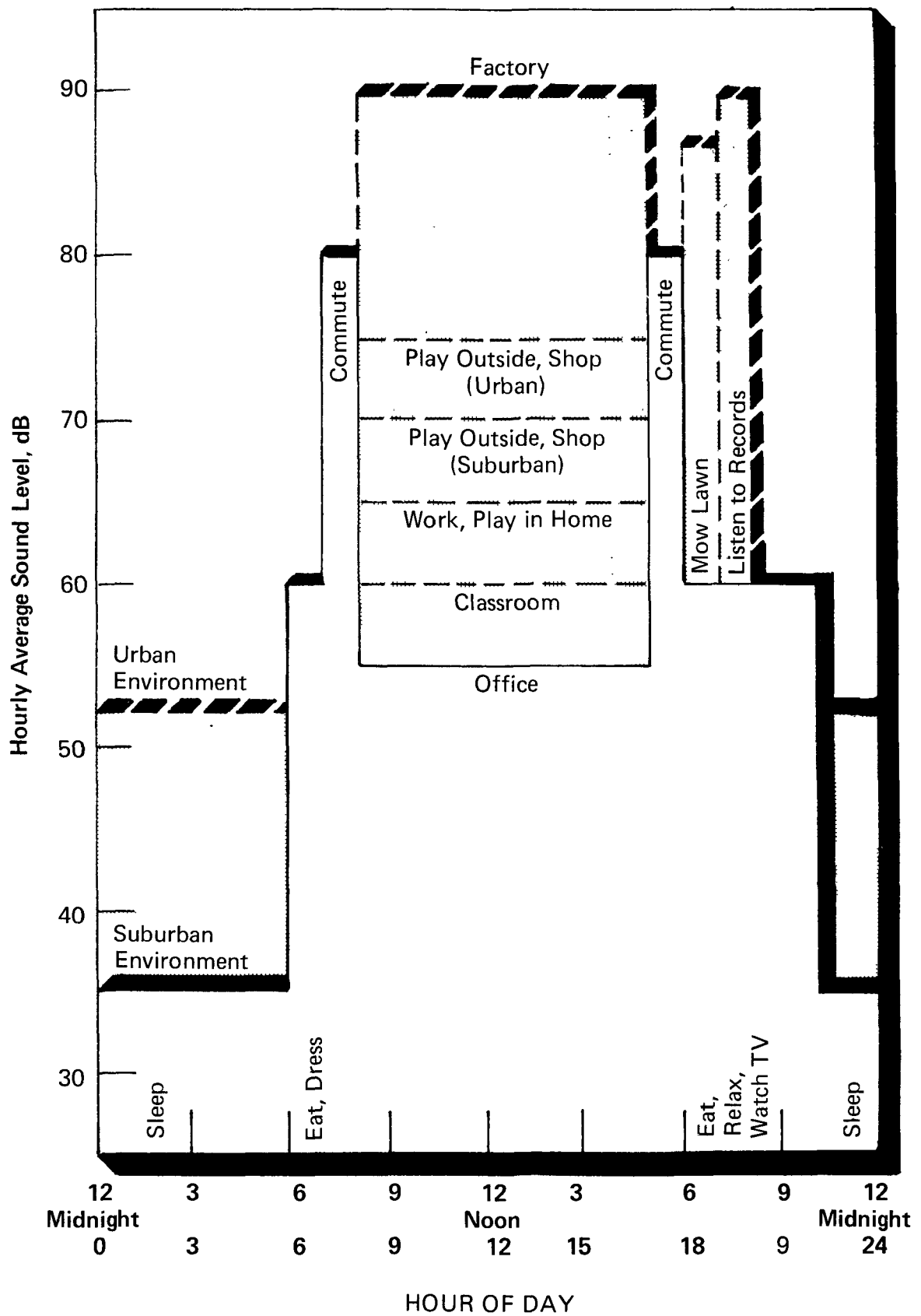


FIGURE 9. GENERALIZED INDIVIDUAL NOISE EXPOSURE PATTERNS

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

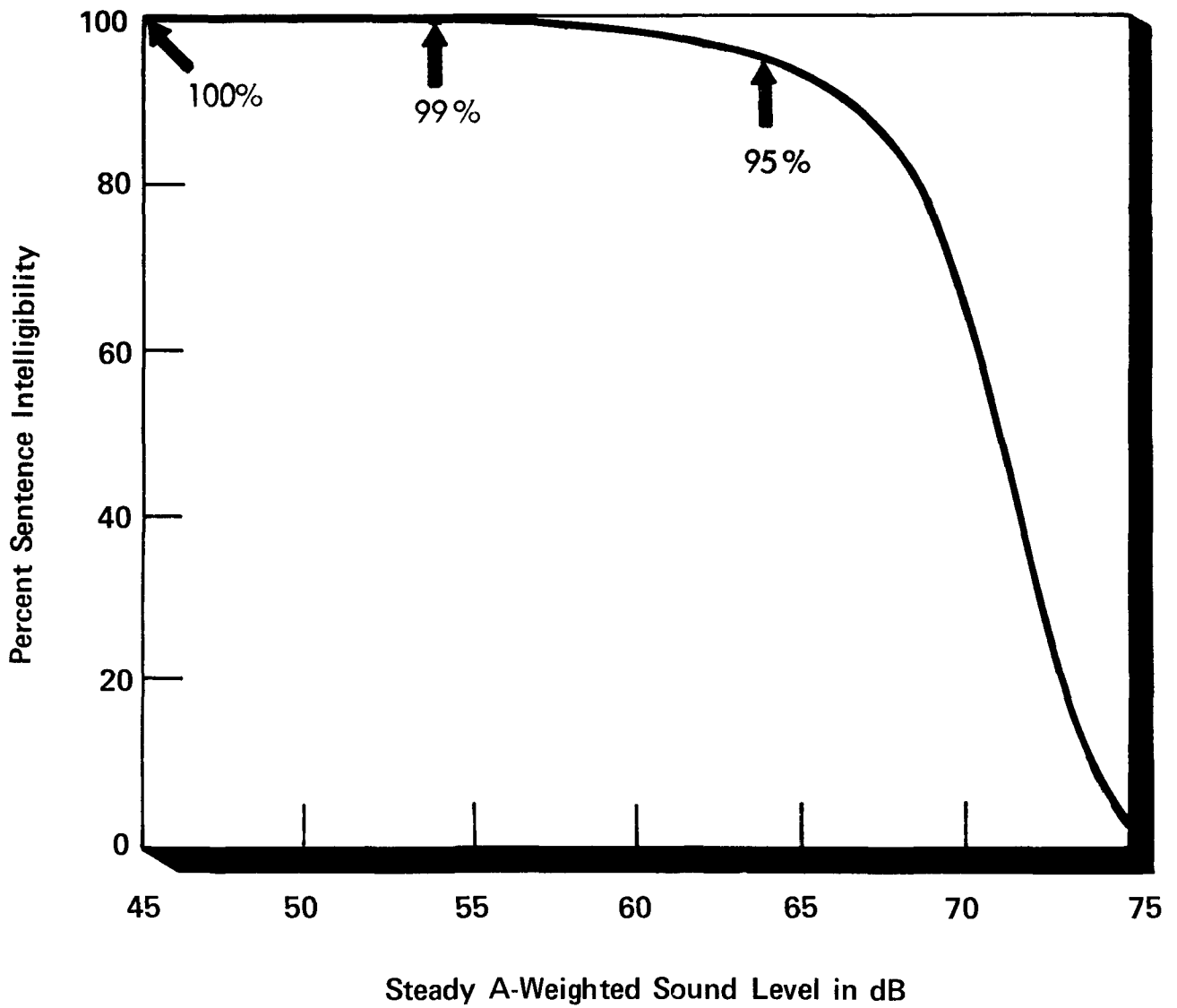


FIGURE 10. INDOOR SENTENCE INTELLIGIBILITY

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.

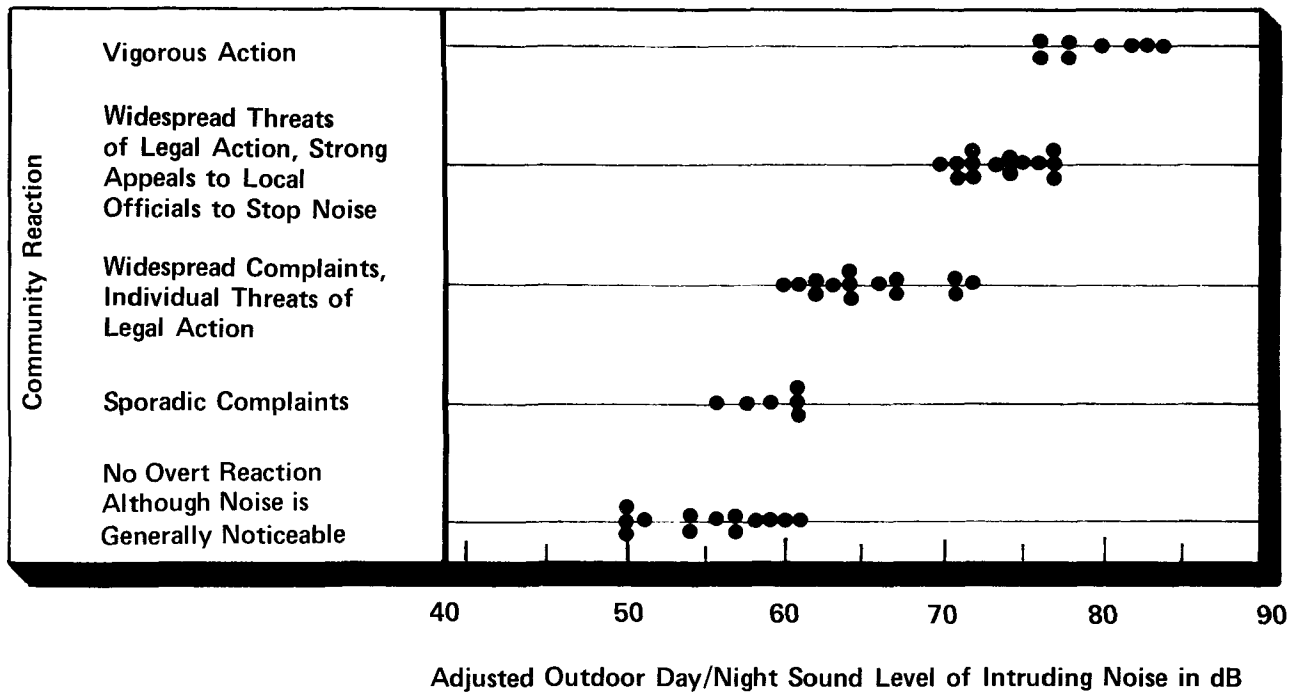


FIGURE 11. COMBINED DATA FROM COMMUNITY CASE STUDIES ADJUSTED FOR CONDITIONS OF EXPOSURE

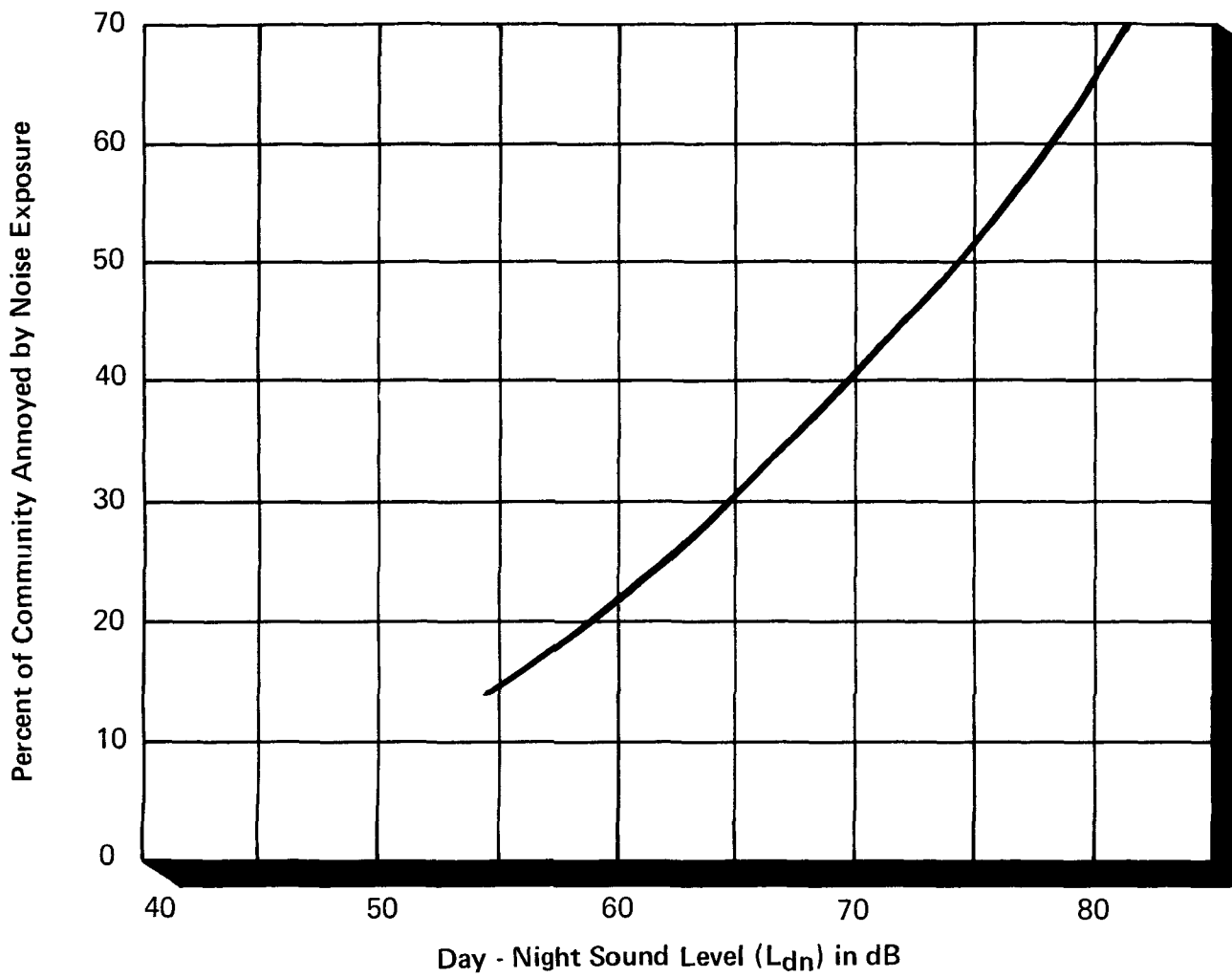


FIGURE 12. PERCENTAGE OF POPULATION ANNOYED BY COMMUNITY NOISE (HEATHROW AIRPORT STUDY)

- 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.

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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		
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