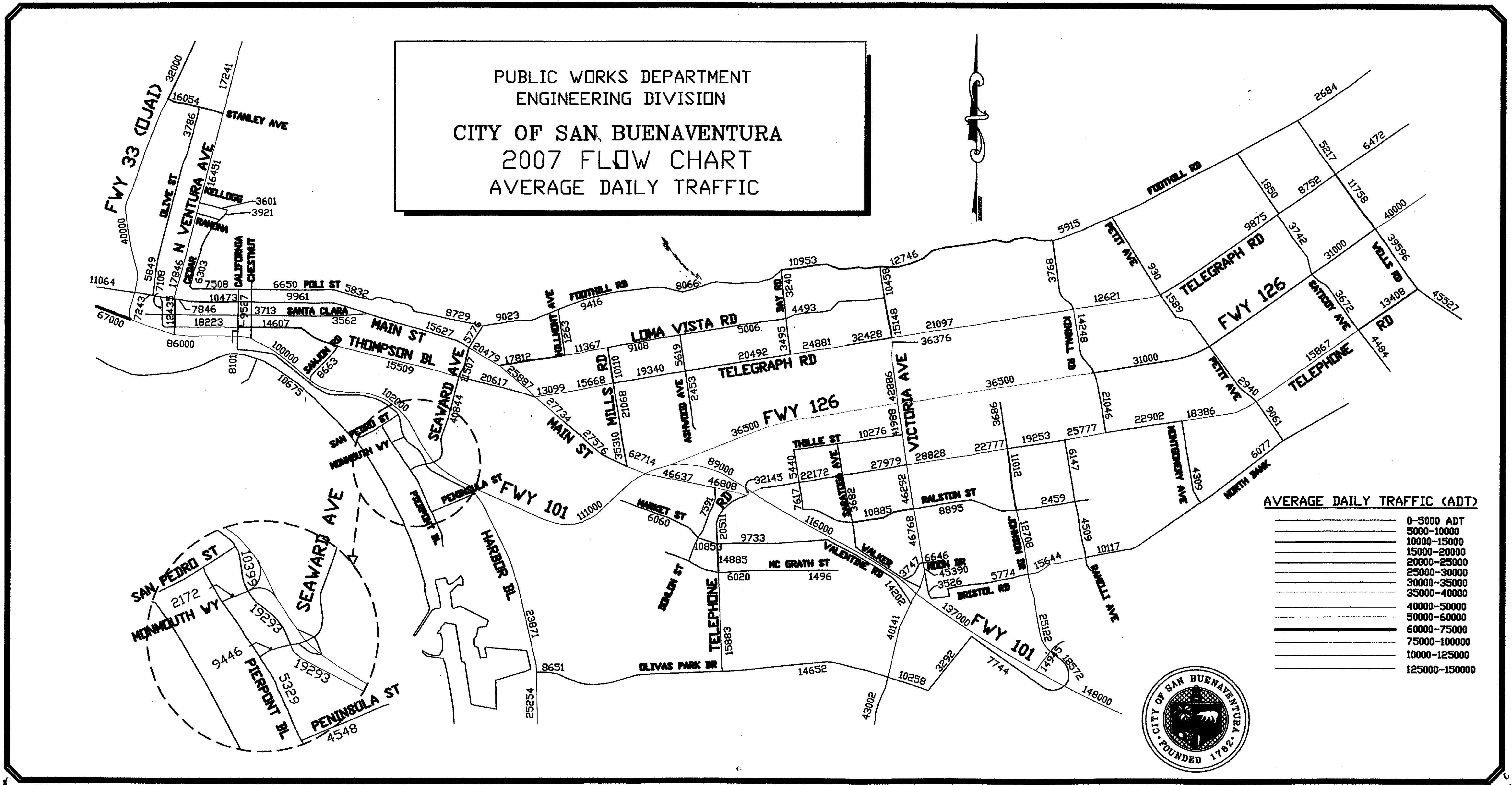
PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION

CITY OF SAN BUENAVENTURA
2007 FLOW CHART
AVERAGE DAILY TRAFFIC



San Buenaventura, CA
Code of Ordinances

Chapter 10.650 - Noise Control[11]

Footnotes:

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Cross reference— *Public health and safety regulations, div. 8.*

ARTICLE 1. - NOISE REGULATIONS GENERALLY

Sec. 10.650.110. - Noise regulations, general.

A. *Declaration of policy.*

1. The council enacts this legislation for the sole purpose of securing and promoting the public health, comfort, safety and welfare of its residents.
2. In order to control unnecessary, excessive and annoying noises in the city, it is declared to be the policy of the city to prohibit noise which is detrimental to the health and welfare of its residents.
3. It shall be the policy of the city to maintain and preserve the quiet atmosphere of the city, and to implement programs and enact legislation consistent with the objectives and goals set forth in the noise element of the comprehensive plan, and aimed at retaining noise levels throughout the city at acceptable values established in the comprehensive plan.

(Code 1971, § 6260)

Sec. 10.650.120. - Definitions.

The following words, phrases and terms, as used in this article, shall have the meanings as indicated:

Agricultural property means a parcel of real property which is zoned "A" (agricultural) on the city's official zoning map, as it may be amended from time to time.

Ambient noise means the composite of all noise from sources near and far, excluding the alleged intrusive noise source. The ambient noise level (or ambient level) is the normal or existing level of environmental noise at a given location.

A weighted sound level means the sound level as measured on a sound level meter using the "A" weighting network. The level so read is designated in units of dBA.

Commercial property means a parcel of real property which is zoned "C-1" (limited commercial), "C-1A" (intermediate commercial), "C-2" (commercial), "C-P-D" (commercial planned development), "C-T-O" (commercial tourist oriented), "H-C" (harbor commercial), "D-T-R" (downtown redevelopment), or "PO" (professional office) on the city's official zoning map, as it may be amended from time to time.

Construction means any site preparation, assembly, erection, substantial repair, alteration, or similar action, for or of public or private rights-of-way, structures, utilities or similar property.

Decibel means a unit for measuring the amplitude of a sound, equal to 20 times the logarithm to the base of ten of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals.

Designated noise zone means a zone consisting of real property corresponding to the city's official zoning map and the noise element of the city's comprehensive plan, as it may be amended from time to time.

Emergency work means work made necessary to protect, provide or restore safe conditions in the community or for the citizenry, or work required to protect persons or property from an imminent exposure to danger, or work by private or public utilities when restoring utility service.

Fixed noise source means a stationary device which creates sounds while in a fixed or stationary position, including but not limited to industrial and commercial machinery and equipment, pumps, fan compressors, generators, air-conditioners and refrigeration equipment.

Impulsive noise means a sound of short duration, and lasting less than one second, with an abrupt onset and rapid delay.

Industrial property means a parcel of real property which is zoned "M-1" (limited industrial), "M-2" (general industrial), or "M-P-D" (manufacturing planned development) on the city's official zoning map, as it may be amended from time to time.

Intrusive noise means that alleged offensive noise which intrudes over and above the ambient noise for the receiving property.

Mobile noise source means any noise source other than a fixed noise source.

Motor vehicles shall include, but not be limited to, mini bikes, ATVs, and other vehicles used for off-road recreational use.

Noise level (sound level) means the "A" weighted sound level.

Noise level limit means the maximum noise level acceptable under this article for the stated time period.

Noise sensitive property shall mean any property, regardless of zone, so designated in the noise element of the city's general plan. Noise sensitive properties include schools, hospitals, convalescent care, boarding, and rest homes.

Person means any individual, firm, association, partnership, joint venture or corporation.

Public right-of-way means that area dedicated or subject to an easement for public use for vehicles and/or pedestrian travel including, but not limited to, streets, alley ways and sidewalks.

Pure tone shall mean any sound which can be judged as audible as a single frequency or set of single frequencies. For the purposes of this chapter, a pure tone shall exist if the one-third octave band sound pressure level in the band with the tone exceeds the arithmetic average of the sound pressure levels of the two contiguous one-third octave bands as follows: by five dB for band frequencies between 160 and 400 Hz; or by 15 dB for band frequencies less than or equal to 125 Hz.

Receiving property means the property for which the intrusive noise is alleged to be offensive.

Residential property means a parcel of real property which is zoned "R-1" (one-family), "R-1-B" (one-family beach), "R-2" (two-family), "R-2-B" (two-family beach), "R-3" (multiple-family), "R-P-D" (residential planned development), or "MHP" (mobile home park) on the city's official zoning map, as it may be amended from time to time.

Sound amplifying equipment means any machine or device for the amplification of the human voice, music or other sound regardless of location. "Sound amplifying equipment," as used in this article, shall not include warning devices on authorized emergency vehicle or horns or other warning devices on any vehicles used only for traffic safety purposes.

Sound level meter means an instrument, including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement of sound levels, which satisfies the requirements pertinent for sound level meters in American National Standards Institute specifications for sound level meters, section 1.4-1971, or the most recent revision thereof, for type S-2A sound level meters.

Supplementary definition of technical terms. Definitions of technical terms not defined herein shall be obtained from American Standard Acoustical Terminology section 1-1-1971 or the most recent revision thereof.

(Code 1971, § 6261)

Sec. 10.650.130. - Designated noise zones.

A. *Assignment of noise zones.* Receiving properties are assigned to designated noise zones as follows:

1. Designated noise zone I: Noise sensitive properties.
2. Designated noise zone II: Residential properties.
3. Designated noise zone III: Commercial properties.
4. Designated noise zone IV: Industrial and agricultural properties.

B. *Exterior noise levels.*

1. *Noise zone exterior noise levels.* The following exterior noise levels, unless otherwise specifically indicated, shall apply to all receiving properties within a designated noise zone for the purpose of establishing noise level limits in subsection B.2. below:

EXPAND

	Designated Zone	Time Interval	Exterior Noise Levels
Zone I	Noise sensitive properties	7 a.m.—10 p.m.	50
		10 p.m.—7 a.m.	45
Zone II	Residential properties	7 a.m.—10 p.m.	50
		10 p.m.—7 a.m.	45
Zone III	Commercial properties	7 a.m.—10 p.m.	60

		10 p.m.—7 a.m.	55
Zone IV	Industrial and agricultural	Anytime	70

2. _____

   Noise level limits. Unless otherwise provided in this article, no person shall operate or cause to be operated any source of sound at any location within the city, or allow the creation of any noise on property owned, leased, occupied or otherwise controlled by such person which causes the noise level when measured on any receiving property to exceed the following noise level limits:

   (a) The exterior noise levels for that land use, as specified in subsection B.1. above, for a total period of more than 30 minutes in any consecutive 60 minutes;

   (b) The exterior noise levels plus five dB for a total period of more than 15 minutes in any consecutive 60 minutes;

   (c) The exterior noise levels plus ten dB for a total period of more than five minutes in any consecutive 60 minutes; or

   (d) The exterior noise levels plus 15 dB for a total period of more than one minute in any consecutive 60 minutes; or

   (e) The exterior noise levels plus 20 dB for any period of time.

3. *Intrusive noise measurement duration.* It shall be sufficient for the noise level limits in sections 2.(a), (b), (c) and (d), above, to be measured for no less than one minute of any portion of the periods stated in subsections 2.(a), (b), (c) and (d), provided that any witness to the intrusive noise can testify to the fact that the intrusive noise continued at the same level or greater level than the level measured by the enforcing officer for a period in excess of the period allowed in subsections 2.(a), (b), (c) and (d).

4. *Ambient noise level in excess of noise level limit.* If the ambient noise level exceeds that permissible for any of the noise level limits in subsections (a), (b), (c) and (d) of subsection 2. above, the noise level limit shall be increased in five dB increments as appropriate to encompass or reflect said ambient noise level. In the event the ambient noise level exceeds the noise level limit in subsection 2.(e) above, this limit shall be increased to the maximum ambient noise level.

5. *Boundary between different zones.* If the measurement location is on a boundary between two different designated noise zones, the lower noise level limit applicable to the two zones shall apply.

6.

Content of intrusive noise. In the event the intrusive noise is judged by the enforcing officer to contain a steady, audible, pure tone such as a whine, screech or hum, or is an impulsive noise, or is a repetitive noise exceeding one second in duration or contains music or speech, the noise level limits set forth in subsection 2. above shall be reduced by five dB.

C. *Interior noise level limits.*

1. *Definition, noise zone interior noise levels.* The following interior noise levels, unless otherwise specifically indicated, shall apply within all receiving multifamily residential units within noise zones I and II for the purpose of establishing noise level limits in subsection 2. below:

EXPAND

	Time Interval	Interior Noise
Multifamily residential	10:00 p.m. to 7:00 a.m.	40
	7:00 a.m. to 10:00 p.m.	45

2. *Residential unit, interior noise level limits.* No person shall operate or cause to be operated within a multifamily residential unit, any source of sound or allow the creation of any noise which causes the noise level when measured inside a neighboring receiving residential unit whether adjacent or not, to exceed the following noise level limits:

   (a) The interior noise levels as specified in subsection 1. above for a total period of more than five minutes in any consecutive 60 minutes;

   (b) The interior noise levels, plus five dB for a total period of more than one minute in any consecutive 60 minutes; or

   (c) The interior noise levels, plus ten dB for any period of time.

3. *Ambient noise level in excess of noise level limit.* If the ambient noise level exceeds that permissible for noise level limits in subsection 3.(a) or (b) above, the limit shall be increased in five dB increments as appropriate to reflect said ambient noise level. In the event the ambient noise level exceeds the noise level limit in subsection 3.(c) above, this limit shall be increased to the maximum ambient noise level.

4. *Content of intrusive noise.* In the event the intrusive noise is judged by the enforcing officer to contain a steady, audible, pure tone such as a whine, screech or hum, or is an impulsive noise or a repetitive noise exceeding one second in duration, or

contains music or human voices, the noise level limits set forth in subsection 2. above shall be reduced by five dB.

(Code 1971, § 6262)

Sec. 10.650.140. - Sound level measurement.

A. *Use of "A" weighted sound level.* Any sound levels measured pursuant to the provisions of this article shall be "A" weighted sound levels, measured with a sound level meter using the "A" weighting and slow response, except for impulsive noise, for which the fast response shall be used. The microphone shall be located four to five feet above the ground and ten feet or more from the nearest reflective surface.

B. *Interior noise measurement.* Interior noise measurements shall be made within the affected residential unit. The measurements shall be made at a point at least four feet from the wall, ceiling or floor nearest the noise source with windows opened or closed at the discretion of the resident.

C. *Calibration prior to measurement.* Calibration of the measurement equipment, utilizing an acoustic calibrator, shall be performed prior to making any noise measurements.

D. *Ambient noise level measurement.* When ambient noise levels are measured, these levels should be measured whenever possible at a location and time of day comparable to that used for measuring the intrusive noise.

E. *Method for sound level measurement.* The director of community development may, from time to time, cause preparation of a noise control enforcement manual to assist in implementing the purpose of this article.

(Code 1971, § 6263)

Sec. 10.650.150. - Special noise sources.

A. *Radios, television sets and similar devices.* No person within any residential zone of the city shall use or operate any radio receiving set, musical instrument, phonograph, television set or other machine or device for the producing or reproducing of sound in such a manner as to create any noise which exceeds the noise level limits of this article.

B. *Animals and fowl.* No person shall keep or maintain, or permit the keeping of, upon any premises owned, occupied or controlled by such person, any animal or fowl otherwise permitted to be kept which by any sound, cry or behavior, creates any noise which exceeds the noise level limits of this article.

C.

Machinery, equipment, fans and air-conditioning. No person shall operate any machinery, equipment, pump, fan, air-conditioning apparatus or tool of any nature or similar mechanical device so as to create any noise which exceeds the noise level limits of this article.

D. *Construction of buildings and structures.*

1. Between the hours of 8:00 p.m. of one day and 7:00 a.m. of the next, no person adjacent to or within any residential zone in the city shall operate power construction equipment or tools or perform any outside construction or repair work on buildings or structures, or operate any pile driver, steam shovel, pneumatic hammer, steam or electric hoist or other construction device so as to create any noise which exceeds the noise level limits of this article. These specified construction activities are permitted between the hours of 7:00 a.m. and 8:00 p.m. The performance of emergency work is exempt from the provisions of this section.
2. Home repairs and routine maintenance of personal property such as automobiles or boats is not considered construction.
3. The planning commission and city council shall retain the right to impose more restrictive hours of construction upon any projects involving construction activity by adding appropriate conditions to the city's approval of subdivisions, planned development permits, conditional use permits, variances and other projects.

E. *Domestic power tools, machinery.* Between the hours of 8:00 p.m. of one day and 7:00 a.m. of the next, no person in a residential zone shall operate or permit the operation of any mechanically powered saw, sander, drill, grinder, lawnmower or garden tool or similar tool, so as to create any noise which exceeds the noise level limits of this article. These specified domestic activities are permitted between the hours of 7:00 a.m. and 8:00 p.m.

F. *Vehicles.*

1. *Vehicles off public right-of-way.* No person shall operate or cause to be operated any motor vehicle, off a right-of-way, in such a manner that the sound levels emitted therefrom exceed the noise level limits of this article.
2. *Vehicle repair and testing.* No person shall repair, rebuild, modify or test any motor vehicle in such a manner as to create any noise which exceeds the noise level limits of this article.
3. *Standing motor vehicles.* No person shall operate or permit the operation of any motor vehicle with a gross vehicle weight rating (GVWR) in excess of 6,000 pounds, or any auxiliary equipment attached to such a vehicle, for a period longer than five minutes in any hour while the vehicle is stationary, for reasons other than traffic congestion, on a public right-of-way or public space within 200 feet of a residential area between the hours of 10:00 p.m. and 7:00 a.m.

(Code 1971, § 6264)

Sec. 10.650.160. - General noise regulations.

A. *Unlawful noise.* Notwithstanding any other provision of this article, and in addition thereto, it shall be unlawful for any person to make or continue, or cause to be made or continued, any loud, unnecessary, or unusual noise which disturbs the peace or quiet of any neighborhood or which causes discomfort or annoyance to any reasonable person of ordinary or normal sensitivity residing in the area.

B. *Environmental factors.* The environmental factors which may be considered in determining whether a violation of provisions of subsection A. exists includes, but is not limited to, the following:

1. The sound level of the intrusive noise.
2. The sound level of the ambient noise.
3. The proximity of the noise to residential sleeping facilities.
4. The nature and zoning of the area from which the noise emanates.
5. The number of persons affected by the alleged intrusive noise.
6. The time of day or night the noise occurs.
7. The duration of the noise and its tonal content.
8. Whether the noise is continuous, recurrent, or intermittent.

(Code 1971, § 6265)

Sec. 10.650.170. - Exemptions.

A. *Emergency exemption.* The emission of sound for the purpose of alerting persons to the existence of an emergency or the emission of sound in the performance of emergency work shall not be subject to the provisions of this chapter.

B. *Warning devices.* Warning devices necessary for the protection of public safety, as, for example, police and fire and ambulance sirens, including the testing of such devices shall not be subject to the provisions of this chapter.

C. *Playgrounds and school grounds.* Activities conducted on public playgrounds and public or private school grounds including, but not limited to, school athletic and school entertainment events, are exempt from the provisions of this chapter.

D.

Newly constructed or modified public utility facilities. Newly constructed or modified public utility facilities constructed in an industrial zone in a mixed industrial/residential area shall be exempt from the requirements of this chapter if the facilities result in a lessening of pre-existing noise levels emanating from the public utility site, and if the total noise level emanating from the site does not exceed 60 dbA as measured at any receiving property. Where a project is installed or constructed in stages, the "pre-existing noise levels emanating from the public utility site," as used herein, shall mean the noise level existing prior to the commencement of the first stage of such project.

E. *Pilot concert series.* Amplified sound generated by the pilot concert series located in the Ventura City Hall upper parking lot shall be exempt from the provisions of this chapter. The pilot concert series shall be subject to a sound control plan. The sound control plan shall be approved by the community development director and include provisions regarding onsite sound monitoring, curfew, sound and bass noise limits, penalties for exceeding curfew and sound limits, and public complaints.

(Code 1971, § 6266; Ord. No. 2014-011, § 1, 8-4-14)

Sec. 10.650.180. - Violations and other remedies.

A. *Generally.* Violations of the provisions of this article shall be subject to the penalties specified in section 1.150.010 and sections 1.150.020 through 1.005.070 of this Code.

B. *Other remedies.* As an additional remedy, the operation or maintenance of any device, instrument, vehicle or machinery in violation of any provision of this chapter, which operation or maintenance cause discomfort or annoyance to reasonable persons of ordinary or normal sensitivity or which endangers the comfort, repose, health or peace of residents in the area, shall be deemed and is declared to be, a public nuisance and may be subject to abatement by a restraining order or injunction issued by a court of competent jurisdiction. This specific authorization of injunctive relief is based upon the council's determination that significant public harm will result from intrusive noise disturbances and the council's determination that injunctive relief is an appropriate way to prevent noise nuisances from causing public injury.

(Code 1971, § 6267)

ARTICLE 2. - DISTURBANCES CAUSED BY PARTIES AND OTHER ASSEMBLAGES OF PERSONS

Sec. 10.650.210. - Purpose.

The purpose of this article is to establish standards and controls of large parties, gatherings or assemblages ("the events") on private property when such events are determined to be a threat to the public peace, health, safety or general welfare and require initial police response and return calls to the location of the party, gathering or assemblage in order to disperse uncooperative participants.

The repeated return of police officers to a location constitutes a drain of emergency person power and resources, often leaving other areas of the city without police protection.

(Code 1971, § 6600)

Sec. 10.650.220. - Definitions.

For the purposes of this article, the following definitions shall apply:

Event shall refer to a party, gathering or assemblage.

Host shall refer to any person conducting and/or permitting an event including, but not limited to:

1. Owner(s) and/or lessee(s) of the property where an event is being given;
2. Person(s) hosting an event;
3. Person(s) receiving money or other consideration for granting access to an event;
4. Person(s) serving, furnishing, or making available alcoholic beverages at an event;
5. Parent(s) or legal guardian(s) of a minor who is also a host.

(Code 1971, § 6610)

Sec. 10.650.230. - Notice of disturbance; host signature.

When police department personnel ("city police") respond to a complaint involving a disturbance caused by or resulting from an event, the responding officer(s) may issue a written notice to the host of the event, if such person is available on the premises, if the responding officer(s) determine(s) that there is a threat to the public peace, health, safety, or general welfare. The notice shall state that (a) if city police return to the same premises within the following 12-hour period in response to a complaint involving a disturbance caused by or resulting from an event; or (b) if city police return to the same premises a total of three times or more within a six-month period, in response to a complaint involving a disturbance caused by or resulting from an event and involving the same host; and (c) if the responding officer(s) determine(s) that there is a threat to the public peace, health, safety, or general welfare; then each such further response after the initial response shall constitute special police services. The notice shall state that the host will be assessed for the cost of providing such special police services. The notice shall be signed by the available host, acknowledging receipt of the warning, and a signed copy of the notice shall be left with the available host. If a second or subsequent response is required, city police shall have the available host sign a "second response" voucher, acknowledging the occurrence of the second response and one additional voucher for each response thereafter.

(Code 1971, § 6611)

Sec. 10.650.240. - Notice of disturbance; signature unavailable.

If no host is available on the premises when the police are present, or the host refuses to sign receipt of the notice, a copy of the notice shall be posted in a conspicuous place on the premises on each occasion the police respond.

(Code 1971, § 6612)

Sec. 10.650.250. - Second response; cost of special police assignment.

Utilization of police personnel during any response after the first warning to any event where the responding officers determine there is a threat to the public peace, health, safety or general welfare shall be deemed to be a special police service over and above the services normally provided. The cost of this special police service may include, but not be limited to, damages to city property and/or injuries to city personnel.

(Code 1971, § 6613)

Sec. 10.650.260. - Collection of fees.

All fees and charges levied per city services described in section 10.650.250 shall be due and payable upon presentation.

All fees and charges for such special police services shall constitute a valid and subsiding debt in favor of the city and against the owner of the premises, the person in charge of the premises and the person responsible for the assemblage or, if any of the foregoing persons are a minor, the parents and guardians of such person. If any amount remains unpaid after reasonable and practical attempts have been made by the city to obtain payment, a civil action may be filed with the court for the amount due and payable, together with any penalties, any related charges and fees accrued due to nonpayment and all fees and charges required to file and pursue such civil action.

Fees and charges to be levied for recovering city costs for notification and collection of delinquent accounts shall be established by resolution of the city council. Such fees and charges are part of fees and charges established for the services rendered and shall be collected as such.

(Code 1971, § 6614)

ARTICLE 3. - COMMERCIAL ADVERTISING

Sec. 10.650.310. - Loud or unusual noises.

A. *Prohibited.* No person shall make any loud or unusual noises which exceed the standards set forth in this chapter, upon any street or sidewalk or in any doorway or entrance of any building opening into any such street or sidewalk for the purpose of advertising, announcing or calling attention to any goods, wares, merchandise, place of business, show, entertainment or event to attract attention to such objects.

B. *Exception, parades and similar events.* This section does not apply to the playing of music by a band or orchestra in a parade or other celebration for which a permit has been issued by the city or the playing of music by a school band or orchestra at school events, or to licensed "hawkers" for operation along city-approved parade routes during a parade.

(Code 1971, § 6235)

‹ Sec. 10.600.010. - Convicted persons. Chapter 10.700 - False Crime Reports ›

Map prepared by GIS for:

City of San Buenaventura Department of Community Development Planning Division

ZONING DISTRICT MAP

NOTES

This Zoning District Map reflects Zoning Classification based on information current as of: February 2020
Last Update: Ordinance No. 2019-025

Transects from the Downtown Specific Plan, Midtown Corridor Development Code and Community Memorial Hospital Development Code, Victoria Plan, UC Hansen Plan, Saticoy Wells Plan, Parklands, and Olivas Park Dr have been added.

In the event there is any conflict between the text of the zoning ordinance and this map, the provisions of the text of the zoning ordinance shall prevail.

For Zoning Regulations please contact:
Planning Division
City Hall, Room 117, 501 Poli St.,
Ventura, California 93001.

Phone: (805) 654-7894 Internet: maps.cityofventura.net

21 Feb 2020

Guidelines for Energy Project Applications Requiring CEQA Compliance:

Pre-filing and Proponent's Environmental Assessments

November 2019

Version 1.0

Energy Division

Infrastructure Permitting and CEQA Unit

California Public Utilities Commission

Guidelines for Energy Project Applications Requiring CEQA Compliance:

Pre-filing and Proponent's Environmental Assessments

Contents

Foreword

November 12, 2019

To: Applicants Filing Proponent's Environmental Assessments for Energy Infrastructure Projects at the California Public Utilities Commission (CPUC or Commission)

From: Merideth Sterkel (Program Manager, Infrastructure Planning and Permitting) and Mary Jo Borak and Lonn Maier, Supervisors, Infrastructure Permitting and California Environmental Quality Act, Energy Division, CPUC

Subject: Introducing revisions to the Pre-filing Guidelines for Energy Infrastructure Projects and a Unified and Updated Electric and Gas PEA Checklist

We are pleased to release a 2019 revision to the California Environmental Quality Act (CEQA) Proponent's Environmental Assessments (PEA) Checklist. This substantially revised document is now entitled "Guidelines for Energy Project Applications Requiring CEQA Compliance: Pre-filing and Proponent's Environmental Assessments" (Guidelines). Future updates to this document will be made as determined necessary. The CPUC's Rules of Practice and Procedure Sections 2.4 provide that all applications to the CPUC for authority to undertake projects that are not statutorily or categorically exempt from CEQA requirements shall include an Applicant-prepared PEA.

Updates Overview

Prior versions of the Working Draft PEA Checklist were published in 2008 and 2012. For this 2019 update, extensive revisions were made to all sections based on our experience with the prior checklist versions. All electric and natural gas projects are now addressed in a single PEA Checklist, and the following updates were made:

- **CEQA Statute and Guidelines 2019 Updates:** The PEA Checklist is updated pursuant to the 2019 CEQA Statues and Guidelines, including new energy and wildfire resource areas.
- **Pre-filing Consultation Guidelines:** Pre-filing guidelines are now provided since the pre-filing and PEA development processes are intertwined.
- **Unified PEA Checklist for Energy Projects:** All electric and natural gas projects are now addressed in a single PEA Checklist.
- **Additional CEQA Impact Questions:** Questions are included for the following PEA Checklist sections: 5.4, Biological Resources; 5.6, Energy; 5.9, Hazards, Hazardous Materials, and Public Safety; 5.16, Recreation; 5.17, Transportation; and 5.19, Utilities and Service Systems.
- **CPUC Draft Environmental Measures:** Draft measures are provided in PEA Checklist Attachment 4 for Aesthetics, Air Quality, Cultural Resources, Greenhouse Gas Emissions, Utilities and Service Systems and Wildfire.

Purpose of the Guidelines Document

The purpose and objective of the PEA Checklist included within this Guidelines document has not changed, which is to provide project Proponents (Applicants) with detailed guidance about information our CEQA Unit Staff expect in sufficient PEAs. The document details the information Applicants must provide the CPUC to complete environmental reviews that satisfy CEQA requirements. Specifically, the Pre-filing Consultation Guidelines and PEA Checklist, together, are intended to achieve the following objectives:

1. Provide useful guidance to Applicants, CPUC staff, and outside consultants regarding the type and detail of information needed to quickly and efficiently deem an application complete;

2. Ensure PEAs provide reviewers with a detailed project description and associated information sufficient to deem an application complete, avoid lengthy review periods and numerous data requests for the purpose of augmenting a PEA, and avoid unnecessary PEA production costs;
3. Increase the level of consistency between PEAs submitted and provide for more consistent review by CPUC CEQA Unit Staff and outside consultants; and
4. Promote transparency and reduce the potential for conflicts between utility and CPUC Staff about the types, scope, and thoroughness of data expected for data adequacy purposes.

The Guidelines document provides detailed instructions to Applicants for use during the Pre-filing process and PEA development. The document is intended to fully inform Applicants and focus the role of outside consultants, thus, enabling Applicants to submit more complete, useful, and immediately data-adequate PEAs.

Benefits of High Quality and Complete PEAs

CPUC CEQA Unit Staff seek to complete the environmental review process required under CEQA as quickly and efficiently as possible. Table 1 shows the average duration in months of CPUC applications that require CEQA documents. While there are tensions between speed and quality in all project management, the achievement of expeditious environmental reviews can result in lower project costs to ratepayers. Our staff have reviewed the timelines for 108 past CPUC applications that required review pursuant to CEQA and determined that the average length of time from application filing to PEA deemed complete is four months, regardless of the type of CEQA document. The goal for our agency is to deem PEAs complete within 30 days. The faster PEAs are deemed complete, the sooner staff can prepare the CEQA document. With each delay to PEA completeness, the fundamental project purpose and need and baseline circumstances may shift, requiring refreshing of the data. The Guidelines document will improve the initial accuracy of PEAs and reduce the time required to deem PEAs complete. Once an application is formally filed, the Applicant will receive a notification letter from CPUC CEQA Unit Staff when the PEA is deemed complete.

Table 1. Average Duration in Months of CPUC Applications that Require CEQA Documents (1996–2019)

	I: Application Filed to PEA Deemed Complete	II: PEA Deemed Complete to Draft Environmental Document Circulated	III: Draft Environmental Document to Final Released	IV: Final Released to Proposed Decision	V: Proposed Decision to Final Decision (with Certification of CEQA Document)	I-V: Overall Duration (1)
Environmental Impact Report (EIR; n=49)	5	13	7	5	2	**29**
Initial Study/ Mitigated Negative Declaration (IS/MND; n=56)	4	8	3	4	1	**19**
All Document Types (n=108)	4	8	4	5	2	**23**
Range: All Document Types	*1-9*	*5-18*	*2-10*	*1-7*	*1-2*	***12-38***

Note:
(1) The overall duration is not a sum of the average durations for each step. The overall duration was calculated using "n," the number of applications with data available for the date of application filing and final decision date. Not all projects had data available for each step. The data include several instances where the CEQA document was developed in conjunction with a NEPA document, e.g., an EIR/Environmental Impact Statement or IS/MND/Environmental Assessment/Finding of No Significant Impact was prepared instead of an EIR or MND, respectively. The above data is not inclusive of projects that had averages and ranges that are statistically abnormal.

Lessons Learned about the PEA Process

In the past, Applicants have filed PEAs using the checklist to ensure the correct information was provided but have not followed the format and organization of the PEA checklist and sometimes chose not to engage in Pre-filing activities with our staff. To achieve the objectives and benefits listed above, Applicants will file all future PEAs in the same organizational format as the updated checklist and adhere to the Pre-filing Consultation Guidelines in coordination with CPUC CEQA Unit Staff.

The Guidelines document describes the level effort required for the assessments necessary to not only finalize a CEQA document but ensure its legal defensibility. While final design and survey information is preferred, the PEA may incorporate preliminary design and survey data as appropriate and in consultation with CEQA Unit Staff during Pre-filing. We recognize that projects are fact specific, and deviations from the Pre-filing Consultation Guidelines and PEA Checklist are inevitable but providing concise and accurate information as soon as possible is paramount. Any deviations from these Guidelines must include clear justification and should be discussed and submitted during the Pre-filing Consultation process to avoid subsequent delays.

The PEA Checklist is written with the assumption that an Environmental Impact Report will be prepared, however, a Mitigated Negative Declaration or other form of CEQA document (e.g., exemption) may be appropriate. This determination, however, must be made in consultation with CPUC CEQA Unit Staff during Pre-filing and prior to submittal of the Draft PEA.

Future Modifications and Improvements

Like the predecessor PEA checklists, this is a working document that will be modified over time based on experience and changes to the CEQA Statute and Guidelines. To meet the above stated objectives and maintain consistency with CEQA. We expect Applicants, their consultants, CPUC consultants, and the CPUC to engage in a regular and ongoing dialogue about specific improvements to the CEQA process overall, and these Guidelines in particular.

We look forward to working with Applicants during the Pre-filing Consultation process to ensure that the level of effort that goes into preparing PEAs can be effectively and efficiently transferred into the CEQA document prepared by CPUC Staff and consultants. Applicants are invited to debrief with our staff about the efficacy of these Guidelines.

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/s/
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California Public Utilities Commission

Mary Jo Borak
/s/
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Lonn Maier
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Pre-Filing Consultation Guidelines

The following Pre-filing Consultation Guidelines apply to all PEAs filed with applications to the CPUC and outline a process for Applicants to engage with CPUC CEQA Unit Staff about upcoming projects that will require environmental review pursuant to CEQA. The CPUC is typically the Lead Agency for large projects by investor-owned gas and electric utilities. The CPUC's CEQA Unit Staff are experienced with developing robust CEQA documents for long, linear energy projects. The PEA Checklist, starting in the next section, is based upon that experience.

Pre-filing Consultation Process

During Pre-filing Consultation, Applicants and CPUC Staff meet to discuss the upcoming application. Successful projects will commence Pre-filing Consultation no less than six months prior to application filing at the CPUC. When the application is formally filed at the CPUC, the Application and the PEA are submitted to the CPUC Docket Office.

1. Meetings with CPUC Staff

To initiate Pre-filing Consultation, Applicants will request and attend a meeting with CPUC CEQA Unit Staff at least six months prior to application filing.

   a. Applicants can request a Pre-Filing Consultation meeting via email or letter. Initial contact via telephone may occur, but staff request written documentation of Pre-filing Consultation commencement.

   b. For the initial meeting, Applicants will provide staff with a summary of the proposed project including maps and basic GIS data at least one week prior to the meeting.

   c. Applicants will receive initial feedback on the scope of the proposed project and PEA. Staff will work with Applicants to establish a schedule for subsequent Pre-filing meetings and milestones.

2. Consultant Resources

CPUC CEQA Unit Staff will initiate the consultant contract immediately following the initial Pre-filing Consultation meeting. CPUC's consultant contract resources will be executed prior to Applicant filing of the Draft PEA. The consultant contract is critical to the Pre-filing Consultation process. Applicants are encouraged to request updates about the status of the contract. The CPUC may use its on-call consulting resources contract for these purposes. If CEQA Unit Staff determine that their on-call consulting resources are not appropriate due to the anticipated project scope, staff may initiate a request for proposals process to engage consulting resources, and the resulting contracting process will be completed and consultant contract in place prior to Draft PEA filing.

3. Draft PEA Provided Prior to PEA Filing

A complete Draft PEA will be filed at least three months prior to application filing. CPUC CEQA Unit Staff and the CPUC consultant team will review and provide comments on the Draft PEA to the Applicant early in the three-month period to allow time for Applicant revisions to the PEA.

4. Project Site Visits

One or more site visits will be scheduled with CPUC CEQA Unit Staff and their consultant at the time of Draft PEA filing (or prior). Appropriate federal, state, and local agencies will also be engaged at this time.

5. Consultation with Public Agencies

The Applicant and CPUC CEQA Unit Staff will jointly reach out and conduct consultation meetings with public agencies and other interested parties in the project area. CPUC CEQA Unit Staff may also choose to conduct separate consultation meetings if needed.

If a federal agency will be a co-lead pursuant to the National Environmental Policy Act and coordinating with the CPUC during the environmental review process, the Applicant and CPUC CEQA Unit Staff will ensure that the agency has the opportunity to comment on the Draft PEA and participate jointly with the CPUC throughout the application review process. Applicant and Commission CEQA Unit Staff coordination with the federal agency (if applicable) will likely need to occur more than six months in advance of application filing.

6. Alternatives Development

PEAs will be drafted with the assumption that an Environmental Impact Report (EIR) will be prepared. Applicants will include a reasonable range of alternatives in the PEA (even though a Mitigated Negative Declaration [MND] may ultimately be prepared), including sufficient information about each alternative. In some situations, CPUC CEQA Unit Staff and project Applicants may agree during Pre-filing Consultation that an MND is likely and a reasonable range of alternatives is not required for the PEA. This determination, however, must be made in consultation with CEQA Unit Staff during Pre-filing and is not final. The type of document to be prepared may change based on public scoping results and other findings during the environmental review process.

CEQA Unit Staff will provide feedback on the range of alternatives prior to Draft PEA filing (if possible) based on their review of the Draft PEA. It is critical that Applicants receive feedback from CEQA Unit Staff about the range of alternatives prior to filing the PEA. Applicants will ensure that each alternative is described and evaluated in the PEA with an equal level of detail as the proposed project unless otherwise instructed in writing by CEQA Unit Staff.

7. Format of PEA Submittal

Each PEA submittal will include the completed PEA Checklist tables. Each PEA submittal will be formatted and organized as shown in the Example PEA Table of Contents provided in the PEA Checklist unless otherwise directed by CPUC CEQA Unit Staff in writing prior to application filing. The example PEA Table of Contents is modeled after typical CPUC EIRs.

8. Transmission and Distribution System Information

A key component of CEQA projects analyzed during CPUC environmental reviews is the context of the project within the larger transmission and distribution system. Detailed descriptions of the regional transmission system, including GIS data, to which the proposed project would interconnect are required. The required level of detail about interconnecting systems is project specific and will be specified by CEQA Unit Staff in writing during Pre-filing Consultation. Detailed distribution system information may also be required.

9. Data and Technical Adequacy

Applicants will focus PEA development efforts on providing thorough, up-to-date data and technical reports required for CPUC CEQA Unit Staff to complete the environmental document and alternatives analysis.

The Applicant-drafted PEA Executive Summary, Introduction, Project Description, Description of Alternatives, and other chapters typically found in past CPUC EIRs and Initial Study/MNDs will be *thorough*—emulate the level of detail provided in typical CPUC EIRs. The setting sections provided for

PEA Chapter 5, Environmental Analysis, will also be thorough. Applicants will ensure that the PEA text, graphics, and file formats can be efficiently converted into CPUC's CEQA document with minimal revision, reformatting, and redevelopment by CPUC Staff and consultants.

The impact analyses and determinations provided for Chapter 5, Environmental Analysis, and Chapter 6, Comparison of Alternatives, need not be as thorough as those to be prepared by the CPUC for its CEQA document. These two sections are expected to be revised and redeveloped by CPUC Staff and consultants. Other sections of the CEQA document will only be revised and redeveloped by CPUC Staff and consultants if determined to be necessary after PEA filing.

10. Applicant Proposed Measures

The Pre-filing Consultation process can support the development Applicant Proposed Measures (APMs); measures that Applicants incorporate into the PEA project description to avoid or reduce what otherwise may be considered significant impacts. APMs that use phrases, such as, "as practicable," "as needed," or other conditional language will be superseded by Mitigation Measures if required to avoid or reduce a potentially significant impact. CPUC CEQA Unit Staff and their consultant team may review and provide comments on the Draft PEA APMs during Pre-filing Consultation.

Applicants will carefully consider each CPUC Draft Environmental Measure identified in Chapter 5 of this PEA Checklist. The measures may be applied to the proposed project if appropriate and may be subject to modification by the CPUC during its environmental review.[1]

11. PEA Checklist Deviations

CPUC CEQA Unit Staff understand that the PEA Checklist requires Applicants to develop a significant quantity of information. There are times when it is appropriate to deviate from the PEA Checklist. Deviations to the Pre-Filing Consultation Guidelines or the PEA Checklist contents may be approved by the CPUC's CEQA Unit Staff. Staff approval will be in writing and will occur prior to Applicant filing of the Draft PEA. Note that any deviations approved in writing by staff during the Pre-filing period may be reversed or modified after application and PEA filing and at any time throughout the environmental review period at the discretion of CPUC CEQA Unit Staff.

12. Submittal of Confidential Information

CPUC Staff are available during Pre-filing Consultation to discuss concerns that Applicants may have about confidentiality. However, the CEQA process requires public disclosure about projects, and such disclosure can often appear to conflict with Applicant requests for confidentiality. CPUC CEQA Unit Staff will rely on CPUC adopted confidentiality procedures to resolve confidentiality concerns. Applicants that expect aspects of a PEA filing to be confidential must follow CPUC confidentiality procedures. Applicants may mark information as confidential if allowed pursuant to General Order 66 or latest applicable Commission rule (e.g., see Public Records Act Proceeding Rulemaking (R.14-11-001).

13. Additional CEQA Impact Questions

Additional CEQA Impact Questions that are specific to the types of projects evaluated by the Commission's CEQA Unit are identified in the PEA Checklist to be considered in addition to the checklist items in CEQA Guidelines Appendix G.

The next section of this Guidelines document provides the PEA Checklist for all energy project applications that require CEQA compliance.

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[1] At this time, the CPUC environmental measures are in draft format, see PEA Checklist Attachment 4. They may be formally incorporated into Chapter 5 of future versions of the PEA Checklist.

Proponent's Environmental Assessment (PEA) Checklist

The PEA Checklist provides project Applicants (e.g., projects involving electric transmission lines, electric substations or switching stations, natural gas transmission pipelines, and underground natural gas storage facilities) with detailed guidance regarding the level of detail CPUC CEQA Unit Staff expect to deem PEAs complete. Applicants will prepare their PEAs using the same section headers and numbering as provided in the PEA Checklist. Applicants will also provide supporting data that is specific to each item within the PEA Checklist. As noted in the Pre-Filing Consultation Guidelines, the PEA Checklist is written with the assumption that an EIR will be prepared. PEA contents may not need to support the development of an EIR, but this determination can only be made in consultation with CPUC CEQA Unit Staff as described in the Pre-Filing Consultation Guidelines.

Formatting and Basic PEA Data Needs, Including GIS Data

1. Provide **editable and fully functional source files** in electronic format for all PDF files, hardcopies, maps, images, and diagrams. Files will be provided in their original file format as well as the output file format. All Excel and other spreadsheet files or modeling files will include all underlying formulas/modeling details. All modeling files must be fully functional.
2. Details about the types of **GIS data and maps** to be submitted are provided in Attachment 1. GIS data not specified in this checklist may also be requested depending on the Proposed Project and alternatives.
3. The Applicant is responsible for ensuring that all project features, including project components and temporary and permanent work areas, are included within all **survey boundaries** (e.g., biological and cultural resources).
4. Excel spreadsheets with **emissions calculations** will be provided that are complete with all project assumptions, values, and formulas used to prepare emissions calculations in the PEA. Accompanying PDF files with the same information will be provided as Appendix B to the PEA (see List of Appendices below).
5. Applicants will provide in an Excel spreadsheet a comprehensive **mailing list** that includes the names and addresses of all affected landowners and residents, including unit numbers for multi-unit properties for both the proposed project <u>and alternatives</u>.
    a. An affected resident or landowner is defined as one whose place of residence or property is:
        i. Crossed by or abuts any component of the proposed project or an alternative including any permanent or temporary disturbance area (either above or below ground) and any extra work area (e.g., staging or parking area); or
        ii. Located within approximately 1,000 feet[2] of the edge of any construction work area.
    b. Include in the following information for each resident in a spreadsheet, at minimum: parcel APN number, owner name and mailing address, and parcel physical address. If individual occupant names, facility names, or business names are available, also provide these names and addresses in the spreadsheet. A sample mailing list format is provided in Table 2.

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[2] Notice to all property owners within 300 feet of a Proposed Project is required at the time of application filing under GO 131-D. Commission notices of CEQA document preparation may be mailed to residents and property owners greater than 300 feet from a Proposed Project to ensure adequate notification (e.g., 1,000 feet) and the extent of notification will be determined on a project specific basis. Appropriate notice expectations will be discussed during Pre-filing (e.g., with respect to visual impact areas and other types of impacts specific to the Proposed Project and its study area).

Table 2. Sample Project Mailing List

Category	Company/ Agency	Name	Mailing Address	Phone Number	Email	APN	Source
State Agency	California Resources Agency	John Doe	1234 California Street City, CA 98765	(333) 456-7899	johndoe@email.com	123-456-789	County Assessor
Individual	n/a	Jane Doe	222 Main Street City, CA 97531	(909) 876-5432	janedoe@email.com	101-202-303	Public meeting on Month, Day 2019

6. **PEA Organization:** This PEA Checklist is organized to include each of the chapters and sections found in typical CPUC EIRs. The following sections will serve as the outline for all Draft PEAs submitted during Pre-filing and all PEAs filed with the CPUC Docket Office. PEAs will include each chapter and section identified (in matching numerical order) unless otherwise directed by CPUC CEQA Unit Staff in writing prior to filing.

Cover

A single sheet with the following information:	Applicant Notes, Comments
Title "Proponent's Environmental Assessment" and filing date	
Proponent Name (the Applicant)	
Name of the proposed project[3]	
Technical subheading summarizing the type of project and its major components, in one sentence or about 40 words, for example: A new 1,120 MVA, 500/115kV substation, 10 miles of new singled-circuit 500kV transmission lines, 25 miles of new and replaced double-circuit 115kV power lines, and upgrades at three existing substations are proposed.	
Location of the proposed project (all counties and municipalities or map figure for the cover that shows the areas crossed)	
Proceeding for which the PEA was prepared and CPUC Docket number (if known) or simply leave a blank where the Docket number would go	
Primary Contact's name, address, telephone number, and email address for both the project Applicant(s) and entities that prepared the PEA	
See example PEA cover in Figure 1.	

[3] If approved by the California Independent System Operator (CAISO), the project name listed will match the name specified in the CAISO approval. If multiple names apply, list all versions.

Figure 1. Example PEA Cover

Proponent's Environmental Assessment for California Utility Company's Evergreen Electric Substation and Transmission Line Project

May 1, 2019 (PEA filing date)

A new 230 kV substation, 10 miles of new single-circuit 230kV transmission lines, and upgrades at two existing substations are proposed.

The Proposed Project would be located primarily in __ County but would also cross __ and __ counties and areas within the City of __.

Application A.19-05-01 to the California Public Utilities Commission

Prepared by California Environmental Consulting
1234 Avenue
City, CA Zip Code
Primary Contact's Name
Position
Phone Number
Email

Prepared for California Utility Company
1234 Avenue
City, CA Zip Code
Primary Contact's Name
Position
Phone Number
Email

Table of Contents

Sections

Order	The format of the PEA will be organized as follows:	Applicant Notes, Comments
--	Cover	
--	Table of Contents, List of Tables, List of Figures, List of Appendices	
1	Executive Summary	
2	Introduction	
3	Proposed Project Description	
4	Description of Alternatives	
5	Environmental Analysis	
5.1	Aesthetics	
5.2	Agriculture and Forestry	
5.3	Air Quality	
5.4	Biological Resources	
5.5	Cultural Resources	
5.6	Energy	
5.7	Geology, Soils, and Paleontological Resources	
5.8	Greenhouse Gas Emissions	
5.9	Hazards, Hazardous Materials, and Public Safety	
5.10	Hydrology and Water Quality	
5.11	Land Use and Planning	
5.12	Mineral Resources	
5.13	Noise	
5.14	Population and Housing	
5.15	Public Services	
5.16	Recreation	
5.17	Transportation	
5.18	Tribal Cultural Resources	
5.19	Utilities and Service Systems	
5.20	Wildfire	
5.21	Mandatory Findings of Significance	
6	Comparison of Alternatives	

7	Cumulative Impacts and Other CEQA Considerations	
8	List of Preparers	
9	References[4]	
--	Appendices	

Required PEA Appendices and Supporting Materials

Order	Title	Applicant Notes, Comments
Appendix A	Detailed Maps and Design Drawings	
Appendix B	Emissions Calculations	
Appendix C	Biological Resources Technical Reports (see Attachment 2)	
Appendix D	Cultural Resources Studies (see Attachment 3)	
Appendix E	Detailed Tribal Consultation Report[5]	
Appendix F	Environmental Data Resources Report, Phase I Environmental Site Assessment, or similar hazardous materials report	
Appendix G	Agency Consultation and Public Outreach Report and Records of Correspondence	
Appendix H	Construction Fire Prevention Plan[6]	

Potentially Required[7] Appendices and Supporting Materials

Order	Title	Applicant Notes, Comments
Appendix I	Noise Technical Studies	
Appendix J	Traffic Studies	
Appendix K	Geotechnical Investigations (may preliminary at time of PEA filing)	
Appendix L	Hazardous Substance Control and Emergency Response Plan / Hazardous Waste and Spill Prevention Plan	

4 References will be organized by section but contained in a single chapter called, "References."
5 Include summary and timing of all correspondence to and from any Tribes and the State Historic Preservation Office/Native American Heritage Commission, including Sacred Lands File search results, and full description of any issues identified by Tribes in their interactions with the Applicant.
6 The Construction Fire Prevention Plan will be provided to federal, state, and local fire agencies for review and comment as applicable to where components of the proposed project would be located. CPUC will approve the final Construction Fire Prevention Plan. Record of the request for review and comment and any comments received from these agencies will be provided to CPUC CEQA Unit Staff.
7 Anticipated Appendix and study requirements should be discussed with CPUC CEQA Unit Staff during Pre-filing.

Appendix M	Erosion and Sedimentation Control Best Management Practice Plan / Draft Storm Water Pollution Prevention Plan (may be preliminary at time of PEA filing)	
Appendix N	FAA Notice and Criteria Tool Results	
Appendix O	Revegetation or Site Restoration Plan	
Appendix P	Health and Safety Plan	
Appendix Q	Existing Easements[8]	
Appendix R	Blasting Plan (may be preliminary at time of PEA filing)	
Appendix S	Traffic Control/Management Plan (may be preliminary at time of PEA filing)	
Appendix T	Worker Environmental Awareness Program (may preliminary at time of PEA filing)	
Appendix U	Helicopter Use and Safety Plan (may be preliminary at time of PEA filing)	
Appendix V	Electric and Magnetic Fields Management Plan (may be part of the Application rather than the PEA)	

[8] Easements should be provided military lands, conservation easements, or other lands where the real estate agreement specifies the range of activities that can be conducted

1 Executive Summary

This section will include, but is not limited to, the following:	PEA Section and Page Number[9]	Applicant Notes, Comments
1.1: Proposed Project Summary. Provide a summary of the proposed project and its underlying purpose and basic objectives.		
1.2: Land Ownership and Right-of-Way Requirements. Provide a summary of the existing and proposed land ownership and rights-of-way for the proposed project.		
1.3: Areas of Controversy. Identify areas of anticipated controversy and public concern regarding the project.		
1.4: Summary of Impacts a) Identify all impacts expected by the Applicant to be potentially significant. Identify and discuss Applicant Proposed Measures here and provide a reference to the full listing of Applicant Proposed Measures provided in the table described in Section 3.11 of this PEA Checklist. b) Identify any significant and unavoidable impacts that may occur.		
1.5: Summary of Alternatives. Summarize alternatives that were considered by the Applicant and the process and criteria that were used to select the proposed project.		
1.6: Pre-filing Consultation and Public Outreach Summary. Briefly summarize Pre-filing consultation and public outreach efforts that occurred and identify any significant outcomes that were incorporated into the proposed project.		
1.7: Conclusions. Provide a summary of the major PEA conclusions.		
1.8: Remaining Issues. Describe any major issues that must still be resolved.		

9 The *PEA Section and Page Number* column and *Applicant Notes, Comments* column are intended to be filled out and provided with PEA submittals. The PEA Checklist is provided in Word to all Applicants to allow column resizing as appropriate to reduce PEA checklist length when completed for submittal. Landscape formatting may also be appropriate for completed PEA Checklist tables.

2 Introduction

2.1 Project Background

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
2.1.1: Purpose and Need a) Explain why the proposed project is needed. b) Describe localities the proposed project would serve and how the project would fit into the local and regional utility system. c) If the proposed project was identified by the California Independent System Operator (CAISO), thoroughly describe the CAISO's consideration of the proposed project and provide the following information: i. Include references to all CAISO Transmission Planning Processes that considered the proposed project. ii. Explain if the proposed project is considered an economic, reliability, or policy-driven project or a combination thereof. iii. Identify whether and how the Participating Transmission Owner recommended the project in response to a CAISO identified need, if applicable. iv. Identify if the CAISO approved the original scope of the project or an alternative and the rationale for their approval either for the original scope or an alternative. v. Identify how and whether the proposed project would exceed, combine, or modify in any way the CAISO identified project need. vi. If the Applicant was selected as part of a competitive bid process, identify the factors that contributed to the selection and CAISO's requirements for in-service date. d) If the project was not considered by the CAISO, explain why.		
(Natural Gas Storage Only) e) Provide storage capacity or storage capacity increase in billion cubic feet. If the project does not increase capacity, make this statement. f) Describe how existing storage facilities will work in conjunction with the proposed project. Describe the purchasing process (injection, etc.) and transportation arrangements this facility will have with its customers.		
2.1.2: Project Objectives a) Identify and describe the basic project objectives.[10] The objectives will include reasons for constructing the project based on its		

[10] Tangential project goals should not be included as basic project objectives, such as, minimizing environmental impacts, using existing ROWs and disturbed land to the maximum extent feasible, ensuring safety during construction and operation, building on property already controlled by the Applicant/existing site control. Goals of this type do not describe the underlying purpose or basic objectives but, rather, are good general practices for all projects.

purpose and need (i.e., address a specific reliability issue). The description of the project objectives will be sufficiently detailed to permit CPUC to independently evaluate the project need and benefits to accurately consider them in light of the potential environmental impacts. The basic project objectives will be used to guide the alternatives screening process, when applicable. b) Explain how implementing the project will achieve the basic project objectives and underlying purpose and need. c) Discuss the reasons why attainment of each basic objective is necessary or desirable.		
2.1.3: Project Applicant(s). Identify the project Applicant(s) and ownership of each component of the proposed project. Describe each Applicant's utility services and their local and regional service territories.		

2.2 Pre-filing Consultation and Public Outreach[11]

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
2.2.1: Pre-filing Consultation and Public Outreach a) Describe all Pre-filing consultation and public outreach that occurred, such as, but not limited to: i. CAISO ii. Public agencies with jurisdiction over project areas or resources that may occur in the project area iii. Native American tribes affiliated with the project area iv. Private landowners and homeowner associations v. Developers for large housing or commercial projects near the project area vi. Other utility owners and operators vii. Federal, state, and local fire management agencies b) Provide meeting dates, attendees, and discussion summaries, including any preliminary concerns and how they were addressed and any project alternatives that were suggested. c) Clearly identify any significant outcomes of consultation that were incorporated into the proposed project. d) Clearly identify any developments that could coincide or conflict with project activities (i.e., developments within or adjacent to a proposed ROW).		
2.2.2: Records of Consultation and Public Outreach. Provide contact information, notification materials, meeting dates and materials, meeting notes, and records of communication organized by entity as an Appendix to the PEA (Appendix G).		

[11] CPUC CEQA Unit Staff request that consultation and public outreach that occurs during the Pre-filing period and throughout environmental review include the assigned CPUC Staff person and CPUC consultant.

2.3 Environmental Review Process

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
2.3.1: Environmental Review Process. Provide a summary of the anticipated environmental review process and schedule.		
2.3.2: CEQA Review a) Explain why CPUC is the appropriate CEQA Lead agency. b) Identify other state agencies and any federal agencies that may have discretionary permitting authority over any aspect of the proposed project. c) Identify all potential involvement by federal, state, and local agencies not expected to have discretionary permitting authority (i.e., ministerial actions). d) Summarize the results of any preliminary outreach with these agencies as well as future plans for outreach.		
2.3.3: NEPA Review (if applicable). If review according to the National Environmental Policy Act (NEPA) is expected, explain the portions of the project that will require the NEPA review process. Discuss which agency is anticipated to be the NEPA Lead agency if discretionary approval by more than one federal agency is required.		
2.3.4: Pre-filing CEQA and NEPA Coordination. Describe the results of Pre-filing coordination with CEQA and NEPA review agencies (refer to CPUC's Pre-Filing Consultation Guidelines). Identify major outcomes of the Pre-filing coordination process and how the information was incorporated into the PEA, including suggestions on the type of environmental documents and joint or separate processes based on discussions with agency staff.		

2.4 Document Organization

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
2.4: PEA Organization. Summarize the contents of the PEA and provide an annotated list of its sections.		

3 Proposed Project Description[12]

3.1 Project Overview

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.1: Project Overview a) Provide a concise summary of the proposed project and components in a few paragraphs. b) Described the geographical location of the proposed project (i.e., county, city, etc.). c) Provide an overview map of the proposed project location.		

3.2 Existing and Proposed System

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.2.1: Existing System a) Identify and describe the existing utility system that would be modified by the proposed project, including connected facilities to provide context. Include detailed information about substations, transmission lines, distribution lines, compressor stations, metering stations, valve stations, nearby renewable generation and energy storage facilities, telecommunications facilities, control systems, SCADA systems, etc. b) Provide information on users and the area served by the existing system features. c) Explain how the proposed project would fit into the existing local and regional systems. d) Provide a schematic diagram of the existing system features. e) Provide detailed maps and associated GIS data for existing facilities that would be modified by the proposed project.		
3.2.2: Proposed Project System a) Describe the whole of the proposed project by component, including all new facilities and any modifications, upgrades, or expansions to existing facilities and any interrelated activities that are part of the whole of the action. b) Clearly identify system features that would be added, modified, removed, disconnected and left in place, etc. c) Identify the expected capacities of the proposed facilities, highlighting any changes from the existing system. If the project would not change existing capacities, make this statement. For electrical projects, provide the anticipated capacity increase in amps or megawatts or in the typical units for the types of facilities proposed. For gas projects, provide the total volume of gas to be		

12 Applicant review of the Administrative Draft Project Description or sections of the Administrative Draft Project Description prepared for the CEQA document may be requested by CPUC CEQA Unit Staff to ensure technical accuracy.

delivered by the proposed facilities, anticipated system capacity increase (typically in million cubic feet per day), expected customers, delivery points and corresponding volumes, and the anticipated maximum allowable operating pressure(s). d) Describe the initial buildout and eventual full buildout of the proposed project facilities. For example, if an electrical substation or gas compressor station would be installed to accommodate additional demand in the future, then include the designs for both the initial construction based on current demand and the design for all infrastructure that could ultimately be installed within the planned footprint of an electric substation or compressor station. e) Explain whether the electric line or gas pipeline will create a second system tie or loop for reliability. f) Provide information on users and the area served by the proposed system features, highlighting any differences from the existing system. g) Provide a schematic diagram of the proposed system features. h) Provide detailed maps and associated GIS data for proposed facilities that would be installed, modified, or relocated by the proposed project.		
3.2.3: System Reliability. Explain whether the electric line or gas pipeline will create a second system tie or loop for reliability. Clearly explain and show how the proposed project relates to and supports the existing utility systems.		
3.2.4: Planning Area. Describe the system planning area served or to be served by the project. Clearly define the Applicant's term for the planning area (e.g., Electrical Needs Area or Distribution Planning Area).		

3.3 Project Components

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
Required for all Project Types		
3.3.1: Preliminary Design and Engineering a) Provide preliminary design and engineering information for all above-ground and below-ground facilities for the proposed project. The approximately locations, maximum dimensions of facilities, and limits of areas that would be needed to construction and operate the facilities should be clearly defined.[13] b) Provide preliminary design drawings for project features and explain the level of completeness (i.e., percentage). c) Provide detailed project maps (approximately 1:3,000 scale) and associated GIS data of all facility locations and boundaries with attributes and spatial geometry that corresponds to information in the Project Description.		

[13] Refer to Attachment 1 for mapping and GIS data requirements for the project layout and design.

3.3.2: Segments, Components, and Phases a) Define all project segments, components, and phases for the proposed project. b) Provide the length/area of each segment or component, and the timing of each development phase. c) Provide an overview map showing each segment and provide associated GIS data (may be combined with other mapping efforts).		
3.3.3: Existing Facilities a) Identify the types of existing facilities that would be removed or modified by the proposed project (i.e., conductor/cable, poles/towers, substations, switching stations, gas storage facilities, gas pipelines, service buildings, communication systems, etc.). b) Describe the existing facilities by project segment and/or component, and provide information regarding existing dimensions, areas/footprints, quantities, locations, spans, etc. c) Distinguish between above-ground and below-ground facilities and provide both depth and height ranges for each type of facility. For poles/towers, provide the installation method (i.e., foundation type or direct bury), and maximum above-ground heights and below-ground depths. d) Explain what would happen to the existing facilities. Would they be replaced, completely removed, modified, or abandoned? Explain why. e) Identify the names, types, materials, and capacity/volumes ranges (i.e., minimum and maximum) of existing facilities that would be installed or modified by the proposed project. f) Provide diagrams with dimensions representing existing facilities to provide context on how the proposed facilities would be different. g) Briefly describe the surface colors, textures, light reflectivity, and any lighting of existing facilities.		
3.3.4: Proposed Facilities a) Identify the types of proposed facilities to be installed or modified by the proposed project (e.g., conductor/cable, poles/towers, substations, switching stations, gas storage facilities, gas pipelines, service buildings, communication systems). b) Describe the proposed facilities by project segment and/or component, and provide information regarding maximum dimensions, areas/footprints, quantities, locations, spans, etc. c) Distinguish between above-ground and below-ground facilities and provide both depth and height ranges for each type of facility. For poles/towers, provide the installation method (i.e., foundation type or direct bury), and maximum above-ground heights and below-ground depths.		

d) Identify where facilities would be different (e.g., where unique or larger poles would be located, large guy supports or snub poles). e) Provide details about civil engineering requirements (i.e., permanent roads, foundations, pads, drainage systems, detention basins, spill containment, etc.). f) Distinguish between permanent facilities and any temporary facilities (i.e., poles, shoo-fly lines, mobile substations, mobile compressors, transformers, capacitors, switch racks, compressors, valves, driveways, and lighting). g) Identify the names, types, materials, and capacity/volumes ranges (i.e., minimum and maximum) of proposed facilities that would be installed or modified by the proposed project. h) Provide diagrams with dimensions representing existing facilities. i) Briefly describe the surface colors, textures, light reflectivity, and any lighting of proposed facilities.		
3.3.5: Other Potentially Required Facilities a) Identify and describe in detail any other actions or facilities that may be required to complete the project. For example, consider the following questions: i. Could the project require the relocation (temporary or permanent), modification, or replacement of unconnected utilities or other types of infrastructure by the Applicant or any other entity? ii. Could the project require aviation lighting and/or marking? iii. Could the project require additional civil engineering requirements to address site conditions or slope stabilization issues, such as pads and retaining walls, etc.? b) Provide the location of each facility and a description of the facility.		
3.3.6: Future Expansions and Equipment Lifespans a) Provide detailed information about the current and reasonably foreseeable plans for expansion and future phases of development. b) Provide the expected usable life of all facilities. c) Describe all reasonably foreseeable consequences of the proposed project (e.g., future ability to upgrade gas compressor station to match added pipeline capacity).		
Required for Certain Project Types		
3.3.7: Below-ground Conductor/Cable Installations (as Applicable) a) Describe the type of line to be installed (e.g., single circuit cross-linked polyethylene-insulated solid-dielectric, copper-conductor cables). b) Describe the type of casing the cable would be installed in (e.g., concrete-encased duct bank system) and provide the dimensions of the casing.		

c) Describe the types of infrastructure would likely be installed within the duct bank (e.g., transmission, fiber optics, etc.).		
3.3.8: Electric Substations and Switching Stations (as Applicable) a) Provide the number of transformer banks that will be added at initial and full buildout of the substation. Identify the transformer voltage and number of each transformer type. b) Identify any gas insulated switchgear that will be installed within the substation. c) Describe any operation and maintenance facilities, telecommunications equipment, and SCADA equipment that would be installed within the substation.		
3.3.9: Gas Pipelines (as Applicable). For each segment: a) Identify pipe diameter, number and length of exposed sections, classes and types of pipe to be installed, pressure of pipe, and cathodic protection for each linear segment. b) Describe new and existing inspection facilities (e.g., pig launcher sites). c) Describe system cross ties and laterals/taps. d) Identify the spacing between each valve station. e) Describe the compressor station, if needed, for any new or existing pipeline. f) Describe all pipelines and interconnections with existing and proposed facilities: i. Number of interconnections and locations and sizes; ii. All below-ground and above-ground installations; and iii. All remote facility locations for metering, telemetry, control.		
3.3.10: Gas Storage Facilities – Background and Resource Information (as Applicable) a) Provide detailed background information on the natural gas formation contributing to the existing or proposed natural gas facility, including the following: i. Description of overlying stratigraphy, especially caps ii. Description of production, injection, and intervening strata iii. Types of rock iv. Description of types of rocks in formation, including permeability or fractures v. Thickness of strata b) Provide a graphic and/or table showing formation thicknesses. c) Identify and describe any potential gas migration pathways, such as faults, permeable contacts, abandoned wells, underground water or other pipelines. d) Provide a summary and detailed cross-section diagrams of the geologic formations and structures of the oil/gas field or area. e) Provide the first well drilling and production history, abandonment procedures, inspections, etc. f) Describe production zones, including depth, types of formations, and characteristics of field/area.		

g) Describe the existing and proposed storage capacity and limiting factors, such as injection or withdrawal capacities. h) Describe existing simulation studies that were used to predict the reservoir pressure response under gas injection and withdrawal operations, and simulation studies for how the system would change as proposed. Provide the studies as a PEA Appendix. i) Provide the history of the oil/gas field or area.		
3.3.11: Gas Storage Facilities – Well-Head Sites (as Applicable). Describe the location, depth, size and completion information for all existing, abandoned, proposed production and injection, monitoring, and test wells.		
3.3.12: Gas Storage Facilities – Production and Injection (as Applicable) a) Provide the proposed storage capacity of production and injection wells. b) Provide production and injection pressures, depths, and rates. c) Provide production and injection cycles by day, week, and year. d) Describe existing and proposed withdrawal/production wells (i.e., size, depth, formations, etc.). e) Describe existing and proposed cushion gas requirements. f) Describe any cushion gas injection—formation the well is completed in (cushion gas formation), and injection information.		
3.3.13: Gas Storage Facilities – Electrical Energy (as Applicable). Describe all existing and proposed electric lines, telecommunications facilities, and other utilities/facilities (e.g., administrative offices, service buildings, and non-hazardous storage), and chemical storage associated with the proposed project.		
3.3.14: Telecommunication Lines (as Applicable) a) Identify the type of cable that is proposed and length in linear miles by segment. b) Identify any antenna and node facilities that are part of the project. c) For below-ground telecommunication lines, provide the depth of cable and type of conduit. d) For above-ground telecommunication lines, provide: i. Types of poles that will be installed (if new poles are required) ii. Where existing poles will be used iii. Any additional infrastructure (e.g., guy wires) or pole changes required to support the additional cable on existing poles		

3.4 Land Ownership, Rights-of-Way, and Easements

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.4.1: Land Ownership. Describe existing land ownership where each project component would be located. State whether the proposed		

project would be located on property(ies) owned by the Applicant or if additional property would be required.		
3.4.2: Existing Rights-of-Way or Easements a) Identify and describe existing rights-of-way (ROWs) or easements where project components would be located. Provide the approximately lengths and widths in each project area. b) Clearly state if project facilities would be replaced, modified, or relocated within existing ROWs or easements.		
3.4.3: New or Modified Rights-of-Way or Easements a) Describe new permanent or modified ROWs or easements that would be required. Provide the approximately lengths and widths in each project area. b) Describe how any new permanent or modified ROWs or easements would be acquired. c) Provide site plans identifying all properties/parcels and partial properties/parcels that may require acquisition and the anticipated ROWs or easements. Provide associated GIS data. d) Describe any development restrictions within new ROWs or easements, e.g., building clearances and height restrictions, etc. e) Describe any relocation or demolition of commercial or residential property/structures that may be necessary.		
3.4.4: Temporary Rights-of-Way or Easements f) Describe temporary ROWs or easements that would be required to access project areas, including ROWs or easements for temporary construction areas (i.e., staging areas or landing zones). g) Explain where temporary construction areas would be located with existing ROWs or easements for the project or otherwise available to the Applicant without a temporary ROW or easement. h) Describe how any temporary ROWs or easements would be acquired.		

3.5 Construction

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.5.1 Construction Access (All Projects)		
3.5.1.1: Existing Access Roads a) Provide the lengths, widths, ownership details (both public and private roads), and surface characteristics (i.e., paved, graveled, bare soil) of existing access roads that would be used during construction. Provide the area of existing roads that would be used (see example in Table 3 below). b) Describe any road modifications or stabilization that would be required prior to construction, including on the adjacent road		

shoulders or slopes. Identify any roads that would be expanded and provide the proposed width increases. c) Describe any procedures to address incidental road damage cause by project activities following construction. d) Provide detailed maps and associated GIS data for all existing access roads.		

Table 3. Access Roads

Type of Road	Description	Area Proposed Project
Existing Dirt Road	Typically double track. May have been graded previously. No other preparation required, although a few sections may need to be re-graded and crushed rock applied in very limited areas for traction.	_____ acres
New Permanent	Would be xx feet wide, bladed. No other preparation required although crushed rock may need to be applied in very limited areas for traction.	_____ acres
Overland Access	No preparation required. Typically grassy areas that are relatively flat. No restoration would be necessary.	_____ acres

3.5.1.2: New Access Roads a) Identify any new access roads that would be developed for project construction purposes, such as where any blading, grading, or gravel placement could occur to provide equipment access outside of a designated workspace.[14] b) Provide lengths, widths, and development methods for new access roads. c) Identify any temporary or permanent gates that would be installed. d) Clearly identify any roads that would be temporary and fully restored following construction. Otherwise it will be assumed the new access road is a permanent feature. e) Provide detailed maps and associated GIS data for all new access roads.		
3.5.1.3: Overland Access Routes a) Identify any overland access routes that would be used during construction, such as where vehicles and equipment would travel over existing vegetation and where blading, grading, or gravel placement would occur. b) Provide lengths and widths for new access roads. c) Provide detailed maps and associated GIS data for all overland access routes.		
3.5.1.4: Watercourse Crossings a) Identify all temporary watercourse crossings that would be required during construction. Provide specific methods and procedures for temporary watercourse crossings.		

[14] Temporary roads that would not require these activities should be considered an overland route.

b) Describe any bridges or culverts that replacement or installation of would be required for construction access. c) Provide details about the location, design and construction methods.		
3.5.1.5: Helicopter Access. If helicopters would be used during construction: a) Describe the types and quantities of helicopters that would be used during construction (e.g., light, medium, heavy, or sky crane), and a description of the activities that each helicopter would be used for. b) Identify areas for helicopter takeoff and landing. c) Describe helicopter refueling procedures and locations. d) Describe flight paths, payloads, and expected hours and durations of helicopter operation. e) Describe any safety procedures or requirements unique to helicopter operations, such as but not limited to obtaining a Congested Area Plan from the Federal Aviation Administration (FAA).		
3.5.2 Staging Areas (All Projects)		
3.5.2.1: Staging Area Locations a) Identify the locations of all staging area(s). Provide a map and GIS data for each.[15] b) Provide the size (in acres) for each staging area and the total staging area requirements for the project.		
3.5.2.2: Staging Area Preparation a) Describe any site preparation required, if known, or generally describe what might be required (i.e., vegetation removal, new access road, installation of rock base, etc.). b) Describe what the staging area would be used for (i.e., material and equipment storage, field office, reporting location for workers, parking area for vehicles and equipment, etc.). c) Describe how the staging area would be secured. Would a fence be installed? If so, describe the type and extent of the fencing. d) Describe how power to the site would be provided if required (i.e., tap into existing distribution, use of diesel generators, etc.). e) Describe any temporary lightning facilities for the site. f) Describe any grading activities and/or slope stabilization issues.		

[15] While not all potential local site staging areas will be known prior to selection of a contractor, it is expected that approximate area and likely locations of staging areas be disclosed. The identification of extra or optional staging areas should be considered to reduce the risk of changes after project approval that could necessitate further CEQA review.

3.5.3 Construction Work Areas (All Projects)		
3.5.3.1: Construction Work Areas a) Describe known work areas that may be required for specific construction activities (e.g., pole assembly, hillside construction)[16] b) Describe the types of activities that would be performed at each work area. Work areas may include but are not necessarily limited to: i. Helicopter landing zones and touchdown areas ii. Vehicle and equipment parking, passing, or turnaround areas iii. Railroad, bridge, or watercourse crossings iv. Temporary work pads for facility installation, modification, or removal v. Excavations and associated equipment work areas vi. Temporary guard structures vii. Pull-and-tension/stringing sites viii. Jack and bore pits, drilling areas and pull-back areas for horizontal directional drills ix. Retaining walls		
3.5.3.2 Work Area Disturbance a) Provide the dimensions of each work area including the maximum area that would be disturbed during construction (e.g., 100 feet by 200 feet) (see example in Table 4 below). b) Provide a table with temporary and permanent disturbance at each work area (in square feet or acres), and the total area of temporary and permanent disturbance for the entire project (in acres).		
3.5.3.3: Temporary Power. Identify how power would be provided at work area (i.e., tap into existing distribution, use of diesel generators, etc.). Provide the disturbance area for any temporary power lines.		
3.5.4 Site Preparation (All Projects)		
3.5.4.1: Surveying and Staking. Describe initial surveying and staking procedures for site preparation and access.		
3.5.4.2: Utilities a) Describe the process for identifying any underground utilities prior to construction (i.e., underground service alerts, etc.). b) Describe the process for relocating any existing overhead or underground utilities that aren't directly connected to the project system. c) Describe the process for installing any temporary power or other utility lines for construction.		

[16] Understanding that each specific work area may not be determined until the final work plan is submitted by the construction contractor, estimate total area likely to be disturbed.

Table 4. Work Areas

	Proposed Project (approximate metrics)
Pole Diameter: • Wood • Self-Supporting Steel	 _____ inches _____inches
Lattice Tower Base Dimension: • Self-Supporting Lattice Structure	_____feet
Auger Hole Depth: • Wood • Self-Supporting Steel	 _____ to _____ feet _____ to _____ feet
Permanent Footprint per Pole/Tower: • Wood • Self-Supporting Steel • Self-Supporting Steel Tower	 _____ sq. feet _____ sq. feet _____ sq. feet
Number of Poles/Towers: • Wood • Self-Supporting Steel • Self-Supporting Steel Tower	 _____ _____ _____
Average Work Area around Pole/Towers (e.g., for old pole removal and new pole installation): • Tangent structure work areas • Dead End / Angle structure work areas	 _____ sq. feet _____ sq. feet
Total Permanent Footprint for Poles/Towers	Approximately _____ acres

3.5.4.3: Vegetation Clearing a) Describe what types of vegetation clearing may be required (e.g., tree removal, brush removal, flammable fuels removal) and why (e.g., to provide access, etc.). b) Provide calculations of temporary and permanent disturbance of each vegetation community and include all areas of vegetation removal in the GIS database. Distinguish between disturbance that would occur in previously developed areas (i.e., paved, graveled, or otherwise urbanized), and naturally vegetated areas. c) Describe how each type of vegetation removal would be accomplished. d) Describe the types of equipment that would be used for vegetation removal.		
3.5.4.4: Tree Trimming Removal a) For electrical projects, distinguish between tree trimming as required under CPUC General Order 95-D and tree removal. b) Identify the types, locations, approximate numbers, and sizes of trees that may need to be removed or trimmed substantially. c) Identify potentially protected trees that may be removed or substantially trimmed, such as but not limited to riparian trees, oaks trees, Joshua trees, or palm trees.		

d) Describe the types of equipment that would typically be used for tree removal.		
3.5.4.5: Work Area Stabilization. Describe the processes to stabilize temporary work areas and access roads including the materials that would be used (e.g., gravel).		
3.5.4.6: Grading a) Describe any earth moving or substantial grading activities (i.e., grading below a 6-inch depth) that would be required and identify locations where it would occur. b) Provide estimated volumes of grading (in cubic yards) including total cut, total fill, cut that would be reused, cut that would be hauled away, and clean fill that would be hauled to the site.		
3.5.5 Transmission Line Construction (Above Ground)		
3.5.5.1: Poles/Towers a) Describe the process and equipment for removing poles, towers, and associated foundations for the proposed project (where applicable). Describe how they would be disconnected, demolished, and removed from the site. Describe backfilling procedures and where the material would be obtained. b) Describe the process and equipment for installing or otherwise modifying poles and towers for the proposed project. Describe how they would be put into place and connected to the system. Identify any special construction methods (e.g., helicopter installation) at specific locations or specific types of poles/towers. c) Describe how foundations, if any, would be installed. Provide a description of the construction method(s), approximate average depth and diameter of excavation, approximate volume of soil to be excavated, approximate volume of concrete or other backfill required, etc. for foundations. Describe what would be done with soil removed from a hole/foundation site. d) Describe how the poles/towers and associated hardware would be delivered to the site and assembled. e) Describe any pole topping procedures that would occur, identify specific locations and reasons, and describe how each facility would be modified. Describe any special methods that would be required to top poles that may be difficult to access.		
3.5.5.2: Aboveground and Underground Conductor/Cable a) Provide a process-based description of how new conductor/cable would be installed and how old conductor/cable would be removed, if applicable. b) Identify where conductor/cable stringing/installation activities would occur. c) Provide a diagram of the general sequencing and equipment that would be used. d) Describe the conductor/cable splicing process.		

e) Provide the general or average distance between pull-and-tension sites. Describe the approximate dimensions and where pull-and-tension sites would generally be required (as indicated by the designated work areas), such as the approximate distance to pole/tower height ratio, at set distances, or at significant direction changes. Describe the equipment that would be required at these sites. f) For underground conductor/cable installations, describe all specialized construction methods that would be used for installing underground conductor or cable. If vaults are required, provide their dimensions and location/spacing along the alignment. Provide a detailed description for how the vaults would be delivered to the site and installed. g) Describe any safety precautions or areas where special methodology would be required (e.g., crossing roadways, stream crossing).		
3.5.5.3: Telecommunications. Identify the procedures for installation of proposed telecommunication cables and associated infrastructure.		
3.5.5.4: Guard Structures. Identify the types of guard structures that would be used at crossings of utility lines, roads, railroads, highways, etc. Describe the different types of guard structures or methods that may be used (i.e., buried poles and netting, poles secured to a weighted object, bucket trucks, etc.). Describe any pole installation and removal procedures associated with guard structures. Describe guard structure installation and removal process and duration that guard structures would remain in place.		
3.5.5.5: Blasting a) Describe any blasting that may be required to construct the project. b) If blasting may be required, provide a Blasting Plan that identifies the blasting locations; types and amounts of blasting agent to be used at each location; estimated impact radii; and, noise estimates. The Blasting Plan should be provided as an Appendix to the PEA. c) Provide a map identifying the locations where blasting may be required with estimated impact radii. Provide associated GIS data.		
3.5.6 Transmission Line Construction (Below Ground)		
3.5.6.1: Trenching a) Describe the approximate dimensions of the trench (e.g., depth, width). b) Provide the total approximate volume of material to be removed from the trench, the amount to be used as backfill, and any amount to subsequently be removed/disposed of offsite in cubic yards. c) Describe the methods used for making the trench (e.g., saw cutter to cut the pavement, backhoe to remove, etc.). d) Provide off-site disposal location, if known, or describe possible option(s). e) Describe if dewatering would be anticipated and if so, how the trench would be dewatered, the anticipated flows of the water,		

whether there would be treatment, and how the water would be disposed of. f) Describe the process for testing excavated soil or groundwater for the presence of pre-existing environmental contaminants that could be exposed from trenching operations. g) If a pre-existing hazardous waste were encountered, describe the process of removal and disposal. h) Describe the state of the ground surface after backfilling the trench. i) Describe standard Best Management Practices to be implemented.		
3.5.6.2: Trenchless Techniques (Microtunnel, Jack and Bore, Horizontal Directional Drilling) a) Identify any locations/features for which the Applicant expects to use a trenchless (i.e., microtunneling, jack and bore, horizontal directional drilling) crossing method and which method is planned for each crossing. b) Describe the methodology of the trenchless technique. c) Provide the approximate location and dimensions of the sending and receiving pits. d) Describe the methodology of excavating and shoring the pits. e) Provide the total volume of material to be removed from the pits, the amount to be used as backfill, and the amount subsequently to be removed/disposed of offsite in cubic yards. f) Describe process for safe handling of drilling mud and bore lubricants. g) Describe the process for detecting and avoiding "fracturing-out" during horizontal directional drilling operations. h) Describe the process for avoiding contact between drilling mud/lubricants and stream beds. i) If engineered fill would be used as backfill, indicate the type of engineered backfill and the amount that would be typically used (e.g., the top 2 feet would be filled with thermal-select backfill). j) Describe if dewatering is anticipated and, if so, how the pits would be dewatered, the anticipated flows of the water, whether there would there be treatment, and how the water would be disposed of. k) Describe the process for testing excavated soil or groundwater for the presence of pre-existing environmental contaminants. Describe the process of disposing of any pre-existing hazardous waste that is encountered during excavation. l) Describe any standard BMPs that would be implemented for trenchless construction.		
3.5.7 Substation, Switching Stations, Gas Compressor Stations		
3.5.7.1: Installation or Facility Modification. Describe the process and equipment for removing, installing, or modifying any substations, switching stations, or compressor stations including: a) Transformers/ electric components b) Gas components c) Control and operation buildings d) Driveways		

e) Fences f) Gates g) Communication systems (SCADA) h) Grounding systems		
3.5.7.2: Civil Works. Describe the process and equipment required to construct any slope stabilization, drainage, retention basins, and spill containment required for the facility.		
3.5.8 Gas Pipelines		
3.5.8.1: Gas Pipeline Construction. Describe the process for proposed pipeline construction including site development, trenching and trenchless techniques, pipe installation, and backfilling.		
3.5.8.2: Water Crossings. Describe water feature crossings that will occur during trenching, the method of trenching through stream crossings, and the process for avoiding impacts to the water features required for pipeline construction. Identify all locations where the pipeline will cross water features. Cite to any associated geotechnical or hydrological investigations completed and provide a full copy of each report as an Appendix to the PEA.[17]		
3.5.8.3: Gas Pipeline Other Requirements a) Describe hydrostatic testing process including pressures, timing, source of flushing water, discharge of water. b) Describe energy dissipation basin, and the size and length of segments to be tested. c) Describe pig launching locations and any inline inspection techniques used during or immediately post construction.		
3.5.9 Gas Storage Facilities		
3.5.9.1: Gas Storage Construction a) Describe the process for constructing the gas storage facility including constructing well pads and drilling wells. b) Describe the specific construction equipment that would be used, such as the type of drill rig (i.e., size, diesel, electric, etc.), depth of drilling, well-drilling schedule and equipment.		
3.5.9.2: Drilling Muds and Fluids. Describe the use of any drilling muds, fluids, and other drilling materials. Provided estimated types and quantities.		
3.5.10 Public Safety and Traffic Control (All Projects)		
3.5.10.1: Public Safety a) Describe specific public safety considerations during construction and best management practices to appropriately manage public safety. Clearly state when and where they each safety measure would be applied.		

[17] If a geotechnical study is not available at the time of PEA filing, provide the best information available.

b) Identify procedures for managing work sites in urban areas, covering open excavations securely, installing barriers, installing guard structures, etc. c) Identify specific project areas where public access may be restricted for safety purposes and provide the approximate durations and timing of restricted access at each location.		
3.5.10.2: Traffic Control a) Describe traffic control procedures that would be implemented during construction. b) Identify the locations, process, and timing for closing any sidewalks, lanes, roads, trails, paths, or driveways to manage public access. c) Identify temporary detour routes and locations. d) Provide a preliminary Traffic Control Plan(s) for the project.		
3.5.10.3: Security. Describe any security measures, such as fencing, lighting, alarms, etc. that may be required. State if security personnel will be stationed at project areas and anticipated duration of security.		
3.5.10.4: Livestock. Describe any livestock fencing or guards that may be necessary to prevent livestock from entering project areas. State if the fencing would be electrified and if so, how it would be powered.		
3.5.11 Dust, Erosion, and Runoff Controls (All Projects)		
3.5.11.1: Dust. Describe specific best management practices that would be implemented to manage fugitive dust.		
3.5.11.2: Erosion. Describe specific best management practices that would be implemented to manage erosion.		
3.5.11.3: Runoff. Describe specific best management practices that would be implemented to manage stormwater runoff and sediment.		
3.5.12 Water Use and Dewatering (All Projects)		
3.5.12.1: Water Use. Describe the estimated volumes of water that would be used by construction activity (e.g., dust control, compaction, etc.). State if recycled or reclaimed water would be used and provide estimated volumes. Identify the anticipated sources where the water would be acquired or purchased. Identify if the source of water is groundwater and the quantity of groundwater that could be used.		
3.5.12.2: Dewatering a) Describe dewatering procedures during construction, including pumping, storing, testing, permitted discharging, and disposal requirements that would be followed. b) Describe the types of equipment and workspace considerations to be used to dewater, store, transport, or discharge extracted water.		
3.5.13 Hazardous Materials and Management (All Projects)		
3.5.13.1: Hazardous Materials a) Describe the types, uses, and volumes of all hazardous materials that would be used during construction. b) State if herbicides or pesticides may be used during construction.		

c) If a pre-existing hazardous waste were encountered, describe the process of removal and disposal.		
3.5.13.2: Hazardous Materials Management a) Identify specific best management practices that would be followed for transporting, storing, and handling hazardous materials. b) Identify specific best management practices that would be followed in the event of an incidental leak or spill of hazardous materials. c) Provide a Hazardous Substance Control and Emergency Response Plan / Hazardous Waste and Spill Prevention Plan as an Appendix to the PEA, if appropriate.		
3.5.14 Waste Generation and Management (All Projects)		
3.5.14.1: Solid Waste a) Describe solid waste streams from existing and proposed facilities during construction. b) Identify procedures to be implemented to manage solid waste, including collection, containment, storage, treatment, and disposal. c) Provide estimated total volumes of solid waste by construction activity or project component. d) Describe the recycling potential of solid waste materials and provide estimated volumes of recyclable materials by construction activity or project component. e) Identify the locations of appropriate disposal and recycling facilities where solid wastes would be transported.		
3.5.14.2: Liquid Waste a) Describe liquid waste streams during construction (i.e., sanitary waste, drilling fluids, contaminated water, etc.) b) Describe procedures to be implemented to manage liquid waste, including collection, containment, storage, treatment, and disposal. c) Provide estimated volumes of liquid waste generated by construction activity or project component. d) Identify the locations of appropriate disposal facilities where liquid wastes would be transported.		
3.5.14.3: Hazardous Waste a) Describe potentially hazardous waste streams during construction and procedures to be implemented to manage hazardous wastes, including collection, containment, storage, treatment, and disposal. b) If large volumes of hazardous waste are anticipated, such as from a pre-existing contaminant in the soil that must be collected and disposed of, provide estimated volumes of hazardous waste that would be generated by construction activity or project component. c) Identify the locations of appropriate disposal facilities where hazardous wastes would be transported.		
3.5.15 Fire Prevention and Response (All Projects)		
3.5.15.1: Fire Prevention and Response Procedures. Describe fire prevention and response procedures that would be implemented during		

construction. Provide a Construction Fire Prevention Plan or specific procedures as an Appendix to the PEA.		
3.5.15.2: Fire Breaks. Identify any fire breaks (i.e., vegetation clearance) requirements around specific project activities (i.e., hot work). Ensure that such clearance buffers are included in the limits of the defined work areas, and the vegetation removal in that area is attributed to Fire Prevention and Response (refer to 3.5.4.3: Vegetation Clearing).		

3.6 Construction Workforce, Equipment, Traffic, and Schedule

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.6.1: Construction Workforce a) Provide the estimated number of construction crew members. In the absence of project-specific data, provide estimates based on past projects of a similar size and type. b) Describe the crew deployment. Would crews work concurrently (i.e., multiple crews at different sites); would they be phased? How many crews could be working at the same time and where? c) Describe the different types of activities to be undertaken during construction, the number of crew members for each activity (i.e. trenching, grading, etc.), and number and types of equipment expected to be used for the activity. Include a written description of the activity. See example in Table 5.		
3.6.2: Construction Equipment. Provide a tabular list of the types of equipment expected to be used during construction of the proposed project including the horsepower. Define the equipment that would be used by each phase as shown in the example table below (Table 5).		

Table 5. Construction Equipment and Workforce

Work Activity				Activity Production				
Equipment Description	Estimated Horse-power	Probable Fuel Type	Equipment Quantity	Estimated Workforce	Estimated Start Date	Estimated End Date	Duration of Use (Hrs./Day)	Estimated Production
Survey				**4**	**January 2020**	**December 2020**		**358 Miles**
1-Ton Truck, 4x4	300	Diesel	2		January 2020	December 2020	10	1 Mile/Day
Staging Yards				**5**	**DOP**			
1-Ton Truck, 4x4	300	Diesel	1		Duration of Project		4	
R/T Forklift	350	Diesel	1				5	
Boom/Crane Truck	350	Diesel	1				5	
Water Truck	300	Diesel	2				10	
Jet A Fuel Truck	300	Diesel	1				4	
Truck, Semi-Tractor	500	Diesel	1				6	
Road Work				**6**	**January 2020**	**March 2020**		**426 Miles**
1-Ton Truck, 4x4	300	Diesel	2		January 2020	March 2020	5	
Backhoe/Front Loader	350	Diesel	1		January 2020	March 2020	7	
Track Type Dozer	350	Diesel	1		January 2020	March 2020	7	
Motor Grader	350	Diesel	1		January 2020	March 2020	5	
Water Truck	300	Diesel	2		January 2020	March 2020	10	
Drum Type Compactor	250	Diesel	1		January 2020	March 2020	5	
Excavator	300	Diesel	1		January 2020	February 2020	7	
Lowboy Truck/Trailer	500	Diesel	1		January 2020	February 2020	4	

3.6.3: Construction Traffic a) Describe how the construction crews and their equipment would be transported to and from the proposed project site. b) Provide vehicle type, number of vehicles, and estimated hours of operation per day, week, and month for each construction activity and phase. c) Provide estimated vehicle trips and vehicles miles traveled (VMT) for each construction activity and phase. Provide separate values for construction crews commuting, haul trips, and other types of construction traffic.		
3.6.4: Construction Schedule a) Provide the proposed construction schedule (e.g., month and year) for each segment or project component, and for each construction activity and phase. b) Provide and explain the sequencing of construction activities, and if they would or would not occur concurrently. c) Provide the total duration of each construction activity and phase in days or weeks. d) Identify seasonal considerations that may affect the construction schedule, such as weather or anticipated wildlife restrictions, etc. The proposed construction should account for such factors.		
3.6.5: Work Schedule a) Describe the anticipated work schedule, including the days of the week and hours of the day when work would occur. Clearly state if work would occur at night or on weekends and identify when and where this could occur. b) Provide the estimated number of days or weeks that construction activities would occur at each type of work area. For example, construction at a stationary facility or staging area may occur for the entire duration of construction, but construction at individual work areas along a linear project would be limited to a few hours, days or weeks, and only a fraction of the total construction period.		

3.7 Post-Construction

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.7.1: Configuring and Testing. Describe the process and duration for post-construction configuring and testing of facilities. Describe the number of personnel and types of equipment that would be involved.		
3.7.2: Landscaping. Describe any landscaping that would be installed. Provide a conceptual landscape plan that identifies the locations and types of plantings that will be used. Identify whether plantings will include container plants or seeds. Include any water required for landscaping in the description of water use above.		

3.7.3 Demobilization and Site Restoration		
3.7.3.1: Demobilization. Describe the process for demobilization after construction activities, but prior to leaving the work site. For example, describe final processes for removing stationary equipment and materials, etc.		
3.7.3.2: Site Restoration. Describe how cleanup and post-construction restoration would be performed (i.e., personnel, equipment, and methods) on all project ROWs, sites, and extra work areas. Things to consider include, but are not limited to, restoration of the following: a) Restoring natural drainage patterns b) Recontouring disturbed soil c) Removing construction debris d) Vegetation e) Permanent and semi-permanent erosion control measures f) Restoration of all disturbed areas and access roads, including restoration of any public trails that are used as access, as well as any damaged sidewalks, agricultural infrastructure, or landscaping, etc. g) Road repaving and striping, including proposed timing of road restoration for underground construction within public roadways		

3.8 Operation and Maintenance

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.8.1: Regulations and Standards a) Identify and describe all regulations and standards applicable to operation and maintenance of project facilities. b) Provide a copy of any applicable Wildfire Management Plan and describe any special procedures for wildfire management.		
3.8.2: System Controls and Operation Staff a) Describe the systems and methods that the Applicant would use for monitoring and control of project facilities (e.g., on-site control rooms, remote facilities, standard monitoring and protection equipment, pressure sensors, automatic shut-off valves, and site and equipment specific for monitoring and control such as at natural gas well pads). b) If new full-time staff would be required for operation and/or maintenance, provide the number of positions and purpose.		
3.8.3: Inspection Programs a) Describe the existing and proposed inspection programs for each project component, including the type, frequency, and timing of scheduled inspections (i.e., aerial inspection, ground inspection, pipeline inline inspections). b) Describe any enhanced inspections, such as within any High Fire Threat Districts consistent with applicable Wildfire Management Plan requirements.		

c) Describe the inspection processes, such as the methods, number of crew members, and how access would occur (i.e., walk, vehicle, all-terrain vehicle, helicopter, drone, etc.). If new access would be required, describe any restoration that would be provided for the access roads.		
3.8.4: Maintenance Programs a) Describe the existing and proposed maintenance programs for each project component. b) Describe scheduled maintenance or facility replacement after the designated lifespan of the equipment. c) Identify typical parts and materials that require regular maintenance and describe the repair procedures. d) Describe any access road maintenance that would occur. e) Describe maintenance for surface or color treatment. f) Describe cathodic protection maintenance that would occur. g) Describe ongoing landscaping maintenance that would occur.		
3.8.5: Vegetation Management Programs a) Describe vegetation management programs within and surrounding project facilities. Distinguish between any different types of vegetation management. b) Describe any enhanced vegetation management, such as within any High Fire Threat Districts consistent with any applicable Wildfire Management Plan requirements. Identify the areas where enhanced vegetation management would be conducted.		

3.9 Decommissioning

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.9.1: Decommissioning. Provide detailed information about the current and reasonably foreseeable plans for the disposal, recycling, or future abandonment of all project facilities.		

3.10 Anticipated Permits and Approvals

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.10.1: Anticipated Permits and Approvals. Identify all necessary federal, state, regional, and local permits that may be required for the project. For each permit, list the responsible agency and district/office representative with contact information, type of permit or approval, and status of each permit with date filed or planned to file. For example: a) Federal Permits and Approvals i. U.S. Fish and Wildlife Service ii. U.S. Army Corps of Engineers iii. Federal Aviation Administration iv. U.S. Forest Service		

v. U.S. Department of Transportation – Office of Pipeline Safety vi. U.S. Environmental Protection Agency (Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation, and Liability Act) b) State and Regional Permits i. California Department of Fish and Wildlife ii. California Department of Transportation iii. California State Lands Commission iv. California Coastal Commission v. State Historic Preservation Office, Native American Heritage Commission vi. State Water Resources Control Board vii. California Division of Oil, Gas and Geothermal Resources viii. Regional Air Quality Management District ix. Regional Water Quality Control Board (National Pollutant Discharge Elimination System General Industrial Storm Water Discharge Permit) x. Habitat Conservation Plan Authority (if applicable) See also Table 6 of example permitting requirements and processes.		
3.10.2: Rights-of-Way or Easement Applications. Demonstrate that applications for ROWs or other proposed land use have been or soon will be filed with federal, state, or other land-managing agencies that have jurisdiction over land that would be affected by the project (if any). Discuss permitting plans and timeframes and provide the contact information at the federal agency(ies) approached.		

3.11 Applicant Proposed Measures

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.11 Applicant Proposed Measures a) Provide a table with the full text of any Applicant Proposed Measure. Where applicable, provide a copy of Applicant procedures, plans, and standards referenced in the Applicant Proposed Measures. b) Within Chapter 5, describe the basis for selecting a particular Applicant Proposed Measure and how the Applicant Proposed Measure would reduce the impacts of the project.[18] c) Carefully consider each CPUC Draft Environmental Measure identified in Chapter 5 of this PEA Checklist. The CPUC Draft Environmental Measures will be applied to the proposed project where applicable.		

[18] Applicant Proposed Measures that use phrases, such as, "as practicable" or other conditional language are not acceptable and will be superseded by Mitigation Measures if required to avoid or reduce a potentially significant impact.

Table 6. Example Permitting Requirements and Processes

Note: In addition to the CPCN or PTC, the applicant may also be required to secure resource agency permits for the project.

Disclaimer: Below is a general list of permits required for transmission projects. Permit requirements for individual projects may vary slightly depending on project conditions.

Agency	Permit	Regulation	Protected Resource	Trigger	Application Process	Timing
				Federal		
Army Corps of Engineers	404 Permit	Clean Water Act	Waters of the United States (including wetlands)	Placement of dredge or fill material into waters of the U.S., including wetlands. If project impacts less than 0.5 acres a **nationwide permit (NWP)** is typically issued	**NWP:** prepare a preconstruction notification (PCN) along with the draft Corps's application (Engineer Form 4345). Information in the PCN includes, but is not limited to: results of wetland delineation including areas of waters of the U.S.; temporary and permanent impacts to waters of the U.S. and discussion of avoidance; construction techniques, timeline, and equipment that would be used; special status species that potentially occur in the project area, and discussion of mitigation (if applicable) to replace wetlands	**NWP:** takes approximately nine months from the date of application submittal (depending on level of impacts and level of consultation required by other agencies). Initial review is 30 days after which application is deemed complete or additional information is requested.
				If project would impact more than 0.5 acres a **regional or individual permit** may be required.	**Regional or Individual Permit:** Same requirements as NWP as well as preparation and submittal of 404(b)(1) Alternatives analysis which identifies the Least Environmentally Damaging Practicable Alternative (LEDPA). Public notice also required	**Regional or Individual Permit:** An additional three to six months may be required on top of the nine months expected for an NWP. A 30 day public notice is also required to inform the public about the project before the Corps issues the permit.
USFWS	Section 7 Consultation	Federal Endangered Species Act	Federally Listed Species	Potential impact to a federally listed threatened or endangered species	Biological Assessment (BA) prepared and submitted to Corps. BA contains information on each species and describes potential for "take" of species and/or habitat.	The timeline for processing and receiving a formal **Biological Opinion (BO)** from USFWS can be six months to a year from when the Corps has initiated consultation and depending on the level of impact to listed species. The typical timeline for issuance of a BO is no less than 135 days after acceptance of the BA as complete.
US Department of Agriculture, Forest Service	Special Use Authorization	National Forest Management Act/NEPA	National Forest lands	Use of federal lands managed by the USDA Forest Service for a transmission line. Typically constitutes a Major Federal Action which in turn triggers NEPA analysis.	**Special Use Authorization Application:** prepare a special use application for consideration by the Forest Service. Prior to submitting a proposal, applicant is required to arrange a preapplicaiton meeting at the local Forest Service office. Application typically includes project plan, operating plans, liability insurance, licenses/registrations and other documents. If it is determined that NEPA is required either an EA or EIS would be prepared. The NEPA document may be prepared jointly with the CEQA document.	Revies of Special Use Authorization applications is often dependent upon what level of NEPA analysis is required. An EA is typically 9-12 months, and EIS is generally 18 months. NEPA process may occur concurrently with CEQA process.
US Department of the Interior, Bureau of Land Management	Right-of-Way Grant	Federal Land Policy and Management Act/NEPA	Federal Lands	Use of federal lands managed by the BLM for a transmission line. Typically constitutes a Major Federal Action which in turn triggers NEPA analysis.	**Right-of-Way Application**: Contact the BLM office with management responsibility. Obtain an application form "Application for Transportation and Utility Systems and Facilities on Federal Lands". Arrange a pre-application meeting with a BLM Realty Specialist or appropriate staff member. Submit completed application to the appropriate BLM office. If it is determined that NEPA is required either an EA or EIS would be prepared. The NEPA document may be prepared jointly with the CEQA document.	BLM attempts to review completed applications within 60 days of submittal. Full timing is often dependent upon what level of NEPA analysis is required. An EA is typically 9-12 months, and EIS is generally 18 months. NEPA process may occur concurrently with CEQA process.

Agency	Permit	Regulation	Protected Resource	Trigger	Application Process	Timing
				State (continued)		
State Historic Preservation Officer (SHPO)	Section 106 National Historic Preservation Act (NHPA)	National Historic Preservation Act	Cultural and/or historical resources	Required if there are potential impacts to cultural and/or historical resources that are listed or eligible for listing on the National Register of Historic Places.	Information on cultural and historical resources gathered during the draft CEQA document preparation is included in a 106 Technical Report and submitted to the Corps along with the Area of Potential Effect (APE) map. The information is then evaluated by the Corps' cultural resources evaluator for potential adverse effects within the APE. Depending upon the level of potential adverse effect, the Corps then forwards its finding to SHPO for concurrence or begins the process for a Memorandum of Agreement (MOA). Native American consultation is also mandatory for the 106 process but can begin during preparation of the environmental document. All letters and correspondence for the Native American consultation must be provided to the Corps.Consultation with federally-recongized tribes may require a more extensive consultation.	Once SHPO has received the Corps' determination, it has approximately 60 days to agree or request additional information. However, SHPO has recently become more involved in projects and this timeframe is only an estimate and if a potential adverse effect to cultural or historical resources could occur, the SHPO process can take up to a year or more. Depending on the level of impacts to cultural resources, the Corps may determine no effect and issue the permit before receiving concurrence from SHPO.
California State Lands Commission (CSLC)	Right of Way Lease Agreement	Division 6 of the California Public Resources Code	California Sovereign Lands	May be triggered if the transmission line crosses state lands under the jurisdiction of the CSLC, which includes the beds of 1) more than 120 rivers, streams and sloughs; 2) nearly 40 non-tidal navigable lakes, such as Lake Tahoe and Clear Lake; 3) the tidal navigable bays and lagoons; and 4) the tide and submerged lands adjacent to the entire coast and offshore islands of the State from the mean high tide line to three nautical miles offshore.	Leases or permits may be issued to qualified applicants and the Commission shall have broad discretion in all aspects of leasing including category of lease or permit and which use, method or amount of rental is most appropriate, whether competitive bidding should be used in awarding a lease, what term should apply, how rental should be adjusted during the term, whether bonding and insurance should be required and in what amounts, whether an applicant is qualified based on what it deems to be in the best interest of the State.	Most coordination should be done concurrently with the CEQA process to ensure that any CSLC-required issues are addressed under CEQA. Once a final route/alternative is selected, the lease process may take two to three months for final Commission approval.
				Local / Other		
Air Quality Management District or Air Pollution Control District	Permit to Construct	Federal Clean Air Act	Air Quality	Depends on the air disctrict involved; may not be required for most transmission projects. Some air districts have a trigger level based on disturbed acreage.	Application forms need to be prepared and submiited to the local AQMD or APCD	Typically 30 to 90 days after submittal of a complete application.

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[19] Permitting is project specific. This table is provided for discussion purposes.

3.12 Project Description Graphics, Mapbook, and GIS Requirements

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
3.12.1: Graphics. Provide diagrams of the following as applicable: a) All pole, tower, pipe, vault, conduit, and retaining wall types b) For poles, provide typical drawings with approximate diameter at the base and tip; for towers, estimate the width at base and top. c) A typical detail for any proposed underground duct banks and vaults d) All substation, switchyard, building, and facility layouts e) Trenching, drilling, pole installation, pipe installation, vault installation, roadway construction, facility removal, helicopter uses, conductor installation, traffic control, and other construction activities where a diagram would assist the reader in visualizing the work area and construction approach f) Typical profile views of proposed aboveground facilities and existing facilities to be modified within the existing and proposed ROW (e.g., typical cross-section of existing and proposed facilities by project segment). g) Photos of representative existing and proposed structures		
3.12.2: Mapbook. Provide a detailed mapbook on an aerial imagery basemap at a scale between 1:3000 and 1:6000 (or as appropriate and legible) that show mileposts, roadways, and all project components and work areas including: a) All proposed above-ground and underground structure/facility locations (e.g., poles, conductor, substations, compressor stations, telecommunication lines, vaults, duct bank, lighting, markers, etc.) b) All existing structures/facilities that would be modified or removed c) Identify by milepost where existing ROW will be used and where new ROW or land acquisition will be required. d) All permanent work areas including permanent facility access e) All access roads including, existing, temporary, and new permanent access f) All temporary work areas including staging, material storage, field offices, material laydown, temporary work areas for above ground (e.g., pole installation) and underground facility construction (e.g., trenching and duct banks), helicopter landing zones, pull and tension sites, guard structures, shoo flys etc. g) Areas where special construction methods (e.g., jack and bore, HDD, blasting, retaining walls etc.) may need to be employed		

h) Areas where vegetation removal may occur i) Areas to be heavily graded and where slope stabilization measures would be employed including any retaining walls		
3.12.3: GIS Data. Provide GIS data for all features and ROW shown on the detailed mapbook.		
3.12.4: GIS Requirements. Provide the following information for each pole/tower that would be installed and for each pole/tower that would be removed: a) Unique ID number and type of pole (e.g., wood, steel, etc.) or tower (e.g., self-supporting lattice) both in a table and in the attributes of the GIS data provided b) Identify pole/tower heights and conductor sizes in the attributes of the GIS data provided.		
3.12.5: Natural Gas Facilities GIS Data. For natural gas facilities, provide GIS data for system cross ties and all laterals/taps, valve stations, and new and existing inspection facilities (e.g., pig launcher sites).		

4 Description of Alternatives

All Applicants will assume that alternatives will be required for the environmental analysis and that an EIR will be prepared unless otherwise instructed by CPUC CEQA Unit Staff in writing prior to application filing. See PEA Requirements at the beginning of this checklist document. The consideration and discussion of alternatives will adhere to CEQA Guidelines Section 15126.6. The description of alternatives will be provided in this chapter of the PEA, and the comparison of each alternative to the proposed project is provided in PEA Chapter 6. The amount of detail required for the description of various alternatives to the proposed project and what may be considered a reasonable range of alternatives will be discussed with CPUC during Pre-filing.

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
4.1 Alternatives Considered. Identify alternatives to the proposed project.[20] Include the following: a) All alternatives to the proposed project that were suggested, considered, or studied by the CAISO or by CAISO stakeholders b) Alternatives suggested by the public or agencies during public outreach efforts conducted by the Applicant c) Reduced footprint alternatives, including, e.g., smaller diameter pipelines and space for fewer electric transformers d) Project phasing options (e.g., evaluate the full build out for environmental clearance but consider an initial, smaller buildout that would only be expanded [in phases] if needed) e) Alternative facility and construction activity sites (e.g., substation, compressor station, drilling sites, well-head sites, staging areas) f) Renewable, energy conservation, energy efficiency, demand response, distributed energy resources, and energy storage alternatives g) Alternatives that would avoid or limit the construction of new transmission-voltage facilities or new gas transmission pipelines h) Other technological alternatives (e.g., conductor type) i) Route alternatives and route variations j) Alternative engineering or technological approaches (e.g., alternative types of facilities, or materials, or configurations) k) Assign an identification label and brief, descriptive title to each alternative described in this PEA chapter (e.g., Alternative A: No Project; Alterative B: Reduced Footprint 500/115-kV Substation; Alternative C: Ringo Hills 16-inch Pipeline Alignment; Alternative D1: Lincoln Street Route Variation; etc.). Each alternative will be easily identifiable by reading the brief title. Provide a description of each alternative. The description of each alternative will discuss to what extent it would be potentially feasible,		

[20] Reduced footprint alternatives; siting alternatives; renewable, energy conservation, energy efficiency, demand response, distributed energy resources, and energy storage alternatives; and non-wires alternatives (electric projects only) are typically required. For linear projects, route alternatives and route variations are typically required as well.

meet the project's underlying purpose, meet most of the basic project objectives, and avoid or reduce one or more potentially significant impacts. If the Applicant believes that an alternative is infeasible or the implementation is remote and speculative (CEQA Guidelines Section 15126.6(f)(3), clearly explain why. If significant environmental effects are possible without mitigation, alternatives will be provided in the PEA that are capable of avoiding or reducing any potentially significant environmental effects, even if the alternative(s) substantially impede the attainment of some project objectives or are costlier.[21]		
4.2 No Project Alternative. Include a thorough description of the No Project Alternative. The No Project Alternative needs to describe the range of actions that are reasonably foreseeable if the proposed project is not approved. The No Project Alternative will be described to meet the requirements of CEQA Guidelines Section15126.6(e).		
4.3 Rejected Alternatives. Provide a detailed discussion of all alternatives considered by the Applicant that were not selected by the Applicant for a full description in the PEA and analysis in PEA Chapter 5. The detailed discussion will include the following: a) Description of the alternative and its components b) Map of any alternative sites or routes c) Discussion about the extent to which the alternative would meet the underlying purpose of the project and its basic objectives d) Discussion about the feasibility of implementing the alternative e) Discussion of whether the alternative would reduce or avoid any significant environmental impacts of the proposed project f) Discussion of any new significant impacts that could occur from implementation of the alternative g) Description of why the alternative was rejected h) Any comments from the public or agencies about the alternative during PEA preparation		
For Natural Gas Storage Projects:		
4.4 Natural Gas Storage Alternatives. In addition to the requirements included above, alternatives to be considered for proposed natural gas storage projects include the following, where applicable: a) Alternative reservoir locations considered for gas storage including other field locations and other potential storage areas b) Alternative pipelines, road, and utility siting c) Alternative suction gas requirements, and injection/withdrawal options		

[21] CPUC CEQA Unit Staff will determine whether an alternative could *substantially* reduce one or more potentially significant impacts of the proposed project (CEQA Guidelines Section 15125.5). Applicants are strongly advised to provide more rather than less alternatives for CPUC's consideration or as determined during Pre-filing.

5 Environmental Analysis

Include a description of the environmental setting, regulatory setting, and impact analysis for each resource area. The resource areas addressed will include each environmental factor (resource area) identified in the most recent adopted version of the CEQA Guidelines Appendix G checklist and any additional relevant resource areas and impact questions that are defined in this PEA checklist.

1. Environmental Setting
    a. For each resource area, the PEA will include a detailed description of the natural and built environment in the vicinity of the proposed project area (e.g., topography, land use patterns, biological environment, etc.) as applicable to the resource area. Both regional and local environmental setting information will be provided.
    b. All setting information provided will relate in some way to the impacts of the proposed project discussed in the PEA's impacts analysis, however CPUC's impacts analysis may be more thorough, which may necessitate additional setting information than the Applicant might otherwise provide.
2. Regulatory Setting
    a. Organized by federal, State, regional, and local sections
    b. Describe the policy or regulation and briefly explain why it is applicable to the proposed project.
        i. Identify in the setting all laws, regulations, and policies that would be applicable for CPUC's exclusive jurisdiction over the siting and design of electric and gas facilities. Public utilities under CPUC's jurisdiction are expected to consult with local agencies regarding land use matters. Local laws, regulations, and policies will be considered for the consideration of potential impacts during CPUC's CEQA review (e.g., encroachment, grading, erosion control, scenic corridors, overhead line undergrounding, tree removal, fire protection, permanent and temporary noise limits, zoning requirements, general plan polices, and all local and regional laws, regulations, and policies).
3. Impact Questions
    a. Includes all impact questions in the current version of CEQA Guidelines, Appendix G.
    b. Additional impact questions that are frequently relevant to utility projects are provided in Attachment 4, CPUC Draft Environmental Measures.
4. Impact Analyses
    a. Discussion organized by CEQA Guidelines, Appendix G impact items and any Additional CEQA Impact Questions in the PEA Checklist. Assess all potential environmental impacts and make determinations, such as, No Impact, Less than Significant, Less than Significant with Mitigation, Significant and Unavoidable, or Beneficial Impact with respect to construction, operations, and maintenance activities.
    b. The impact analyses provided in PEA Chapter 5, Environmental Analysis, need not be as thorough as those to be prepared by CPUC for the CEQA environmental document. A preliminary determination will be provided but with only brief justification unless otherwise directed by CPUC Staff in writing during Pre-filing.
5. CPUC Draft Environmental Measures
    a. CPUC Draft Environmental Measures are provided for some of the resource areas in Attachment 4, CPUC Draft Environmental Measures. The measures may be applied to the proposed project as written or modified by the CPUC during its environmental review if the measure would avoid or reduce a potentially significant impact.

b. The CPUC Draft Environmental Measures should be discussed with the CPUC's CEQA Unit Staff during Pre-filing, especially with respect to the development of Applicant Proposed Measures.
c. In general, impact avoidance is preferred to the reduction of potentially significant impacts.

Additional requirements specific to each resource area are identified in the following sections.

5.1 Aesthetics

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.1.1 Environmental Setting		
5.1.1.1: Landscape Setting. Briefly described the regional and local landscape setting.		
5.1.1.2: Scenic Resources. Identify and describe any vistas, scenic highways, national scenic areas, or other scenic resources within and surrounding the project area (approximately 5-mile buffer but may be greater if necessary). Scenic resources may also include but are not limited to historic structures, trees, or other resources that contribute to the scenic values where the project would be located.		
5.1.1.3: Viewshed Analysis a) Conduct a viewshed analysis for the project area (approximately 5-mile buffer but may be greater if necessary). b) Describe the project viewshed, including important visibility characteristics for the project site, such as viewing distance, viewing angle, and intervening topography, vegetation, or structures. c) Provide a supporting map (or maps) showing project area, landscape units, topography (i.e., hillshade), and the results of the viewshed analysis. Provide associated GIS data.		
5.1.1.4: Landscape Units. Identify and describe landscape units (geographic zones) within and surrounding the project area (approximately 5-mile buffer but may be greater if necessary) that categorizes different landscape types and visual characteristics, with consideration to topography, vegetation, and existing land uses. Landscape units should be developed based on the existing landscape characteristics rather than the project's features or segments.		
5.1.1.5: Viewers and Viewer Sensitivity. Identify and described the types of viewers expected within the viewshed and landscape units. Describe visual sensitivity to general visual change based on viewing conditions, use of the area, feedback from the public about the project, and landscape characteristics.		

5.1.1.6: Representative Viewpoints a) Identify representative viewpoints from publicly accessible locations (up to approximately 5-mile buffer but may be greater if appropriate). The number and location of the viewpoints must represent a range of views of the project site from major roads, highways, trails, parks, vistas, landmarks, and other scenic resources near the project site. Multiple viewpoints should be included where the project site would be visible from sensitive scenic resources to provide context on different viewing distances, perspectives, and directions. b) Provide the following information for each viewpoint: i. Number, title, and brief description of the location ii. Types of viewers iii. Viewing direction(s) and distance(s) to the nearest proposed project features iv. Description of the existing visual conditions and visibility of the project site as seen from the viewpoint and shown in the representative photographs c) Provide a supporting map (or maps) showing project features and representative viewpoints with arrows indicating the viewing direction(s). Provide associated GIS data (may be combined with GIS data request below for representative photographs).		
5.1.1.7: Representative Photographs a) Provide high resolution photographs taken from the representative viewpoints in the directions of all proposed project features.[22] Multiple photographs should be provided where project features may be visible in different viewing directions from the same location. b) Provide the following information for each photograph: i. Capture time and date ii. Camera body and lens model iii. Lens focal length and camera height when taken c) Provide GIS data associated with each photograph location that includes coordinates (<1 meter resolution), elevations, and viewing directions, as well as the associated viewpoint.		
5.1.1.8: Visual Resource Management Areas a) Identify any visual resource management areas within and surrounding the project area (approximately 5-mile buffer). b) Describe any project areas within visual resource management areas.		

[22] All representative photographs should be taken using a digital single-lens reflex camera with standard 50-millimeter lens equivalent, which represents an approximately 40-degree horizontal view angle. The precise photograph coordinates and elevations should be collected using a high accuracy GPS unit.

c) Provide a supporting map (or maps) showing project features and visual resource management areas. Provide associated GIS data.		
5.1.2 Regulatory Setting		
5.1.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding aesthetics and visual resource management.		
5.1.3 Impact Questions		
5.1.3.1: Impact Questions. The impact questions include all aesthetic impact questions in the current version of CEQA Guidelines, Appendix G. **5.1.3.2:** Additional CEQA Impact Questions: None.		
5.1.4 Impact Analysis		
5.1.4.1: Visual Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines Appendix G for this resource area and any additional impact questions listed above.		
The following information will be included in the PEA or a technical Appendix to support the aesthetic impact analysis:		
5.1.4.2: Analysis of Selected Viewpoints. Identify the methodology and assumptions that were applied in selecting key observation points for visual simulation. It is recommended that viewpoints are selected where viewers may be sensitive to visual change (public views) and in areas that are visually sensitive, or heavily trafficked or visited.[23]		
5.1.4.3: Visual Simulation a) Identify methodology and assumptions for completing the visual simulations. The simulations should include photorealistic 3-D models of project features and any land changes within the KOP view. The visual simulations should depict conditions: i. Immediately following construction, and ii. After vegetation establishment in all areas of temporary impact to illustrate the visual impact from vegetation removal. b) Provide high resolution images for the visual simulations.		
5.1.4.4: Analysis of Visual Change a) Identify the methodology and assumptions for completing the visual change analysis.[24] The methodology should be consistent with applicable visual resource management criteria. b) Provide a description of the visual change for each selected viewpoint. Describe any conditions that would change over time, such as vegetation growth.		

[23] The KOP selection process should be discussed with CPUC during Pre-filing
[24] The visual impact assessment methodology should be discussed with CPUC during Pre-filing

c) Describe the effects of visual change that would result in the entire project area, as indicated by the selected viewpoints that were simulated and analyzed.		
5.1.4.5: Lighting and Marking. Identify all new sources of permanent lighting. Identify any proposed structures or lines that could require FAA notification. Identify any structures or line segments that could require lighting and marking based on flight patterns and FAA or military requirements. Provide supporting documentation in an Appendix (e.g., FAA notice and criteria tool results).		
5.1.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.2 Agriculture and Forestry Resources

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.2.1 Environmental Setting		
5.2.1.1: Agricultural Resources and GIS a) Identify all agricultural resources that occur within the project area including: i. Areas designated as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance ii. Areas under Williamson Act contracts and provide information on the status of the Williamson Act contract iii. Any areas zoned for agricultural use in local plans iv. Areas subject to active agricultural use b) Provide GIS data for agricultural resources within the proposed project area.		
5.2.1.2: Forestry Resources and GIS a) Identify all forestry resources within the project area including: i. Forest land as defined in Public Resources Code 12220(g)25 ii. Timberland as defined in Public Resource Code section 4526 iii. Timberland zoned Timberland Production as defined in Government Code section 51104(g) b) Provide GIS data for all forestry resources within the proposed project area.		
5.2.2 Regulatory Setting		
5.2.2: Agriculture and Forestry Regulations. Identify all federal, state, and local policies for protection of agricultural and forestry resources that apply to the proposed project.		

[25] Forest land is defined in Public Resources Code as, "land that can support 10 percent native tree cover of any species, including hardwoods, under natural conditions, and that allows for management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation, and other public benefits."

5.2.3 Impact Questions		
5.2.3.1: Agriculture and Forestry Impact Questions. The impact questions include all agriculture and forestry impact questions in the current version of CEQA Guidelines, Appendix G. **5.2.3.2:** Additional CEQA Impact Questions: None.		
5.2.4 Impact Analyses		
5.2.4.1: Agriculture and Forestry Impacts. Provide an impact analysis for each checklist item identified in CEQA Guidelines Appendix G for this resource area and any additional impact questions listed above.		
Incorporate the following discussions into the analysis of impacts:		
5.2.4.2: Prime Farmland Soil Impacts. Calculate the acreage of Prime Farmland soils that would be affected by construction and operation and maintenance.		
5.2.4.3. Williamson Act Impacts. Describe the approach to resolve potential conflicts with Williamson Act contract (if applicable)		
5.2.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.3 Air Quality

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.3.1 Environmental Setting		
5.3.1.1: Air Quality Plans Identify and describe all applicable air quality plans and attainment areas. Identify the air basin(s) for the project area. If the project is located in more than one attainment area and/or air basin, provide the extent in each attainment area and air basin.		
5.3.1.2: Air Quality. Describe existing air quality in the project area. a) Identify existing air quality exceedance of National Ambient Air Quality Standards and California Ambient Air Quality Standards in the air basin. b) Provide the number of days that air quality in the area exceeds state and federal air standards for each criteria pollutant that where air quality standards are exceeded. c) Provide air quality data from the nearest representative air monitoring station(s).		
5.3.1.3: Sensitive Receptor Locations. Identify the location and types of each sensitive receptor locations[26] within 1,000 feet of the project area. Provide GIS data for sensitive receptor locations.		

[26] Sensitive Receptor locations may include hospitals, schools, and day care centers, and such other locations as the air district board or California Air Resources Board may determine (California Health and Safety Code § 42705.5(a)(5)).

5.3.2 Regulatory Setting		
5.3.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding aesthetics and visual resource management.		
5.3.2.2: Air Permits. Identify and list all necessary air permits.		
5.3.3 Impact Questions		
5.3.3.1: Impact Questions. The impact questions include all air quality impact questions in the current version of CEQA Guidelines, Appendix G. **5.3.3.2:** Additional CEQA Impact Questions: None.		
5.3.4 Impact Analysis		
5.3.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines Appendix G for this resource area and any additional impact questions listed above.		
The following information will be presented in the PEA or a technical Appendix to support the air quality impact analysis:		
5.3.4.2: Air Quality Emissions Modeling. Model project emissions using the most recent version of CalEEMod and/or a current version of other applicable modeling program. Provide all model input and output data sheets in Microsoft Excel format to allow CPUC to evaluate whether project data was entered into the modeling program accurately. The assumptions used in the air quality modeling must be consistent with all PEA information about the project's schedule, workforce, and equipment. The following information will be addressed in the emissions modeling, Air Quality Appendix, and PEA: a) Quantify the expected emissions of criteria pollutants from all project-related sources. Quantify emissions for both construction and operation (e.g., compressor equipment). b) Identify manufacturer's specifications for all proposed new emission sources. For proposed new, additional, or modified compressor units, include the horsepower, type, and energy source. c) Describe any emission control systems that are included in the air quality analysis (e.g., installation of filters, use of EPA Tier II, III, or IV equipment, use of electric engines, etc.). d) When multiple air basins may be affected by the project, model air emissions within each air basin and provide a narrative (supported by calculations) that clearly describes the assumptions around the project activities considered for each air basin. Provide modeled emissions by attainment area or air basin (supported by calculations).		

5.3.4.3: Air Quality Emissions Summary. Provide a table summarizing the air quality emissions for the project and applicable thresholds for each applicable attainment area. Include a summary of uncontrolled emissions (prior to application of any APMs) and controlled emissions (after application of APMs). Clearly identify the assumptions that were applied in the controlled emissions estimates.		
5.3.4.4: Health Risk Assessment. Complete a Health Risk Assessment when air quality emissions have the potential to lead to human health impacts[27]. If health impacts are not anticipated from project emissions, the analysis should clearly describe why emissions would not lead to health impacts.		
5.3.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.4 Biological Resources

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.4.1 Environmental Setting		
5.4.1.1: Biological Resources Technical Report. Provide a Biological Resources Technical Report as an Appendix to the PEA that includes all information specified in Attachment 2.		
The following biological resources information will be presented in the PEA:		
5.4.1.2: Survey Area (Local Setting). Identify and describe the biological resources survey area as documented in the Biological Resources Technical Report. All temporary and permanent project areas must be within the survey area.		
5.4.1.3: Vegetation Communities and Land Cover a) Identify, describe, and quantify vegetation communities and land cover types within the biological resources survey area. b) Clearly identify any sensitive natural vegetation communities that meet the definition of a biological resource under CEQA (i.e., rare, designated, or otherwise protected), such as, but not limited to, riparian habitat. c) Provide a supporting map (or maps) showing project features and vegetation communities and land cover type.		

[27] Refer to Office of Environmental Health Hazard Assessment (OEHHA) most recent guidance for preparation of Health Risk Assessments to determine whether a Health Risk Assessment is required for the project. The need for an HRA should also be discussed with CPUC during Pre-filing.

5.4.1.4: Aquatic Features a) Identify, describe, and quantify aquatic features within the biological resources survey area that may provide potentially suitable aquatic habitat for rare and special-status species. b) Identify and quantify potentially jurisdictional aquatic features and delineated wetlands, according to the Wetland Delineation Report and Biological Resources Technical Report. c) Provide a supporting map (or maps) showing project features and aquatic resources.		
5.4.1.5: Habitat Assessment. Identify rare and special-status species with potential to occur in the project region (approximately a 5-mile buffer but may be larger if necessary). For each species, provide the following information: a) Common and scientific name b) Status and/or rank c) Habitat characteristics (i.e., vegetation communities, elevations, seasonal changes, etc.) d) Blooming characteristics for plants e) Breeding and other dispersal (range) behavior for wildlife f) Potential to occur within the survey area (i.e., Present, High Potential, Moderate Potential, Low Potential, or Not Expected), with justification based on the results of the records search, survey findings, and presence of potentially suitable habitat g) Specific types and locations of potentially suitable habitat that correspond to the vegetation communities and land cover and aquatic features		
5.4.1.6: Critical Habitat a) Identify and describe any critical habitat for rare or special-status species within and surrounding the project area (approximately a 5-mile buffer). b) Provide a supporting map (or maps) showing project features and critical habitat.		
5.4.1.7: Native Wildlife Corridors and Nursery Sites a) Identify and describe regional and local wildlife corridors within and surrounding the project area (approximately a 5-mile buffer), including but not limited to, landscape and aquatic features that connect suitable habitat in regions otherwise fragmented by terrain, changes in vegetation, or human development. b) Identify and describe regional and local native wildlife nursery sites within and surrounding the project area (approximately a 5-mile buffer), as identified through the records search, surveys, and habitat assessment.		

c) Provide a supporting map (or maps) showing project features, native wildlife corridors, and native nursery sites.		
5.4.1.8: Biological Resource Management Areas a) Identify any biological resource management areas (i.e., conservation or mitigation areas, HCP or NCCP boundaries, etc.) within and surrounding the project area (approximately 5-mile buffer). b) Identify and quantify any project areas within biological resource management areas. c) Provide a supporting map (or maps) showing project features and biological resource management areas.		
5.4.2 Regulatory Setting		
5.4.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding biological resources.		
5.4.2.2: Habitat Conservation Plan. Provide a copy of any relevant Habitat Conservation Plan.		
5.4.3 Impact Questions		
5.4.3.1: Impact Questions. The impact questions include all biological resource impact questions in the current version of CEQA Guidelines, Appendix G. **5.4.3.2:** Additional CEQA Impact Question: Would the project create a substantial collision or electrocution risk for birds or bats?		
5.4.4 Impact Analysis		
5.4.4.1: Impact Analysis Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for Biological Resources and any additional impact questions listed above.		
The following information will be included in the impact analysis:		
5.4.4.2: Quantify Habitat Impacts. Provide the area of impact in acres by each habitat type. Quantify temporary and permanent impacts. For all temporary impacts provide the following: a) Description of the restoration and revegetation approach b) Vegetation species that would be planted within the area of temporary disturbance c) Procedures to reduce invasive weed encroachment within areas of temporary disturbance d) Expected timeframe for restoration of the site		
5.4.4.3: Special-Status Species Impacts. Identify anticipated impacts on special-status species. Identify any take permits that are anticipated for the project. If an existing habitat conservation plan (HCP) or natural communities conservation plan (NCCP) would be used for the project, provide current accounting of take coverage included in the HCP/NCCP		

to demonstrate that there is sufficient habitat coverage remaining under the existing permit.		
5.4.4.4: Wetland Impacts. Quantify the area (in acres) of temporary and permanent impacts on wetlands. Include the following details: a) Provide a table identifying all wetlands, by milepost and length, crossed by the project and the total acreage of each wetland type that would be affected by construction. b) Discuss construction and restoration methods proposed for crossing wetlands. c) If wetlands would be filled or permanently lost, describe proposed measures to compensate for permanent wetland losses. d) If forested wetlands would be affected, describe proposed measures to restore forested wetlands following construction.		
5.4.4.5: Avian Impacts. Describe avian obstructions and risk of electrocution from the project. Describe any standards that will be implemented as part of the project to reduce the risk of collision and electrocution.		
5.4.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.5 Cultural Resources[28]

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.5.1 Environmental Setting		
5.5.1.1: Cultural Resource Reports. Provide a cultural resource inventory and evaluation report that addresses the technical requirement provided in Attachment 3.		
5.5.1.2: Cultural Resources Summary. Summarize cultural resource survey and inventory results and survey methods. Do not provide any confidential cultural resource information within the PEA chapter.		
5.5.1.3: Cultural Resource Survey Boundaries. Provide a map with mileposts showing the boundaries of all survey areas in the report. Provide the GIS data for the survey area. Provide confidential GIS data for the resource locations and boundaries separately under confidential cover.		
5.5.2 Regulatory Setting		
5.5.2.1: Regulatory Setting. Identify applicable federal and state regulations for protection of cultural resources.		

[28] For a description and evaluation of cultural resources specific to Tribes, see Section 5.18, Tribal Cultural Resources.

5.5.3 Impact Questions		
5.5.3.1: Impact Questions. The impact questions include all cultural resource impact questions in the current version of CEQA Guidelines, Appendix G. **5.5.3.2:** Additional CEQA Impact Questions: None.		
5.5.4 Impact Analysis		
5.5.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis		
5.5.4.2: Human Remains. Describe the potential for encountering human remains or grave goods during the trenching or any other phase of construction. Describe the procedures that would be used if human remains are encountered.		
5.5.4.3: Resource Avoidance. Describe avoidance procedures that would be implemented to avoid known resources.		
5.5.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.6 Energy

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.6.1 Environmental Setting		
5.6.1.1: Existing Energy Use. Identify energy use of existing infrastructure if the proposed project would replace or upgrade an existing facility.		
5.6.2 Regulatory Setting		
5.6.2.1: Regulatory Setting. Identify applicable federal, state, or local regulations or policies applicable to energy use for the proposed project.		
5.6.3 Impact Questions		
5.6.3.1: Impact Questions: The impact questions include all energy impact questions in the current version of CEQA Guidelines, Appendix G. **5.6.3.2:** Additional CEQA Impact Question: Would the project add capacity for the purpose of serving a non-renewable energy resource?		

5.6.4 Impact Analysis		
5.6.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.6.4.2: Nonrenewable Energy. Identify renewable and non-renewable energy projects that may interconnected to or be supplied by the proposed project.		
5.6.4.3: Fuels and Energy Use a) Provide an estimation of the amount of fuels (gasoline, diesel, helicopter fuel, etc.) that would be used during construction and operation and maintenance of the project. Fuel estimates should be consistent with Air Quality calculations supporting the PEA. b) Provide the following information on energy use: i. Total energy requirements of the project by fuel type and end use ii. Energy conservation equipment and design features iii. Identification of energy supplies that would serve the project		
5.6.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.7 Geology, Soils, and Paleontological Resources

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.7.1 Environmental Setting		
5.7.1.1: Regional and Local Geologic Setting. Briefly describe the regional and local physiography, topography, and geologic setting in the project area.		
5.7.1.2: Seismic Hazards a) Provide the following information on potential seismic hazards in the project area: i. Identify and describe regional and local seismic risk including any active faults within and surrounding the project area (will be a 10-mile buffer unless otherwise instructed in writing by CEQA Unit Staff during Pre-filing) ii. Identify any areas that are prone to seismic-induced landslides iii. Provide the liquefaction potential for the project area b) Provide a supporting map (or maps) showing project features and major faults, areas of landslide risk, and areas at high risk of liquefaction. Provide GIS data for all faults, landslides, and areas of high liquefaction potential.		

5.7.1.3: Geologic Units. Identify and describe the types of geologic units in the project area. Include the following information for each geologic unit: a) Summarize the geologic units within the project area. b) Identify any previous landslides in the area and any areas that are at risk of landslide. c) Identify any unstable geologic units. d) Provide a supporting map (or maps) showing project features and geologic units. Clearly identify any areas with potentially hazardous geologic conditions. Provide associated GIS data.		
5.7.1.4: Soils. Identify and describe the types of soils in the project area. a) Summarize the soils within the project area. b) Clearly identify any soils types that could be unstable (e.g., at risk of lateral spreading, subsidence, liquefaction, or collapse). c) Provide information on erosion susceptibility for each soil type that occurs in the project area. d) Provide a supporting map (or maps) showing project features and soils. Provide associated GIS data.		
5.7.1.5: Paleontological Report. Provide a paleontological report that includes the following: a) Information on any documented fossil collection localities within the project area and a 500-foot buffer. b) A paleontological resource sensitivity analysis based on published geological mapping and the resource sensitivity of each rock type. c) Supporting maps and GIS data.		
5.7.2 Regulatory Setting		
5.7.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding geology, soils, and paleontological resources.		
5.7.3 Impact Questions		
5.7.3.1: Impact Questions. The impact questions include all geology, soils, and paleontological resource impact questions in the current version of CEQA Guidelines, Appendix G. **5.7.3.2:** Additional CEQA Impact Questions: None.		
5.7.4 Impact Analysis		
5.7.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		

5.7.4.2: Geotechnical Requirements. Identify any geotechnical requirements that would be implemented to address effects from unstable geologic units or soils. Describe how the recommendation would be applied (i.e., when and where).		
5.7.4.3: Paleontological Resources. Identify the potential to disturb paleontological resources based on the depth of proposed excavation and paleontological sensitivity of geologic units within the project area.		
5.7.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.8 Greenhouse Gas Emissions

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.8.1 Environmental Setting		
5.8.1.1: GHG Setting. Provide a description of the setting for greenhouse gases (GHGs). The setting should consider any GHG emissions from existing infrastructure that would be upgraded or replaced by the proposed project.		
5.8.2 Regulatory Setting		
5.8.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards for greenhouse gases.		
5.8.3 Impact Questions		
5.8.3.1 Impact Questions. The impact questions include all greenhouse gas impact questions in the current version of CEQA Guidelines, Appendix G. **5.8.3.2:** Additional CEQA Impact Questions: None.		
5.8.4 Impact Analysis		
5.8.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.8.4.2: GHG Emissions. Provide a quantitative assessment of GHG emissions for construction and operation and maintenance of the proposed project. Provide model results and all model files. Modeling will be conducted using the latest version of the emissions model at the time of application filing (e.g., most recent version of CalEEMod). GHG emissions will be provided for the following conditions: a) Uncontrolled emissions (before APMs are applied) b) Controlled emissions considering application of APMs i. Based on the modeled GHG emissions, quantify the project's contribution to and analyze the project's effect on		

climate change. Identify and provide justification for the timeframe considered in the analysis. ii. Discuss any programs already in place to reduce GHG emissions on a system-wide level. This includes the Applicant's voluntary compliance with the EPA SF6 reduction program, reductions from energy efficiency, demand response, LTPP, etc. iii. For any significant impacts, identify potential strategies that could be employed by the project to reduce GHGs during construction or operation and maintenance consistent with OPR Advisory on CEQA and Climate Change.		
Natural Gas Storage		
5.8.4.3: Natural Gas Storage Accident Conditions. In addition to the requirements above, identify the potential GHG emissions that could result in the event of a gas leak.		
5.8.4.4: Monitoring and Contingency Plan. Provide a comprehensive monitoring plan that would be implemented during project operation to monitor for gas leaks. The plan should identify a monitoring schedule, description of monitoring activities, and actions to be implemented if gas leaks are observed.		
5.8.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.9 Hazards, Hazardous Materials, and Public Safety[29]

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.9.1 Environmental Setting		
5.9.1.1: Hazardous Materials Report. Provide a Phase I Environmental Site Assessment or similar hazards report for the proposed project area. Describe any known hazardous materials locations within the project area and the status of the site.		
5.9.1.2: Airport Land Use Plan. Identify any airport land use plan(s) within the project area.		
5.9.1.3: Fire Hazard. Identify if the project occurs within federal, state, or local fire responsibility areas and identify the fire hazard severity rating for all project areas, including temporary work areas and access roads.		
5.9.1.4: Metallic Objects. For electrical projects, identify any metallic pipelines or cables within 25 feet of the project.		

29 For fire risk specific to state responsibility areas or lands classified as very high fire hazard severity zones, see Section 5.20, Wildfire.

5.9.1.5: Pipeline History (for Natural Gas Projects). Provide a narrative describing the history of the pipeline system(s) to which the project would connect, list of previous owner and operators, and detailed summary of the pipeline systems' safety and inspection history.		
5.9.2 Regulatory Setting		
5.9.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards for hazards, hazardous materials, and public safety.		
5.9.2.2: Touch Thresholds. Identify applicable standards for protection of workers and the public from shock hazards.		
5.9.3 Impact Questions		
5.9.3.1: Impact Questions. The impact questions include all hazards and hazardous materials impact questions in the current version of CEQA Guidelines, Appendix G. **5.9.3.2:** Additional CEQA Impact Questions: a) Would the project create a significant hazard to air traffic from the installation of new power lines and structures? b) Would the project create a significant hazard to the public or environment through the transport of heavy materials using helicopters? c) Would the project expose people to a significant risk of injury or death involving unexploded ordnance? d) Would the project expose workers or the public to excessive shock hazards?		
5.9.4 Impact Analysis		
5.9.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.9.4.2: Hazardous Materials. Identify the hazardous materials (i.e., chemicals, solvents, lubricants, and fuels) that would be used during construction and operation of the project. Estimate the quantity of each hazardous material that would be stored on site during construction and operation.		
5.9.4.3: Air Traffic Hazards. If the project involves construction of above-ground structures (including structure replacement) within the airport land use plan area, provide a discussion of how the project would or would not conflict with height restrictions identified in the airport land use plan and how the project would comply with any FAA or military requirements for the above ground facilities.		
5.9.4.4: Accident or Upset Conditions. Describe how the project facilities would be designed, constructed, operated, and maintained to		

minimize potential hazard to the public from the failure of project components as a result of accidents or natural catastrophes.		
5.9.4.5: Shock Hazard. For electricity projects, identify infrastructure that may be susceptible to induced current from the proposed project. Describe strategies (e.g., cathodic protection) that the project would employ to reduce shock hazards and avoid electrocution of workers or the public.		
For Natural Gas and Gas Storage:		
5.9.4.6: Health and Safety Plan. Include in the Health and Safety Plan, plans for addressing gas leaks, fires, etc. Identify sensitive receptors, methods of evacuation, and protection measures. The Plan will be provided as an Appendix to the PEA.		
5.9.4.7: Health Risk Assessment. Provide a Health Risk Assessment including risk from potential gas leaks, fires, etc. Identify sensitive receptors that would be affected and potential impacts on them if there is a gas release.[30]		
5.9.4.8: Gas Migration. Describe potential for and effects of gas migration through natural and manmade pathways. a) Provide Applicant Proposed Measures for avoiding gas emissions at the surface from gas migration pathways. b) Provide Applicant Proposed Measures for avoiding emissions of mercaptan and/or other odorizing agents.		
5.9.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.10 Hydrology and Water Quality

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.10.1 Environmental Setting		
5.10.1.1: Waterbodies. Identify by milepost all ephemeral, intermittent, and perennial surface waterbodies crossed by the project. For each, list its water quality classification, if applicable.		
5.10.1.2: Water Quality. Identify any downstream waters that are on the state 303(d) list and identify whether a total maximum daily load (TMDL) has been adopted or the date for adoption of a TMDL. Identify existing sources of impairment for downstream waters. Describe any management plans that are in place for downstream waters.		
5.10.1.3: Groundwater Basin. Identify all known EPA and state groundwater basins and aquifers crossed by the project.		

[30] Refer to the requirements for Health Risk Assessments in Section 5.3.4.4.

5.10.1.4: Groundwater Wells and Springs. Identify the locations of all known public and private groundwater supply wells and springs within 150 feet of the project area.		
5.10.1.5: Groundwater Management. Identify the groundwater management status of any groundwater resources in the project area and any groundwater resources that may be used by the project. Describe if groundwater resources in the basin have been adjudicated. Identify any sustainable groundwater management plan that has been adopted for groundwater resources in the project area or describe the status of groundwater management planning in the area.		
5.10.2 Regulatory Setting		
5.10.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding hydrologic and water quality.		
5.10.3 Impact Questions		
5.10.3.1: Impact Questions. The impact questions include all hydrology and water quality impact questions in the current version of CEQA Guidelines, Appendix G. **5.10.3.2:** Additional CEQA Impact Questions: None.		
5.10.4 Impact Analysis		
5.10.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in the current version of CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.10.4.2: Hydrostatic Testing. Identify all potential sources of hydrostatic test water, quantity of water required, withdrawal methods, treatment of discharge, and any waste products generated.		
5.10.4.3: Water Quality Impacts. Describe impacts to surface water quality, including the potential for accelerated soil erosion, downstream sedimentation, and reduced surface water quality.		
5.10.4.4: Impermeable Surfaces. Describe increased run-off and impacts on groundwater recharge due to construction of impermeable surfaces. Provide the acreage of new impermeable surfaces that will be created as a result of the project.		
5.10.4.5: Waterbody Crossings. Identify by milepost all waterbody crossings. Provide the following information for crossing: a) Identify whether the waterbody has contaminated waters or sediments. b) Describe the waterbody crossing method and any approaches to avoid the waterbody. c) Describe typical additional work area and staging area requirements at waterbody and wetland crossings.		

d) Describe any dewatering or water diversion that will be required during construction near the waterbody. Identify treatment methods for any dewatering. e) Describe any proposed restoration methods for work near or within the waterbody.		
5.10.4.6: Groundwater Impacts. If water would be obtained from groundwater supplies, evaluate the project's consistency with any applicable sustainable groundwater management plan.		
5.10.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.11 Land Use and Planning

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.11.1 Environmental Setting		
5.11.1.1: Land Use. Provide a description of land uses within the area traversed by the project route as designated in the local General Plan (e.g., residential, commercial, agricultural, open space, etc.).		
5.11.1.2: Special Land Uses. Identify by milepost and segment all special land uses within the project area including: a) All land administered by federal, state, or local agencies, or private conservation organizations b) Any designated coastal zone management areas c) Any designated or proposed candidate National or State Wild and Scenic Rivers crossed by the project d) Any national landmarks		
5.11.1.3: Habitat Conservation Plan. Provide a copy of any Habitat Conservation Plan applicable to the project area or proposed project. Also required for Section 5.4, Biological Resources.		
5.11.2 Regulatory Setting		
5.11.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards for land use and planning.		
5.11.3 Impact Questions		
5.11.3.1: Impact Questions. The impact questions include all land use questions in the current version of CEQA Guidelines, Appendix G. **5.11.3.2:** Additional CEQA Impact Questions: None.		
5.11.4 Impact Analysis		
5.11.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		

5.11.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.12 Mineral Resources

This section will include, but is not limited to, the following:	**PEA Section and Page Number**	**Applicant Notes, Comments**
5.12.1 Environmental Setting		
5.12.1.1: Mineral Resources. Provide information on the following mineral resources within 0.5 mile of the proposed project area: a) Known mineral resources b) Active mining claims c) Active mines d) Resource recovery sites		
5.12.2 Regulatory Setting		
5.12.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards for minerals.		
5.12.3 Impact Questions		
5.12.3.1: Impact Questions. The impact questions include all mineral resource impact questions in the current version of CEQA Guidelines, Appendix G. **5.12.3.2:** Additional CEQA Impact Questions: None.		
5.12.4 Impact Analysis		
5.12.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
5.12.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.13 Noise

This section will include, but is not limited to, the following:	**PEA Section and Page Number**	**Applicant Notes, Comments**
5.13.1 Environmental Setting		
5.13.1.1: Noise Sensitive Land Uses. Identify all noise sensitive land uses within 1,000 feet of the proposed project. Provide GIS data for sensitive receptors within 1,000 feet of the project.		
5.13.1.2: Noise Setting. Provide the existing noise levels (Lmax, Lmin, Leq, and Ldn sound level and other applicable noise parameters) at noise sensitive areas near the proposed project. All noise measurement data and the methodology for collecting the data will be provided in a noise study as an Appendix to the PEA.		

5.13.2 Regulatory Setting		
5.13.2.1: Regulatory Setting. Identify applicable state, and local laws, policies, and standards for noise.		
5.13.3 Impact Questions		
5.13.3.1 Impact Questions. The impact questions include all noise questions in the current version of CEQA Guidelines, Appendix G. **5.13.3.2:** Additional CEQA Impact Questions: None.		
5.13.4 Impact Analysis		
5.13.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.13.4.2: Noise Levels a) Identify noise levels for each piece of equipment that could be used during construction. b) Provide a table that identifies each phase of construction, the equipment used in each construction phase, and the length of each phase at any single location (see example in Table 7 below). c) Estimate cumulative equipment noise levels for each phase of construction. d) Include phases of operation if noise levels during operation have the potential to frequently exceed pre-project existing conditions. e) Identify manufacturer's specifications for equipment and describe approaches to reduce impacts from noise.		

Table 7. Construction Noise Levels

Equipment Required	Equipment Noise Levels (Leq; 50 feet)	Phase Noise Level (Leq; 50 feet)	Phase Duration at Each Location	Receptor Nearest to Construction Phase	Noise Level at Nearest Receptor (Leq)	Exceeds Noise Standard at Nearest Receptor?	Distance to Not Exceed Standard
Site Preparation/Grading							
Dozer	78 dBA	82 dBA	5 days	Residence on Main Street; 100 feet from Substation Site	76 dBA	Yes	112 feet
Gradall	79 dBA						
Dump Truck	73 dBA						
Construct Tower Foundation							
Auger Rig	77 dBA	82 dBA	11 days	School on Education Avenue; 130 feet from Tower A12	73 dBA	No	N/A
Dump Truck	73 dBA						
Excavator	77 dBA						
Concrete Truck	75 dBA						

For Natural Gas:		
5.13.4.3: Compressor Station Noise. Provide site plans of compressor stations or other noisy, permanent equipment, showing the location of the nearest noise sensitive areas within 1 mile of the proposed ROW. If new compressor station sites are proposed, measure or estimate the existing ambient sound environment based on current land uses and		

activities. For existing compressor stations (operated at full load), include the results of a sound level survey at the site property line and nearby noise-sensitive areas. Include a plot plan that identifies the locations and duration of noise measurements.		
5.13.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.14 Population and Housing

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.14.1 Environmental Setting		
5.14.1.1: Population Estimates. Identify population trends for the areas (county, city, town, census designated place) where the project would take place.		
5.14.1.2: Housing Estimates. Identify housing estimates and projections in areas where the project would take place.		
5.14.1.3: Approved Housing Developments a) Provide the following information for all housing development projects within 1 mile of the proposed project that have been recently approved or may be approved around the PEA and application filing date: i. Project name ii. Location iii. Number of units and estimated population increase iv. Approval date and construction status v. Contact information for developer (provided in the public outreach Appendix) b) Ensure that the project information provided above is consistent with the PEA analysis of cumulative project impacts.		
5.14.2 Regulatory Setting		
5.14.2.1: Regulatory Setting. Identify any applicable federal, state or local laws or regulations that apply to the project.		
5.14.3 Impact Questions		
5.14.3.1: Impact Questions. The impact questions include all population and housing impact questions in the current version of CEQA Guidelines, Appendix G. **5.14.3.2:** Additional CEQA Impact Questions: None.		
5.14.4 Impact Analysis		
5.14.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		

Include the following information in the impact analysis:		
5.14.4.2: Impacts to Housing. Identify if any existing or proposed homes occur within the footprint of any proposed project elements or right-of-way. Describe housing impacts (e.g., demolition and relocation of residents) that may occur as a result of the proposed project.		
5.14.4.3: Workforce Impacts. Describe on-site manpower requirements, including the number of construction personnel who currently reside within the impact area, who would commute daily to the site from outside the impact area or would relocate temporarily within the impact area. Chapter 4 of this document can be referenced as applicable. Identify any permanent employment opportunities that would be create by the project and the workforce conditions in the area that the jobs would be created.		
5.14.4.4: Population Growth Inducing. Provide information on the project's growth inducing impacts, if any. The information will include, but is not necessarily limited to, the following: a) Any economic or population growth in the surrounding environment that will directly or indirectly result from the project b) Any obstacles to population growth that the project would remove c) Any other activities directly or indirectly encouraged or facilitated by the project that would cause population growth leading to a significant effect on the environment, either individually or cumulatively		
5.14.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.15 Public Services

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.15.1 Environmental Setting		
5.15.1.1 Service Providers a) Identify the following service providers that serve the project area and provide a map showing the service facilities that could serve the project: i. Police ii. Fire (identify service providers within local and state responsibility areas) iii. Schools iv. Parks v. Hospitals		

b) Provide the documented performance objectives and data on existing emergency response times for service providers in the area (e.g., police or fire department response times).		
5.15.2 Regulatory Setting		
5.15.2.1 Regulatory Setting. Identify any applicable federal, state or local laws or regulations for public services that apply to the project.		
5.15.3 Impact Questions		
5.15.3.1: Impact Questions. The impact questions include all public services impact questions in the current version of CEQA Guidelines, Appendix G. **5.15.3.2:** Additional CEQA Impact Questions: None.		
5.15.4 Impact Analysis		
5.15.4.1 Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.15.4.2: Emergency Response Times a) Describe whether the project would impede ingress and egress of emergency vehicles during construction and operation. b) Include an analysis of impacts on emergency response times during project construction and operation, including impacts during any temporary road closures. Describe approaches to address impacts on emergency response times.		
5.15.4.3: Displaced Population. If the project would create permanent employment or displace people, evaluate the impact of the new employment or relocated people on governmental facilities and services and describe plans to reduce the impact on public services.		
5.15.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.16 Recreation

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.16.1 Environmental Setting		
5.16.1.1: Recreational Setting a) Describe the regional and local recreation setting in the project area including: i. Any recreational facilities or areas within and surrounding the project area (approximately 0.5-mile buffer) including the recreational uses of each facility or area		

ii. Any available data on use of the recreational facilities including volume of use b) Provide a map (or maps) showing project features and recreational facilities and provide associated GIS data.		
5.16.2 Regulatory Setting		
5.16.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding recreation.		
5.16.3 Impact Questions		
5.16.3.1: Impact Questions. The impact questions include all recreation impact questions in the current version of CEQA Guidelines, Appendix G. **5.16.3.2:** Additional CEQA Impact Questions: a) Would the project reduce or prevent access to a designated recreation facility or area? b) Would the project substantially change the character of a recreational area by reducing the scenic, biological, cultural, geologic, or other important characteristics that contribute to the value of recreational facilities or areas? c) Would the project damage recreational trails or facilities?		
5.16.4 Impact Analysis		
5.16.4.1: Impact Analysis: Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
5.16.4.2: Impact Details. Clearly identify the maximum extent of each impact, and when and where the impacts would or would not occur. Organize the impact assessment by project phase, project component, and/or geographic area, as necessary.		
5.16.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.17 Transportation

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.17.1 Environmental Setting		
5.17.1.1: Circulation System. Briefly describe the regional and local circulation system in the project area, including modes of transportation, types of roadways, and other facilities that contribute to the circulation system.		
5.17.1.2: Existing Roadways and Circulation a) Identify and describe existing roadways that may be used to access the project site and transport materials during		

construction or are otherwise adjacent to or crossed by linear project features. Provide the following information for each road: i. Name of the road ii. Jurisdiction or ownership (i.e., State, County, City, private, etc.) iii. Number of lanes in both directions of travel iv. Existing traffic volume (if publicly available data is unavailable or significantly outdated, then it may be necessary to collect existing traffic counts for road segments where large volumes of construction traffic would be routed or where lane or road closures would occur) v. Closest project feature name and distance b) Provide a supporting map (or maps) showing project features and the existing roadway network identifying each road described above. Provide associated GIS data. The GIS data should include all connected road segments within at least 5 miles of the project.		
5.17.1.3: Transit and Rail Services a) Identify and describe transit and rail service providers in the region. b) Identify any rail or transit lines within 1,000 feet of the project area. c) Identify specific transit stops, and stations within 0.5 mile of the project. Provide the frequency of transit service. d) Provide a supporting map (or maps) showing project features and transit and rail services within 0.5 mile of the project area. Provide associated GIS data.		
5.17.1.4: Bicycle Facilities a) Identify and describe any bicycle plans for the region. b) Identify specific bicycle facilities within 1,000 feet of the project area. c) Provide a supporting map (or maps) showing project features and bicycle facilities. Provide associated GIS data.		
5.17.1.5: Pedestrian Facilities a) Identify and describe important pedestrian facilities near the project area that contribute to the circulation system, such as important walkways. b) Identify specific pedestrian facilities that would be near the project, including on the road segments identified per 5.17.1.2. c) Provide a supporting map (or maps) showing project features and important pedestrian facilities. Provide associated GIS data.		

5.17.1.6: Vehicle Miles Traveled (VMT). Provide the average VMT for the county(s) where the project is located.		
5.17.2 Regulatory Setting		
5.17.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards regarding transportation.		
5.17.3 Impact Questions		
5.17.3.1: Impact Questions. All impact questions for this resource area in the current version of CEQA Guidelines, Appendix G. **5.17.3.2:** Additional CEQA Impact Questions: a) Would the project create potentially hazardous conditions for people walking, bicycling, or driving or for public transit operations? b) Would the project interfere with walking or bicycling accessibility? c) Would the project substantially delay public transit?		
5.17.4 Impact Analysis		
5.17.4.1: Impact Analysis. Provide an impact analysis for each significance criteria identified in Appendix G of the CEQA Guidelines for transportation and any additional impact questions listed above[31].		
Include the following information in the impact analysis:		
5.17.4.2: Vehicle Miles Traveled (VMT) a) Identify whether the project is within 0.5 mile of a major transit stop or a high-quality transit corridor. b) Identify the number of vehicle daily trips that would be generated by the project during construction and operation by light duty (e.g., worker vehicles) and heavy-duty vehicles (e.g., trucks). Provide the frequency of trip generation during operation. c) Quantify VMT generation for both project construction and operation. d) Provide an excel file with the VMT assumptions and model calculations, including all formulas and values. e) Evaluate the project VMT relative to the average VMT for the area in which the project is located.		
5.17.4.3: Traffic Impact Analysis. Provide a traffic impact study. The traffic impact study should be prepared in accordance with guidance from the relevant local jurisdiction or Caltrans, where appropriate.		
5.17.4.4: Hazards. Identify any traffic hazards that could result from construction and operation of the project. Identify any lane closures and traffic management that would be required to construct the project.		

[31] Discuss with CPUC during Pre-filing whether a traffic study is needed.

5.17.4.5: Accessibility. Identify any closures of bicycle lanes, pedestrian walkways, or transit stops during construction or operation of the project.		
5.17.4.6: Transit Delay. Identify any transit lines that could be delayed by construction and operation of the project. Provide the maximum extent of the delay in minutes and the duration of the delay.		
5.17.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.18 Tribal Cultural Resources[32]

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.18.1 Environmental Setting		
5.18.1.1: Outreach to Tribes. Provide a list of all tribes that are on the Native American Heritage Commission (NAHC) list of tribes that are affiliated with the project area. Provide a discussion of outreach to Native American tribes, including tribes notified, responses received from tribes, and information of potential tribal cultural resources provided by tribes. Any information of potential locations of tribal cultural resources should be submitted in an Appendix under clearly marked confidential cover. Provide copies of all correspondence with tribes in an Appendix.		
5.18.1.2: Tribal Cultural Resources. Describe tribal cultural resources (TCRs) that are within the project area. a) Summarize the results of attempts to identify possible TCRs using publicly available documentary resources. The identification of TCRs using documentary sources should include review of archaeological site records and should begin during the preparation of the records search report (see Attachment 3). During the inventory phase, a formal site record would be prepared for any resource identified unless tribes object. b) Summarize attempts to identify TCRs by speaking directly with tribal representatives.		
5.18.1.3: Ethnographic Study. The ethnographic study should document the history of Native American use of the area and oral history of the area.		
5.18.2 Regulatory Setting		
5.18.2.1: Regulatory Setting. Identify any applicable federal, state or local laws or regulations for tribal cultural resources that apply to the project.		

[32] For a description of historical resources and requirements for cultural resources that are not tribal cultural resources, refer to Section 5.5 Cultural Resources.

5.18.3 Impact Questions		
5.18.3.1: Impact Questions. The impact questions include all tribal cultural resources impact questions in the current version of CEQA Guidelines, Appendix G. **5.18.3.2:** Additional CEQA Impact Questions: None.		
5.18.4 Impact Analysis		
5.18.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.18.4.2: Information Provided by Tribes. Include an analysis of any impacts that were identified by the tribes during the Applicant's outreach.		
5.18.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.19 Utilities and Service Systems

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.19.1 Environmental Setting		
5.19.1.1: Utility Providers. Identify existing utility providers and the associated infrastructure that serves the project area.		
5.19.1.2: Utility Lines. Describe existing utility infrastructure (e.g., water, gas, sewer, electrical, stormwater, telecommunications, etc.) that occurs in the project ROW. Provide GIS data and/or as-built engineering drawings to support the description of existing utilities and their locations.		
5.19.1.3: Approved Utility Projects. Identify utility projects that have been approved for construction within the project ROW but that have not yet been constructed.[33]		
5.19.1.4: Water Supplies. Identify water suppliers and the water source (e.g., aqueduct, well, recycled water, etc.). For each potential water supplier, provide data on the existing water capacity, supply, and demand.		
5.19.1.5: Landfills and Recycling. Identify local landfills that can accept construction waste and may service the project. Provide documentation of landfill capacity and estimated closure date. Identify any recycling centers in the area and opportunities for construction and demolition waste recycling.		

[33] Note that this project information should be consistent with the cumulative project description included in Chapter 7.

5.19.2 Regulatory Setting		
5.19.2.1: Regulatory Setting. Identify any applicable federal, state or local laws or regulations for utilities that apply to the project.		
5.19.3 Impact Questions		
5.19.3.1: Impact Questions. All impact questions for this resource area in the current version of CEQA Guidelines, Appendix G. **5.19.3.2:** Additional CEQA Impact Question: Would the project increase the rate of corrosion of adjacent utility lines as a result of alternating current impacts?		
5.19.4 Impact Analysis		
5.19.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.19.4.2: Utility Relocation. Identify any project conflicts with existing utility lines. If the project may require relocation of existing utilities, identify potential relocation areas and analyze the impacts of relocating the utilities. Provide a map showing the relocated utility lines and GIS data for all relocations.		
5.19.4.3: Waste a) Identify the waste generated by construction, operation, and demolition of the project. b) Describe how treated wood poles would be disposed of after removal, if applicable. c) Provide estimates for the total amount of waste materials to be generated by waste type and how much of it would be disposed of, reused, or recycled.		
5.19.4.4: Water Supply a) Estimate the amount of water required for project construction and operation. Provide the potential water supply source(s). b) Evaluate the ability of the water supplier to meet the project demand under a multiple dry year scenario. c) Provide a discussion as to whether the proposed project meets the criteria for consideration as a project subject to Water Supply Assessment Requirements under Water Code Section 10912. d) If determined to be necessary under Water Code Section 10912, submit a Water Supply Assessment to support conclusions that the proposed water source can meet the project's anticipated water demand, even in multiple dry year scenarios. Water Supply Assessments should be approved by		

the water supplier and consider normal, single-dry, and multiple-dry year conditions.		
5.19.4.5: Cathodic Protection. Analyze the potential for existing utilities to experience corrosion due to proximity to the proposed project. Identify cathodic protection measures that could be implemented to reduce corrosion issues and where the measures may be applied.		
5.19.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.20 Wildfire

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.20.1 Environmental Setting		
5.20.1.1: High Fire Risk Areas and State Responsibility Areas a) Identify areas of high fire risk or State Responsibility Areas (SRAs) within the project area. Provide GIS data for the Wildland Urban Interface (WUI) and Fire Hazard Severity Zones (FHSZ) mapping along the project alignment. Include areas mapped by CPUC as moderate and high fire threat districts as well as areas mapped by CalFire. b) Identify any areas the utility has independently identified as High FHSZ known to occur within the proposed project vicinity.		
5.20.1.2: Fire Occurrence. Identify all recent (within the last 10 years) large fires that have occurred within the project vicinity. For each fire, identify the following: a) Name of the fire b) Location of fire c) Ignition source and location of ignition d) Amount of land burned e) Boundary of fire area in GIS		
5.20.1.3: Fire Risk. Provide the following information for assessment of baseline fire risk in the area: a) Provide fuel modeling using Scott Burgan fuel models, or other model of similar quality. b) Provide values of wind direction and speed, relative humidity, and temperature for representative weather stations along the alignment for the previous 10 years, gathered hourly. c) Digital elevation models for the topography in the project region showing the relationship between terrain and wind patterns, as well as localized topography to show the effects of terrain on wind flow, and on a more local area to show effect of slope on fire spread.		

d) Describe vegetation fuels within the project vicinity and provide data in map format for the project vicinity. USDA Fire Effects Information System or similar data source should be consulted to determine high-risk vegetation types. Provide the mapped vegetation fuels data in GIS format.		
5.20.1.4: Values at Risk. Identify values at risk along the proposed alignment. Values at risk may include: Structures, improvements, rare habitat, other values at risk, (including utility-owned infrastructure) within 1000 feet of the project. Provide some indication as to its vulnerability (wood structures vs. all steel features). Communities and/or populations near the project should be identified with their proximity to the project defined.		
5.20.1.5: Evacuation Routes. Identify all evacuation routes that are adjacent to or within the project area. Identify any roads that lack a secondary point of access or exit (e.g., cul-de-sacs).		
5.20.2 Regulatory Setting		
5.20.2.1: Regulatory Setting. Identify applicable federal, state, and local laws, policies, and standards for wildfire.		
5.20.2.2: CPUC Standards. Identify any CPUC standards that apply to wildfire management of the new facilities.		
5.20.3 Impact Questions		
5.20.3.1: Impact Questions. All impact questions for this resource area in the current version of CEQA Guidelines, Appendix G. **5.20.3.2:** Additional CEQA Impact Questions: None.		
5.20.4 Impact Analysis		
5.20.4.1: Impact Analysis. Provide an impact analysis for each checklist item identified in CEQA Guidelines, Appendix G for this resource area and any additional impact questions listed above.		
Include the following information in the impact analysis:		
5.20.4.2: Fire Behavior Modeling. For any new electrical lines, provide modeling to support the analysis of wildfire risk.		
5.20.4.3: Wildfire Management. Describe approaches that would be implemented during operation and maintenance to manage wildfire risk in the area. Provide a copy of any Wildfire Management Plan.		
5.20.5 CPUC Draft Environmental Measures		
Refer to Attachment 4, CPUC Draft Environmental Measures.		

5.21 Mandatory Findings of Significance[34]

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
5.21.1: Impact Assessment for Mandatory Findings of Significance. Provide an impact analysis for each of the mandatory findings of significance provided in Appendix G of the CEQA Guidelines. The impact analysis can reference relevant information and conclusion from the biological resources, cultural resources, air quality, hazards, and cumulative sections of the PEA, where applicable.		

6 Comparison of Alternatives

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
6.1: Alternatives Comparison a) Compare the ability of each alternative described in Chapter 4 against the proposed project in terms of its ability to avoid or reduce a potentially significant impact. The alternatives addressed in this section will each be: i. Potentially feasible ii. Meet the underlying purpose of the proposed project iii. Meet most of the basic project objectives, and iv. Avoid or reduce one or more potentially significant impacts. b) The relative effect of the various potentially significant impacts may be compared using the following or similar descriptors and an accompanying analysis: i. Short-term versus long-term impacts ii. Localized versus widespread impacts iii. Ability to fully mitigate impacts c) Impacts that the Applicant believes would be less than significant with mitigation may also be included in the analysis, but only if the steps listed above fail to distinguish among the remaining few alternatives.		
6.2: Alternatives Ranking. Provide a detailed table that summarizes the Applicant's comparison results and ranks the alternatives in order of environmental superiority.[35]		

[34] PEAs need only include a Mandatory Findings of Significance section if CPUC CEQA Unit Staff determine that a Mitigated Negative Declaration may be the appropriate type of document to prepare for the project, as determined through Pre-filing consultation. If no such determination has been made, then a Mandatory Findings of Significance section and the requirements below are not required.

[35] If the proposed project does not rank #1 on the list, the Applicant should provide the rationale for selecting the proposed project.

7 Cumulative and Other CEQA Considerations

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
7.1 Cumulative Impacts		
7.1.1: List of Cumulative Projects a) Provide a detailed table listing past, present, and reasonably foreseeable future projects within and surrounding the project area (approximately 2-mile buffer)[36]. The following information should be provided for each project in the table: i. Project name and type ii. Brief description of the project location(s) and associated actions iii. Distance to and name of the nearest project component iv. Project status and anticipated construction schedule v. Source of the project information and date last checked (for each individual project), including links to any public websites where the information was obtained so it can be reviewed and updated (the project information should be current when the PEA is filed) b) Provide a supporting map (or maps) showing project features and cumulative project locations and/or linear features. Provide associated GIS data.		
7.1.2: Geographic Scope. Define the geographic scope of analysis for each resource topic. The geographic scope of analysis for each resource topic should consider the extent to which impacts can be cumulative. For example, the geographic scope for cumulative noise impacts would be more limited in scale than the geographic scope for biological resource impacts because noise attenuates rapidly with distance. Explain why the geographic scope is appropriate for each resource.		
7.1.3: Cumulative Impact Analysis. Provide an analysis of cumulative impacts for each resource topic included in Chapter 5. Evaluate whether the proposed project impacts are cumulatively considerable[37] for any significant cumulative impacts.		
7.2 Growth-Inducing Impacts		
7.2.1: Growth-Inducing Impacts. Provide an evaluation of the following potential growth-inducing impacts:		

[36] Information on cumulative projects may be obtained from federal, state, and local agencies with jurisdiction over planning, transportation, and/or resource management in the area. Other projects the Applicant is involved in or aware of in the area should be included.

[37] "Cumulatively considerable" means that the incremental effects of an individual project are significant when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects.

a) Would the proposed project foster any economic or population growth, either directly or indirectly, in the surrounding environment? b) Would the proposed project cause any increase in population that could further tax existing community service facilities (i.e., schools, hospitals, fire, police, etc.)? c) Would the proposed project remove any obstacles to population growth? d) Would the proposed project encourage and facilitate other activities that would cause population growth that could significantly affect the environment, either individually or cumulatively?		

8 List of Preparers

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
8.1: List of Preparers. Provide a list of persons, their organizations, and their qualifications for all authors and reviewers of each section of the PEA.		

9 References

This section will include, but is not limited to, the following:	PEA Section and Page Number	Applicant Notes, Comments
9.1: Reference List a) Organize all references cited in the PEA by section within a single chapter called "References." b) Within the References chapter, organize all of the Chapter 5 references under subheadings for each resource area section.		
9.2: Electronic References a) Provide complete electronic copies of all references cited in the PEA that cannot be readily obtained for free on the Internet. This includes any company-specific documentation (e.g., standards, policies, and other documents). b) If the reference can be obtained on the Internet, the Internet address will be provided.		

PEA Checklist Attachments

Attachment 1: GIS Data Requirements

This Attachment includes specific requirements and format of GIS data that is intended to be applicable to all PEAs. The specific GIS data requirements may be updated on a project-specific basis during Pre-filing coordination with CPUC's CEQA Unit Staff.

1. GIS data will be provided in an appropriate format (i.e., point, line, polygon, raster) and scale to adequately verify assumptions in the PEA and supporting materials and determine the level of environmental impacts. At a minimum, all GIS data layers will include the following metadata properties:
    a. The source (e.g., report reference), date, title, and preparer (name or company)
    b. Description of the contents and any limitations of the data
    c. Reference scale and accuracy of the data
    d. Complete attributes that correspond to the detailed mapbook, project description, and figures presented in the PEA and/or supporting application materials, including unique IDs, labels, geometry, and other appropriate project details
2. Where precise boundaries of project features may change (e.g., staging areas and temporary construction work areas), the Applicant will provide GIS data layers with representative boundaries to evaluate potential environmental impacts as a worst-case scenario.
3. Provide GIS data for:
    a. All proposed <u>and alternative</u> project facilities including but not limited to existing and proposed/alternative ROWs; substations and switching stations; pole/tower locations; conduit; vaults, pipelines; valves; compressor stations; metering stations; valve stations, gas wellheads; other project buildings, facilities, and components (both temporary and permanent); telecommunication and distribution lines modifications or upgrades related to the project; marker ball and lighting locations; and mileposts, facility perimeters, and other demarcations or segments as applicable
    b. All proposed areas required for construction and construction planning, including all proposed and alternative disturbance areas (both permanent and temporary); access roads; geotechnical work areas; extra work areas (e.g., staging areas, parking areas, lay-down areas, work areas at and around specific pole/tower sites, pull and tension sites, helicopter landing areas); airport landing areas; underground installation areas (e.g. trenches, vaults, underground work areas); horizontal directional drilling, jack and bore, or tunnel areas; blasting areas; and any areas where special construction methods may need to be employed
    c. Within the PEA checklist there are also specific requirements for environmental resources within Chapter 5. All environmental resource GIS data must meet the minimum mapping standards specified in this Attachment.

Attachment 2: Biological Resource Technical Report Standards

Definitions

The following biological resources will be considered within the scope of the PEA and the Biological Resources Technical Report:

Sensitive Vegetation Communities and Habitats

a) Sensitive vegetation communities/habitats identified in local or regional plans, policies, or regulations, or designated by CDFW[38] or USFWS
b) Areas that provide habitat for locally unique biotic species/communities (e.g., oak woodlands, grasslands, and forests)
c) Habitat that contains or supports rare, endangered, or threatened wildlife or plant species as defined by CDFW and USFWS
d) Habitat that supports CDFW Species of Special Concern
e) Areas that provide habitat for rare or endangered species and that meet the definition in CEQA Guidelines Section 15380
f) Existing game and wildlife refuges and reserves
g) Lakes, wetlands, estuaries, lagoons, streams, and rivers
h) Riparian corridors

Special-Status Species

a) Species listed or proposed for listing as threatened or endangered under the federal Endangered Species Act (ESA) (50 CFR § 17.12 [listed plants], 17.11 [listed animals] and various notices in the Federal Register [proposed species])
b) Species that are candidates for possible future listing as threatened or endangered under the federal ESA (61 FR § 40, February 28, 1996)
c) Species listed or proposed for listing by the State of California as threatened or endangered under the California ESA (14 CCR § 670.5)
d) Plants listed as rare or endangered under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.)
e) Species that meet the definitions of rare and endangered under CEQA. CEQA Guidelines Section 15380 provides that a plant or animal species may be treated as "rare or endangered" even if not on one of the official lists.
f) Plants considered by the California Native Plant Society (CNPS) to be "rare, threatened or endangered in California" (California Rare Plant Rank 1A, 1B, 2A, and 2B) as well as California Rare Plant Rank 3 and 4 plant species
g) Species designated by CDFW as Fully Protected or as a Species of Special Concern
h) Species protected under the Federal Bald and Golden Eagle Protection Act
i) Birds of Conservation Concern or Watch List species
j) Bats considered by the Western Bat Working Group to be "high" or "medium" priority (Western Bat Working Group 2015)

[38] CDFW's Rarity Ranking follows NatureServe's Heritage Methodology (Faber-Langendoen, et al. 2016) in which communities are given a G (global) and S (state) rank based on their degree of imperilment (as measured by rarity, trends, and threats). Communities with a Rarity Ranking of S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable) are considered sensitive by CDFW.

Biological Resource Technical Report Minimum Requirements

Report Contents

The Biological Resource Technical Report will include the following information at a minimum.

a) **Preliminary Agency Consultation.** Describe any pre-survey contact with agencies. Describe any agency approvals that were required for biologists or agency protocols that were applied to the survey effort. Provide copies of correspondence and meeting notes with the names and contact information for agency staff and the dates of consultation as an appendix to the Biological Resources Technical Report.
b) **Records Search.** Provide the results of all database and literature searches for biological resources within and surrounding the project area. Identify all sources reviewed (e.g., CNDDB, CNPS, USFWS, etc.).
c) **Biological Resource Survey Method.** Identify agency survey requirements and protocols applicable to each biological survey that was conducted. Identify the areas where each survey occurred. Identify any limitations for the surveys (e.g., survey timing or climatic conditions) that could affect the survey results.
d) **Vegetation Communities and Land Cover.** Identify all vegetation communities or land cover types (e.g., disturbed or developed) within the biological survey area. The biological survey area should include a 1,000-foot buffer from project facilities to support CPUC's evaluation of indirect effects.
e) **Aquatic Resources.** Identify any wetlands, streams, lakes, reservoirs, estuarine, or other aquatic resources within the biological survey area. Provide a wetland delineation and all data sheets including National Wetlands Inventory maps (or the appropriate state wetland maps, if National Wetlands Inventory maps are not available) that show all proposed facilities and include milepost locations for proposed pipeline routes. Provide a copy of agency verification of the wetland delineation if the delineation has been verified by the U.S. Army Corps of Engineers or CDFW. If the delineation has not been verified, describe the process and timing for obtaining agency verification.
f) **Habitat Assessments.** Evaluate the potential for suitable habitat in the biological survey area for each species identified in the database and literature search.
g) **Native Wildlife Corridors and Nursery Sites.** Identify any wildlife corridors or nursery sites that occur within the biological survey area.
h) **Survey Results.** Describe all survey results and include a copy of any focused (e.g., rare plant, protocol special-status wildlife) biological resources survey reports.

Mapping and GIS Data

Provide detailed maps (at approximately 1:3,000 scale or similar), and all associated GIS data for the Biological Resources Technical Report and any supporting biological survey reports, including:

a) Biological survey area for each survey that was conducted
b) Vegetation communities and land cover types
c) Aquatic resource delineation
d) Special-status plant locations
e) Special-status wildlife locations
f) Avian point count locations
g) Critical habitat
h) California Coastal Commission or Bay Conservation and Development Commission jurisdictional areas

Attachment 3: Cultural Resource Technical Report Standards

Cultural Resource Inventory Report

Provide a cultural resource inventory report that includes archaeological, unique archaeological, and built-environment resources within all areas that could be affected by the proposed project including areas of indirect effect. The inventory report will include the results of both a literature search and pedestrian survey. The contents will address the requirements in *Archaeological Resource Management Reports: Recommended Contents and Guidelines*. The methodology and results of the inventory should be sufficient to provide the reader with an understanding of the nature, character, and composition of newly discovered and previously identified cultural resources so that the required recommendations about the resource(s) CRHR eligibility are clearly understood. No information regarding the location of the cultural resources will be included in these descriptions. The required Department of Parks and Recreation (DPR) 523 forms, including location information and photographs of the resources, are to be included in a removable confidential appendix to the report.[39]

The inventory report will meet the following requirements:

a) The report should clearly discuss the methods used to identify unique archaeological resources (e.g., how the determination was made about the resources' eligibility).
b) The report should identify large resources such as districts and landscapes where resources indicate their presence, even if federal agencies disagree. It is understood that often only a few contributing elements may be in the project area, and that the boundaries of the large resource may need to be revisited as part of future projects. It is acknowledged that boundaries of districts and landscapes can be difficult to define and there is not always good recorded data on these resources.
c) In the case of archaeological resources, the report should discuss whether each one is also a unique archaeological resource and explain why or why not.
d) Descriptions of resources should include spatial relationships to other nearby resources, raw materials sources, and natural features such as water sources and mountains.
e) The evidence that indicates a particular function or age for a resource should be explicitly described with a clear explanation, not simply asserted.

Cultural Resource Evaluation Report

Provide a cultural resource evaluation report. The report contents required by the state of California are outlined in the *Archaeological Resource Management Reports: Recommended Contents and Guidelines*. The evaluation report should also include:

a) Resource descriptions and evaluations together, and not in separate volumes or report sections. This will facilitate understanding of each resource.
b) An evaluation of each potential or eligible California Register of Historical Resources (CRHR) resource within the public archaeology laboratory (PAL) for all seven aspects of integrity[40] using specific examples for each resource. This evaluation needs to be included in the evaluation

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[39] Any aspect of the PEA and associated data that Applicants believe to be confidential will be provided in full but may be marked confidential if allowed pursuant to General Order 66 or latest applicable Commission rule (e.g., see Public Records Act Proceeding R.14-11-001).

[40] The seven aspects of integrity are location, design, setting, materials, workmanship, feeling, and association, as defined in "***Types of Historical Resources and Criteria for Listing in the California Register of Historical Resources***" [14 CCR 4852(c)]).

report for all resources that could be affected by the project even if the resources were not previously evaluated. Previous evaluations should be reviewed to address change over time.

c) An evaluation of each potential or eligible CRHR resource within the PAL under all four criteria using specific examples for each resource. This evaluation needs to be included in the evaluation report for all resources that could be affected by the project even if the resources were not previously evaluated. The cultural resources professional should make their own recommendation regarding eligibility, which does not need to agree with previous recommendations for CRHR or NRHP, as long as it is clearly explained.

d) For **prehistoric archaeological resources**, Criteria 1, 2 and 3[41] should be explicitly considered. Research efforts to search for important events and persons related to the resource must be described. This evaluation needs to be included in the evaluation report for all resources that could be affected by the project even if the resources were not previously evaluated. The cultural resources professional should make their own recommendation, which does not need to agree with previous recommendations for CRHR or NRHP eligibility, as long as it is clearly explained.

e) While **potential unique archaeological resources** could be identified in the records search report or inventory report, the justification for each individual resource to be considered a resource under CEQA should be presented in this report.

f) If surface information collected during survey is sufficient to make an eligibility recommendation, this reasoning should be outlined explicitly for each resource. This is particularly the case for resources that are believed to have buried subsurface components.

g) If archaeological testing or additional historical research was required in order to evaluate a resource, the evaluation report will be explicit about why the work was required, the results for each resource, and the subsequent eligibility recommendation.

h) For large projects with multiple similar resources where the eligibility justifications for similar resources are essentially identical, it is acceptable to discuss these resources as a group. However, eligibility justifications for each individual resource is preferred, so if the grouping strategy is used, the criteria used to group resources must be clearly justified.

i) Large resources such as districts and landscapes may be challenging to fully evaluate in the context of a single project. CPUC encourages the identification and evaluation of these resources with the understanding that often only a few contributing elements may be located within the project area, and that the boundaries of the large resource may need to be revisited as part of future projects. It is understood that a full evaluation of the resource may be beyond the scope of one project. Regardless, the potential for the project to affect any resources within a district or landscape must be defined.

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[41] Criteria for Designation on the California Register are as follows (defined in http://ohp.parks.ca.gov/?page_id=21238):

- Criterion 1: Associated with events that have made a significant contribution to the broad patterns of local or regional history or the cultural heritage of California or the United States.
- Criterion 2: Associated with the lives of persons important to local, California or national history.
- Criterion 3: Embodies the distinctive characteristics of a type, period, region or method of construction or represents the work of a master or possesses high artistic values.
- Criterion 4: Has yielded, or has the potential to yield, information important to the prehistory or history of the local area, California or the nation.

Attachment 4: CPUC Draft Environmental Measures

About this Attachment: The following CPUC Draft Environmental Measures are provided for consideration during PEA development. They should be discussed with the CPUC's CEQA Unit Staff during Pre-filing, especially with respect to the development of Applicant Proposed Measures. The CPUC Draft Environmental Measures may form the basis for mitigation measures in the CEQA document if appropriate to the analysis of potentially significant impacts. These and other CPUC Draft Environmental Measures may be formally incorporated into Chapter 5 of future versions of the PEA Checklist.

5.1 Aesthetics

Aesthetics Impact Reduction During Construction

All project sites will be maintained in a clean and orderly state. Construction staging areas will be sited away from public view where possible. Nighttime lighting will be directed away from residential areas and have shields to prevent light spillover effects. Upon completion of project construction, project staging and temporary work areas will be returned to pre-project conditions, including re-grading of the site and re-vegetation or re-paving of disturbed areas to match pre-existing contours and conditions.

5.3 Air Quality

Dust Control During Construction

The Applicant shall implement measures to control fugitive dust in compliance with all local air district(s) standards. Dust control measures shall include the following at a minimum:

- All exposed surfaces with the potential of dust-generating shall be watered or covered with coarse rock to reduce the potential for airborne dust from leaving the site.
- The simultaneous occurrence of more than two ground disturbing construction phases on the same area at any one time shall be limited. Activities shall be phased to reduce the amount of disturbed surfaces at any one time.
- Cover all haul trucks entering/leaving the site and trim their loads as necessary.
- Use wet power vacuum street sweepers to sweep all paved access road, parking areas, staging areas, and public roads adjacent to project sites on a daily basis (at minimum) during construction. The use of dry power sweeping is prohibited.
- All trucks and equipment, including their tires, shall be washed off prior to leaving project sites.
- Apply gravel or non-toxic soil stabilizers on all unpaved access roads, parking areas, and staging areas at project sites.
- Water and/or cover soil stockpiles daily.
- Vegetative ground cover shall be planted in disturbed areas as soon as possible and watered appropriately until vegetation is established.
- All vehicle speeds shall be limited to fifteen (15) miles per hour or less on unpaved areas.
- Implement dust monitoring in compliance with the standards of the local air district.
- Halt construction during any periods when wind speeds are in excess of 50 mph.

5.5 Cultural Resources

Human Remains (Construction and Maintenance)

Avoidance and protection of inadvertent discoveries that contain human remains shall be the preferred protection strategy with complete avoidance of such resources ensured by redesigning the project. If human remains are discovered during construction or maintenance activities, all work shall be diverted from the area of the discovery, and the CPUC shall be informed immediately. The Applicant shall contact the County Coroner to determine whether or not the remains are Native American. If the remains are determined to be Native American, the Coroner will contact the Native American Heritage Commission (NAHC). The NAHC will then identify the person or persons it believes to be the most likely descendant of the deceased Native American, who in turn would make recommendations for the appropriate means of treating the human remains and any associated funerary objects.

If the remains are on federal land, the remains shall be treated in accordance with the Native American Graves Protection and Repatriation Act (NAGPRA). If the remains are not on federal land, the remains shall be treated in accordance with Health and Safety Code Section 7050.5, CEQA Section 15064.5(e), and Public Resources Code Section 5097.98.

5.8 Greenhouse Gas Emissions

Greenhouse Gas Emissions Reduction During Construction

The following measures shall be implemented to minimize greenhouse gas emissions from all construction sites:

- If suitable park-and-ride facilities are available in the project vicinity, construction workers shall be encouraged to carpool to the job site.
- The Applicant shall develop a carpool program to the job site.
- On road and off-road vehicle tire pressures shall be maintained to manufacturer specifications. Tires shall be checked and re-inflated at regular intervals.
- Demolition debris shall be recycled for reuse to the extent feasible.
- The contractor shall use line power instead of diesel generators at all construction sites where line power is available.
- The contractor shall maintain construction equipment per manufacturing specifications.

5.19 Utilities and Service Systems

Notify Utilities with Facilities Above and Below Ground

The Applicant shall notify all utility companies with utilities located within or crossing the project ROW to locate and mark existing underground utilities along the entire length of the project at least 14 days prior to construction. No subsurface work shall be conducted that would conflict with (i.e., directly impact or compromise the integrity of) a buried utility. In the event of a conflict, areas of subsurface excavation or pole installation shall be realigned vertically and/or horizontally, as appropriate, to avoid other utilities and provide adequate operational and safety buffering. In instances where separation between third-party utilities and underground excavations is less than 5 feet, the Applicant shall submit the intended construction methodology to the owner of the third-party utility for review and approval at least 30 days prior to construction. Construction methods shall be adjusted as necessary to assure that the integrity of existing utility lines is not compromised.

5.20 Wildfire

Construction Fire Prevention Plan

A project-specific Construction Fire Prevention Plan for both construction and operation of the project shall be submitted for review prior to initiation of construction. A draft copy of the Plan shall be provided to the CPUC and state and local fire agencies at least 90 days before the start of any construction activities in areas designated as Very High or High Fire Hazard Severity Zones. Plan reviewers shall also include federal, state, or local agencies with jurisdiction over areas where the project is located. The final Plan shall be approved by the CPUC at least 30 days prior to the initiation of construction activities. The Plan shall be fully implemented throughout the construction period and include the following at a minimum:

- The purpose and applicability of the Plan
- Responsibilities and duties
- Preparedness training and drills
- Procedures for fire reporting, response, and prevention that include:
  - Identification of daily site-specific risk conditions
  - The tools and equipment needed on vehicles and to be on hand at sites
  - Reiteration of fire prevention and safety considerations during tailboard meetings
  - Daily monitoring of the red-flag warning system with appropriate restrictions on types and levels of permissible activity
- Coordination procedures with federal and local fire officials
- Crew training, including fire safety practices and restrictions
- Method(s) for verifying that all Plan protocols and requirements are being followed

A project Fire Marshal or similar qualified position shall be established to enforce all provisions of the Construction Fire Prevention Plan as well as perform other duties related to fire detection, prevention, and suppression for the project. Construction activities shall be monitored to ensure implementation and effectiveness of the Plan.

Fire Prevention Practices (Construction and Maintenance)

The Applicant shall implement ongoing fire patrols during the fire season as defined each year by local, state, and federal fire agencies. These dates vary from year to year, generally occurring from late spring through dry winter periods. During Red Flag Warning events, as issued daily by the National Weather Service, all construction/maintenance activities shall cease, with an exception for transmission line testing, repairs, unfinished work, or other specific activities which may be allowed if the facility/equipment poses a greater fire risk if left in its current state.

All construction/maintenance crews and inspectors shall be provided with radio and cellular telephone access that is operational in all work areas and access routes to allow for immediate reporting of fires. Communication pathways and equipment shall be tested and confirmed operational each day prior to initiating construction/maintenance activities at each work site. All fires shall be reported to the fire agencies with jurisdiction in the area immediately upon discovery of the ignition.

All construction/maintenance personnel shall be trained in fire-safe actions, initial attack firefighting, and fire reporting. All construction/maintenance personnel shall be trained and equipped to extinguish small fires in order to prevent them from growing into more serious threats. All construction/maintenance personnel shall carry at all times a laminated card and be provided a hard hat sticker that list pertinent telephone numbers for reporting fires and defining immediate steps to take if a fire starts. Information on laminated contact cards and hard hat stickers shall be updated and redistributed to all construction/maintenance personnel and outdated cards and hard hat stickers shall be destroyed prior to the initiation of construction/maintenance activities on the day the information change goes into effect.

Construction/maintenance personnel shall have fire suppression equipment on all construction vehicles. Construction/maintenance personnel shall be required to park vehicles away from dry vegetation. Water tanks and/or water trucks shall be sited or available at active project sites for fire protection during construction. The Applicant shall coordinate with applicable local fire departments prior to construction/maintenance activities to determine the appropriate amounts of fire equipment to be carried on vehicles and, should a fire occur, to coordinate fire suppression activities.

Electric Power Plant Environmental Noise Guide

Volume I
2nd Edition

Edison Electric Institute

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4.3.2 Pumps

Large pumps are used for a wide variety of power plant applications, such as: boiler feed pumps, reactor feed pumps, circulating water pumps, condensate pumps, hotwell pumps, emergency fire pumps, fuel oil pumps, cooling tower booster pumps, and service water pumps. Field measurements and/or observations made at many of these installations indicate that the drive motor usually produces more noise than the pump does. The exceptions are the large, high pressure, high capacity boiler and reactor feed pumps, where the pump may produce higher noise levels than its driver mechanism. For all pump-motor sets, except boiler and reactor feed pumps, it is suggested that the total sound power level be calculated on the basis of the motor drive only, in accordance with Section 4.3.1. For pumps driven by auxiliary steam turbines, calculate the total sound power level on the basis of the turbine data of Section 4.3.5. For boiler and reactor feed pumps, the information given below should be used.

Sound Power Level

The estimated sound power levels of boiler and reactor feed pumps are given in Table 4.7. The first part of the table gives the overall and A-weighted sound power levels for pumps in two groups: 1000 to 9000 kW (1300 to 12000 hp) and 9500 to 18000 kW (12600 to 24000 hp). The second part of the table gives the octave band corrections for these two groups.

Directivity Effects

Although discrete frequencies from the pumps may display directivity effects, the directions are usually unpredictable. Therefore, both the broadband and tonal noise from pumps should be considered omnidirectional.

Tonal Characteristics

The data on the pumps in the 1000 to 9000 kW range indicate no strong tones or discrete frequencies.

The data for many of the pumps in the 9500 to 18000 kW range show tonal components in the 250 to 2000 Hz octave bands. Therefore, these larger pumps should be treated as having discrete frequency tones, unless the user knows that specific pumps do not produce these tones.

Temporal Characteristics

Feed pumps are generally steady, continuous noise sources.

Source Height

The source height of a pump should be taken as the elevation of the the drive shaft of the pump.

TABLE 4.7. ESTIMATED SOUND POWER LEVELS OF BOILER AND REACTOR FEED PUMPS

Pump Power Rating		Sound Power Level (dB)	
kW	hp	Overall	A-Weighted
1000	1300	108	104
2000	2700	110	106
4000	5300	112	108
6000	8000	113	109
9000	12000	115	111
----	----	---	---
9500	12600	113	112
12000	16000	115	114
15000	20000	119	118
18000	24000	123	122

Octave-Band Center Frequency (Hz)	Octave-Band Correction (dB) Subtract from Overall L_W	
	Pump Rating 1000-9000 kW (1300-12000 hp)	Pump Rating 9500-18000 kW (12600-24000 hp)
31	11	19
63	5	13
125	7	15
250	8	11
500	9	5
1000	10	5
2000	11	7
4000	12	19
8000	16	23

Support Data

Sound pressure level data have been analyzed for 23 feed pumps operating in both fossil fuel and nuclear plants. The power rating of the pump shows the most reasonable relationship with sound output. Figure 4.13 gives the measured A-weighted sound levels at 1 m plotted against rated pump power in kW and hp. Six different pump manufacturers and 16 different power stations (4 nuclear) are represented in the data. The smaller feed pumps are generally motor driven, and the larger ones are generally steam-turbine driven.

Since the frequency distribution of the noise from motor-driven and turbine-driven pumps differs in this study, they are plotted separately in Figure 4.14. Most of the turbine-driven pumps are characterized by strong

6.8.2 Indoor Source Adjustments

Since outdoor sound sources generally determine the sound levels at the receiver positions, the prediction procedure is based on outdoor sources. But, enclosed plants have indoor sound sources that must also be considered. The noise from an indoor sound source that is transmitted outdoors is a function of the geometry of the room and the area and sound transmission loss of the wall through which the noise passes [1]. The outdoor sound power level, L_{Wo}, radiated from an indoor source, L_W, is given by Equation 6.1:

$$L_{Wo} = L_W - A - B + C - 6, \qquad (6.1)*$$

where:

A is an adjustment term, in dB, for the building geometry (see Table 6.2); B is an adjustment term, in dB, for the sound transmission loss (TL) of the principal exterior wall through which the sound is transmitted to the receiver (see Equation 6.2 and Table 6.3); and C is an adjustment term, in dB, for the area of the principal wall transmitting the sound in the direction of the receiver (see Table 6.4). This calculation should be performed for each octave band.

The adjustment term A assumes no intentionally added sound absorption material inside the room containing the sound source, and so it is essentially constant for all frequency bands. If sound absorption material is present, the reader should refer to a textbook in acoustics [1-3] to estimate the influence of the absorption on the reverberant sound levels in the room. With sound absorption material, the value of A will be greater than the values given in Table 6.2 and will usually vary with frequency.† (See also Table 7.10).

The value of B varies with frequency and is a function of the wall construction. Table 6.3 gives the approximate sound transmission loss, TL, of typical exterior wall constructions. Part 1 lists typical solid wall structures as a function of their surface weight and Part 2 gives the TL of glass.

A typical exterior wall may be made up of portions of each of these components. The B term of Equation 6.1 is the transmission loss of the composite wall, TL_c, as calculated from Equation 6.2

$$B = TL_c = 10 \log \left[\frac{S_1 + S_2 + S_3 + \cdots + S_n}{S_1\tau_1 + S_2\tau_2 + S_3\tau_3 + \cdots + S_n\tau_n} \right] \qquad (6.2)$$

*See special note in Example 6.2.

†Using the textbook procedure, the value of A, in dB at each octave band, is $(L_W - L_p)$ for the distance involved (between the sound source and the wall of interest) and the room constant or room absorption (expressed in m^2 or metric sabins) obtained with the use of sound absorption material in the room. In Equation 6.1, A is positive valued and the negative sign indicates subtraction. In the usual textbook figure, the ordinate is $(L_p - L_W)$ and the difference is a negative quantity. Use the positive value of that quantity for A in Equation 6.1.

TABLE 6.2. ADJUSTMENT TERM A, IN dB, FOR USE IN EQUATION 6.1 (TO ESTIMATE OUTDOOR RADIATED NOISE FROM INDOOR SOURCE). THE ADJUSTMENT TERM VALVES GIVEN IN THIS TABLE ASSUME HARD WALLS WITH AN AVERAGE SOUND ABSORPTION COEFFICIENT OF ABOUT 0.05.

Volume of Room Containing the Sound Source		Distance from Sound Source to Principal Wall* in Direction of Receiver					
		m:	3	6	12	21	30
m^3	ft^3	ft:	10	20	40	70	100
30	1100		0	0	0	0	0
55	1900		1	1	1	1	1
100	3600		3	3	3	3	3
190	6600		5	5	5	5	5
340	12000		6	6	6	6	6
630	22000		8	8	8	8	8
1200	41000		9	10	10	10	10
2100	76000		11	11	11	11	11
3900	140000		13	13	13	13	13
7300	260000		14	15	15	15	15
13000	470000		15	16	16	17	17
25000	870000		16	18	18	18	18
45000	1600000		17	19	20	20	20
83000	2900000		18	21	21	22	22

*Distance is from the approximate center of the sound source to the approximate center of the wall. See Figure 6.2 for determination of the principal wall for radiation of indoor sound to a receiver position.

TABLE 6.3. DATA FOR USE IN ESTIMATING SOUND TRANSMISSION LOSS OF AN EXTERIOR WALL THAT CONTAINS GLASS OR OPENINGS (TO BE USED TO DETERMINE ADJUSTMENT TERM B IN EQUATIONS 6.1 AND 6.2)

Octave Band Center Frequency	Part 1 Approximate Sound Transmission Loss of Typical Sealed Exterior Wall Structure, Excluding Glass Windows, Doors, and Openings (dB) — Average Surface Weight of Wall or Wall Material						Part 2 Approximate Sound Transmission Loss of Single-Thickness Closed Glass Windows (dB) — Glass Thickness	
kg/m^2:	25	50	100	170	250	400	3 mm	6mm
lb/ft^2:	5	10	20	35	50	80	1/8 in.	1/4 in.
31	8	14	20	24	28	31	0	5
63	14	18	24	28	32	35	6	12
125	18	22	28	31	34	37	11	17
250	22	26	30	33	36	39	17	22
500	27	30	33	36	39	42	21	24
1000	30	33	36	39	42	45	24	26
2000	33	36	39	42	45	48	26	28
4000	35	40	43	47	51	54	27	30
8000	38	45	48	52	56	59	30	33

TABLE 6.4 ADJUSTMENT TERM C, IN dB, FOR USE IN EQUATION 6.1 TO ESTIMATE OUTDOOR RADIATED NOISE FROM INDOOR SOURCE

Area of Principal Exterior Wall in Direction From Source to Receiver		Wall Area Adjustment Term C
(m^2)	(ft^2)	(dB)
10	110	10
13	140	11
16	170	12
20	220	13
25	270	14
32	340	15
40	430	16
50	540	17
63	680	18
80	860	19
100	1100	20
130	1400	21
160	1700	22
200	2200	23
250	2700	24
320	3400	25
400	4300	26
510	5500	27
640	6900	28
810	8700	29
1000	11000	30
1300	14000	31
1600	17000	32
2000	22000	33
2600	28000	34
3200	35000	35
4000	44000	36

where:

S_i is the area of a wall segment having sound transmission coefficient τ_i.

In turn, τ is related to transmission loss TL by Equations 6.3 and 6.4:

$$TL = 10 \log 1/\tau \qquad (6.3)$$

$$\tau = 1 \Big/ 10^{TL/10} = 10^{-TL/10} \qquad (6.4)$$

The term C in Equation 6.1 is related to the area of the principal wall that transmits the sound in the direction of the receiver area; it is given in Table 6.4. Actually, C = 10 log Area, if the area is given in m^2, or C = 10 log Area-10, if the area is given in ft^2. Figure 6.2 should be used to determine the principal wall for radiation of sound to a receiver position.

If the sound path from an indoor source to a receiver position is blocked by two or more walls (at least one interior and one exterior), the sound source can be ignored in the direction of that receiver.

Sound radiation from the roof of a building can be ignored; both the TL of the roof and the upward directivity of roof-radiated noise make this noise path of no consequence. Ventilation openings in a roof must not be ignored, however. The effective outdoor sound power level of a roof-installed ventilation opening can be calculated with the use of Equation 6.5

$$L_{Wo} = L_W - A + C \qquad (6.5)$$

where:

A is the adjustment term, in dB, from Table 6.2, in which the distance is from the sound source to the ventilation opening; and C is the adjustment term, in dB, taken from Table 6.4, in which the area is the total area of the ventilation openings that are pointed toward the receiver position.

In no case should the calculated value of L_{Wo} exceed the value of L_W. If the ventilation opening is pointed vertically upward or horizontally, apply the directivity effects of Table 4.22. If the ventilation opening is in the form of a goose-neck or hooded duct with its opening facing the roof surface, assume that the sound power level radiates uniformly in all directions.

The outdoor sound power level of an entire sound source, such as a ventilating fan, mounted in a ventilation opening on the roof or in a side wall is the same as the indoor sound power level, subject to the directional effects discussed later in this section.

U.S. Department
of Transportation

Federal Highway Administration

FHWA Roadway Construction Noise Model User's Guide

FHWA-HEP-05-054
DOT-VNTSC-FHWA-05-01

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January 2006

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Prepared by
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13. ABSTRACT (Maximum 200 words)

The Roadway Construction Noise Model (RCNM) is the Federal Highway Administration's (FHWA) national model for the prediction of construction noise. Due to the fact that construction is often conducted in close proximity to residences and businesses, construction noise must be controlled and monitored to avoid impacts on surrounding communities. In addition to community issues, excessive noise can threaten a construction projects' progress. Each project needs to balance the community's need for peace and quiet with the contractor's need to progress the work.

During the Central Artery/Tunnel (CA/T) project in Boston, Massachusetts, the project's noise control program developed the Construction Noise Control Specification 721.560, the most comprehensive noise specification ever developed in the United States. As part of the CA/T project noise control program, a construction noise prediction spreadsheet was developed. Because the CA/T prediction tool can benefit other state and local governments, the FHWA developed the RCNM, which is based on the noise prediction calculations and equipment database used in the CA/T prediction spreadsheet. The RCNM provides a construction noise screening tool to easily predict construction noise levels and determine compliance with noise limits for a variety of construction noise projects of varying complexity.

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	=	2.5 centimeters (cm)
1 foot (ft)	=	30 centimeters (cm)
1 yard (yd)	=	0.9 meter (m)
1 mile (mi)	=	1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	=	6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	=	0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	=	0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	=	2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	=	4,000 square meters (m^2)

MASS – WEIGHT (APPROXIMATE)

1 ounce (oz)	=	28 grams (gm)
1 pound (lb)	=	0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	=	0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	=	5 milliliters (ml)
1 tablespoon (tbsp)	=	15 milliliters (ml)
1 fluid ounce (fl oz)	=	30 milliliters (ml)
1 cup ©	=	0.24 liter (l)
1 pint (pt)	=	0.47 liter (l)
1 quart (qt)	=	0.96 liter (l)
1 gallon (gal)	=	3.8 liters (l)
1 cubic foot (cu ft, ft^3)	=	0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	=	0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F	=	y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	=	0.04 inch (in)
1 centimeter (cm)	=	0.4 inch (in)
1 meter (m)	=	3.3 feet (ft)
1 meter (m)	=	1.1 yards (yd)
1 kilometer (km)	=	0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	=	0.16 square inch (sq in, in^2)
1 square meter (m^2)	=	1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	=	0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	=	1 hectare (ha) = 2.5 acres

MASS – WEIGHT (APPROXIMATE)

1 gram (gm)	=	0.036 ounce (oz)
1 kilogram (kg)	=	2.2 pounds (lb)
1 tonne (t)	=	1,000 kilograms (kg)
	=	1.1 short tons

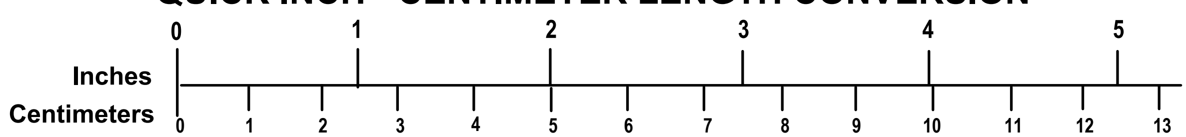
VOLUME (APPROXIMATE)

1 milliliter (ml)	=	0.03 fluid ounce (fl oz)
1 liter (l)	=	2.1 pints (pt)
1 liter (l)	=	1.06 quarts (qt)
1 liter (l)	=	0.26 gallon (gal)
1 cubic meter (m^3)	=	36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	=	1.3 cubic yards (cu yd, yd^3)

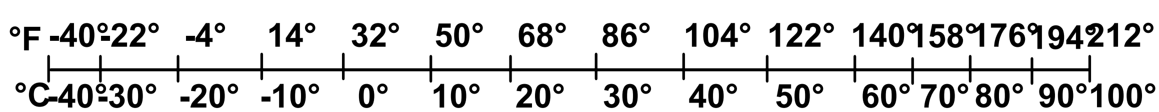
TEMPERATURE (EXACT)

[(9/5) y + 32] °C	=	x °F

QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSION



For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50 SD Catalog No. C13 10286.

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1 Introduction

The Roadway Construction Noise Model (RCNM) is the Federal Highway Administration's (FHWA) national model for the prediction of construction noise. Due to the fact that construction is often conducted in close proximity to residences and businesses, construction noise must be controlled and monitored to avoid impacts on surrounding communities. In addition to community issues, excessive noise can threaten a construction project's progress. Each project needs to balance the community's need for peace and quiet with the contractor's need to progress the work.

The Central Artery/Tunnel (CA/T) project in Boston, Massachusetts, which began in the early 1990s, is the largest urban construction project ever conducted in the United States. Its noise control program developed the Construction Noise Control Specification 721.560, the most comprehensive noise specification ever developed in the United States [1]. As part of the CA/T project noise control program, a construction noise prediction spreadsheet was developed [2]. Because the CA/T prediction tool can benefit other state and local governments, the FHWA developed the RCNM, which is based on the noise prediction calculations and the equipment database used in the CA/T prediction spreadsheet. The RCNM provides a construction noise screening tool to easily predict construction noise levels and to determine compliance with noise limits for a variety of construction noise projects of varying complexity.

2 Background

The RCNM is a national model based on the noise calculations and extensive construction noise data compiled for the CA/T Project. The basis for the national model is a spreadsheet tool developed in support of the CA/T project [2]. The CA/T predictions originated from Environmental Protection Agency (EPA) noise level work [3] and an Empire State Electric Energy Research Corp. Guide [4] which utilizes an "acoustical usage factor" to estimate the fraction of time each piece of construction equipment is operating at full power (i.e., its loudest condition) during a construction operation. Table 1 presents a construction equipment noise database compiled through the CA/T project [2]. This database is used to predict construction noise within the RCNM. The noise levels listed represent the A-weighted maximum sound level (Lmax), measured at a distance of 50 feet from the construction equipment.

Table 1. CA/T equipment noise emissions and acoustical usage factors database.

CA/T Noise Emission Reference Levels and Usage Factors					
filename: EQUIPLST.xls					
revised: 7/26/05		Acoustical	Spec 721.560	Actual Measured	No. of Actual
	Impact	Use Factor	Lmax @ 50ft	Lmax @ 50ft	Data Samples
Equipment Description	Device ?	(%)	(dBA, slow)	(dBA, slow)	(Count)
				(samples averaged)	
All Other Equipment > 5 HP	No	50	85	-- N/A --	0
Auger Drill Rig	No	20	85	84	36
Backhoe	No	40	80	78	372
Bar Bender	No	20	80	-- N/A --	0
Blasting	Yes	-- N/A --	94	-- N/A --	0
Boring Jack Power Unit	No	50	80	83	1
Chain Saw	No	20	85	84	46
Clam Shovel (dropping)	Yes	20	93	87	4
Compactor (ground)	No	20	80	83	57
Compressor (air)	No	40	80	78	18
Concrete Batch Plant	No	15	83	-- N/A --	0
Concrete Mixer Truck	No	40	85	79	40
Concrete Pump Truck	No	20	82	81	30
Concrete Saw	No	20	90	90	55
Crane	No	16	85	81	405
Dozer	No	40	85	82	55
Drill Rig Truck	No	20	84	79	22
Drum Mixer	No	50	80	80	1
Dump Truck	No	40	84	76	31
Excavator	No	40	85	81	170
Flat Bed Truck	No	40	84	74	4
Front End Loader	No	40	80	79	96
Generator	No	50	82	81	19
Generator (<25KVA, VMS signs)	No	50	70	73	74
Gradall	No	40	85	83	70
Grader	No	40	85	-- N/A --	0
Grapple (on backhoe)	No	40	85	87	1
Horizontal Boring Hydr. Jack	No	25	80	82	6
Hydra Break Ram	Yes	10	90	-- N/A --	0
Impact Pile Driver	Yes	20	95	101	11
Jackhammer	Yes	20	85	89	133
Man Lift	No	20	85	75	23
Mounted Impact Hammer (hoe ram)	Yes	20	90	90	212
Pavement Scarafier	No	20	85	90	2
Paver	No	50	85	77	9
Pickup Truck	No	40	55	75	1
Pneumatic Tools	No	50	85	85	90
Pumps	No	50	77	81	17
Refrigerator Unit	No	100	82	73	3
Rivit Buster/chipping gun	Yes	20	85	79	19
Rock Drill	No	20	85	81	3
Roller	No	20	85	80	16
Sand Blasting (Single Nozzle)	No	20	85	96	9
Scraper	No	40	85	84	12
Shears (on backhoe)	No	40	85	96	5
Slurry Plant	No	100	78	78	1
Slurry Trenching Machine	No	50	82	80	75
Soil Mix Drill Rig	No	50	80	-- N/A --	0
Tractor	No	40	84	-- N/A --	0
Vacuum Excavator (Vac-truck)	No	40	85	85	149
Vacuum Street Sweeper	No	10	80	82	19
Ventilation Fan	No	100	85	79	13
Vibrating Hopper	No	50	85	87	1
Vibratory Concrete Mixer	No	20	80	80	1
Vibratory Pile Driver	No	20	95	101	44
Warning Horn	No	5	85	83	12
Welder / Torch	No	40	73	74	5

3 The RCNM

The RCNM is a computer program used to assess construction noise impacts. The computer on which it is installed should be equipped with the Microsoft Windows 98 or newer operating system (OS) and 192 MB or more of random access memory (RAM). The display should be set to 1024 x 768 pixels or greater, and the computer should carry the Adobe Acrobat 4.0 or newer software.

The RCNM allows the estimation of three key metrics of interest: Lmax, Leq, and L10 at receptor locations for a construction operation that can include up to 20 pieces of equipment. RCNM allows for user-defined construction equipment and user-defined noise limit criteria. The two main uses of the RCNM are to allow typical computer users to: 1. easily predict noise emissions from construction equipment, and 2. determine a construction work plan's compliance with noise criteria limits. A variety of construction work scenarios can be created quickly, allowing the user to determine the impact of changing construction equipment and adding/removing the effects of shielding due to noise mitigation devices such as barriers.

3.1 RCNM Main Page

The RCNM consists of one main display page with Input Data and Results sections, shown in Figure 1.

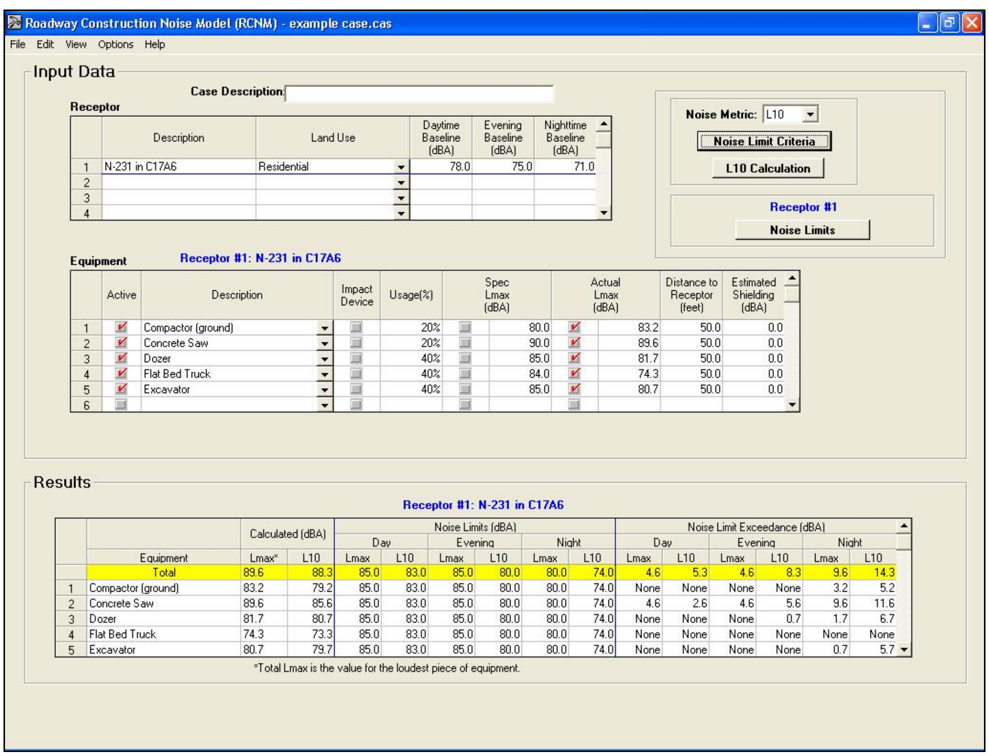

Figure 1. The RCNM main page

Several command buttons and pull-down menus allow the user to modify the input data before results are calculated by the model.

3.1.1 File Menu

The <File> menu, shown in Figure 2, contains items that allow the user to create, open, and save a case, export the results of a case, and exit the program.

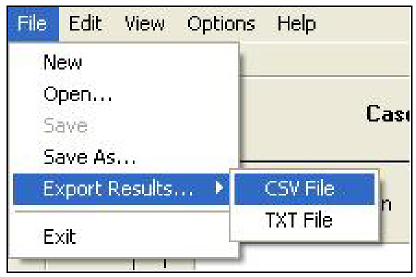

Figure 2. <File> Menu

- <New> creates a new case. If a case is currently open, the user is prompted to save it before closing.
- <Open…> allows the user to open an existing case file ([name].cas).
- <Save> saves the case with the current filename. If this is a new case, the user is asked for a new filename ([name].cas).
- <Save As…> The user is asked for a filename for a new case ([name].cas) and saves the case with that filename.
- <Export Results> prompts the user to save the case results for the current or all receptors to a comma separated value (CSV) file with the following naming convention: [name].csv. This type of file is easily read into a spreadsheet program. The user can also save the case results to a text file (TXT), which saves the results to a space-separated text format with the following naming convention: [name].txt.
- <Exit> closes the application. If changes have been made to the open case, the user is asked if he/she would like to save the case.

3.1.2 Edit Menu

The <Edit> menu, shown in Figure 3, allows the user to copy and paste data, delete data, and undo changes.

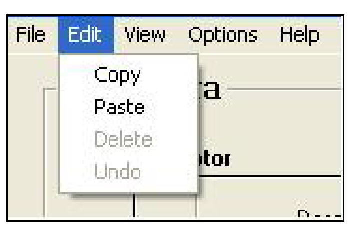

Figure 3. <Edit> Menu

- <Copy> lets the user copy into a clipboard the contents of a single cell or an entire line from an RCNM dialogue box.
- <Paste> lets the user copy the contents of the clipboard into a single cell or an entire line of an RCNM dialogue box.
- <Delete> lets the user delete from the case a receptor or piece of equipment selected in the receptor or equipment dialogue box.
- <Undo> lets the user revert the RCNM one step to where it was before the latest change was made.

3.1.3 View Menu

The <View> menu, shown in Figure 4, allows the user to focus in <Zoom +> on either the Input Data or Results section of the RCNM's main page. To activate Zoom +, click on Zoom + and guide the spyglass + icon to either Input Data or Results and single-click.

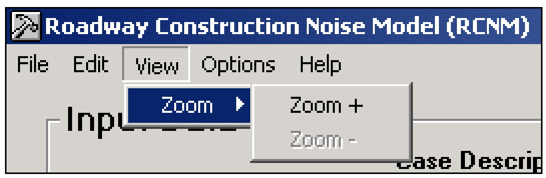

Figure 4. <View> Menu

To deactivate Zoom + and go back to the full RCNM screen, click on Zoom – and guide the spyglass – icon to the Input Data or Results section that has been maximized on the screen.

3.1.4 Options Menu

The <Options> menu, shown in Figure 5, allows the user to modify the equipment list and change the case's units of measure from feet to meters.

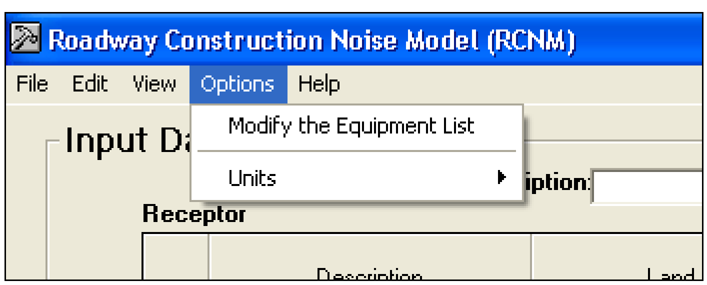

Figure 5. <Options> menu

The <Options> menu allows the user to add new types of equipment to the equipment list. The equipment list modification dialogue box, shown in Figure 6, allows the user to specify a user-defined piece of equipment and add it. The user can specify the following data: whether the equipment is an impact device, the equipment's usage factor[1], and the equipment's Lmax level (spec and/or actual[2]). The user can also delete equipment that's been added by selecting it and clicking the delete button. The default equipment cannot be modified, but it may be deleted entirely from the case by selecting it and clicking the delete button. Selecting the default button restores the default equipment list (from the CA/T Project) and eliminates any user-defined equipment.

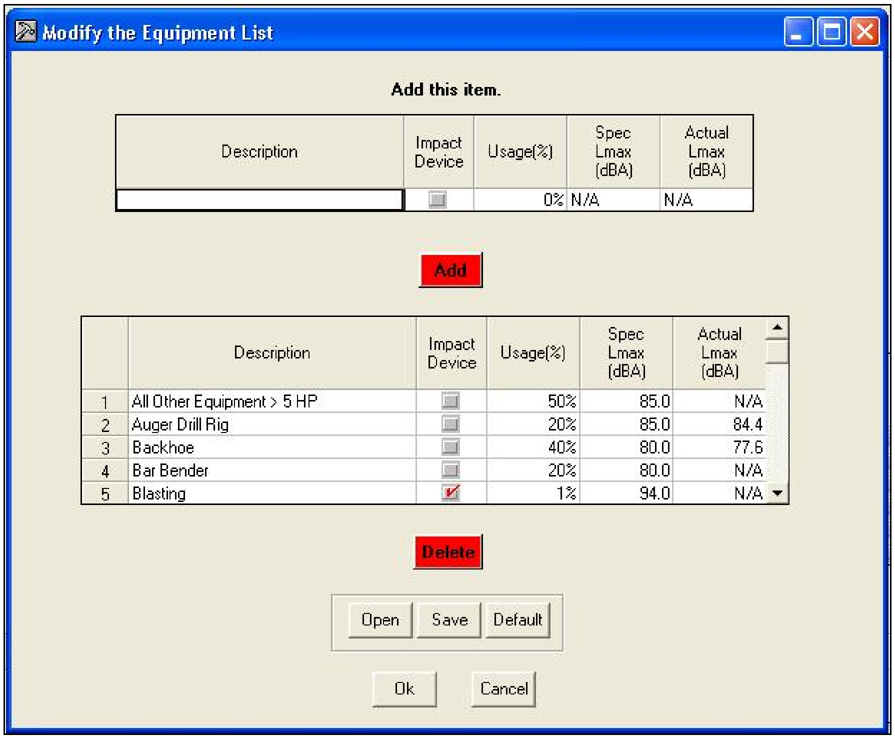

Figure 6. Equipment list modification dialogue box

Data for user-defined pieces of equipment may be saved to an equipment file ([name].equ), along with all other equipment in the current list, including default equipment. This file may be opened in other cases to incorporate these pieces of equipment.

The <Options> menu, as shown in Figure 7, also allows the user to change the case's units of measure from feet to meters or from meters to feet. The only input data affected by this tool are the Distance to Receptor values.

[1] Usage factor is the percentage of time during a construction noise operation that a piece of construction equipment is operating at full power. In the case of construction blasting, the equipment gives a very short duration blast, and can be quantified by using a 1% usage factor in the RCNM to allow for some prediction. Never use a usage factor of zero because the log of zero causes a mathematical impossibility. The usage factor term only affects the computation of Leq and L10. The usage factor does not enter into the equation when calculating the more important term for blasting, that being the Lmax.

[2] "Spec" refers to noise levels stated in noise specifications, and "Actual" refers to Lmax values measured at 50 ft from the equipment.

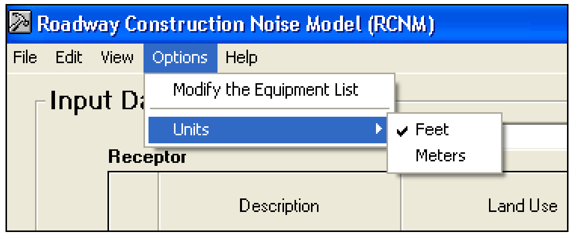

Figure 7. Units modification pull-down menu

3.1.5 Help Menu

The <Help> Menu loads for the user the RCNM User's Guide in Portable Document Format (PDF). This PDF is searchable by key word using the Adobe Acrobat Edit / Find search tool.

3.2 Input Data

The user is required to input receptor data and equipment data before a case can be processed. The user is advised to type in some summary comments about the case in the Case Description dialogue box before inputting data. Also, in order to determine noise limit exceedance values, the user can input noise limit criteria.

3.2.1 Receptors

Multiple receptors may be input for a case, but only one receptor may be processed at a time. The name of the highlighted receptor chosen for processing appears in blue type above the Equipment input dialogue box and the Noise Limits command button (see Figure 1). The user specifies the receptors for a study by entering information into the Receptors input box in the main window of the RCNM. The user is required to enter the receptor name, land use, daytime baseline L10 or Leq, evening baseline L10 or Leq, and nighttime baseline L10 or Leq. The baseline levels indicate the sound level at a receptor before any construction noise contributions. Baseline levels are only necessary if the desired noise criteria limits are based on *relative* increases in noise level. If the desired noise criteria limits are *absolute* noise levels, then the user should insert a placeholder number other than zero.

When entering information for more than one receptor, it may be desirable to copy information already entered. An entire receptor row may be highlighted and copied to another row, where copying multiple rows requires the selection of the same number of rows when pasting (this same functionality also applies to editable cells). Note: Entire rows may be selected by clicking on the row number.

Again, the RCNM will only calculate results for the receptor displayed in blue type in the Input Data portion of the main page. The results for other receptors may be displayed by selecting the desired receptor in the Receptor window; to select a receptor, click in any cell in the row. Up to 100 receptors may be included in any case. Information for receptors is saved in the case file ([name].cas).

3.2.2 Equipment

Core equipment noise data are stored in the RCNM and are accessible by a pull-down menu in the main page, as in Figure 8.

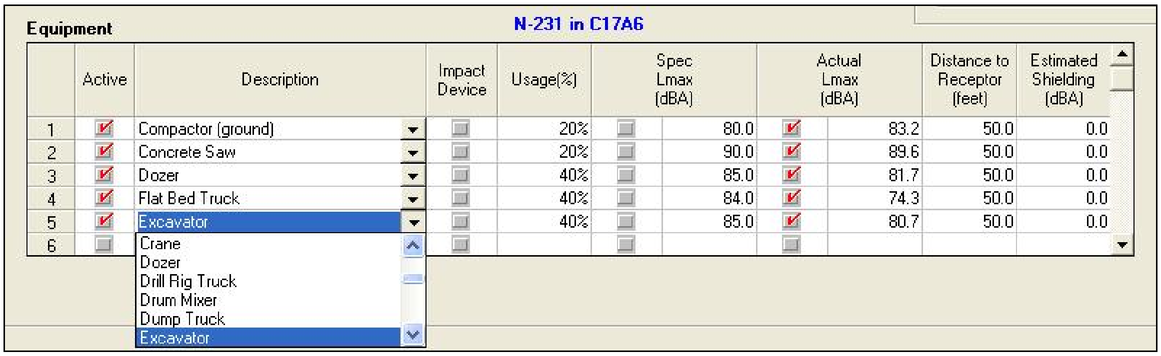

Figure 8. Equipment dialogue box, with pull-down menu shown

As discussed in Section 3.1.4, new pieces of equipment may be added to a case and saved in an equipment file ([name].equ). When the user-defined equipment file is opened through the <Options> / <Modify the Equipment List> menu, user-defined equipment will appear in the equipment pull-down menu. The user activates and inactivates chosen equipment types by ticking and unticking the “Active” checkbox. The user is required to specify:

1. The type of reference emission levels to use (“Spec”, if applicable, or “Actual”, [the default is “Actual”]);
2. Distance to Receptor – that is, the distance between each type of equipment and the receptor being analyzed (the default distance is 50 feet); and
3. Estimated Shielding (in dBA) associated with each type of equipment (can leave the default value of 0.0 when not considering shielding). **NOTE: A Best Practices document is presented in Appendix A showing how to determine Estimated Shielding using several Rules of Thumb developed from experience at the CA/T project.**

When entering information for more than one piece of equipment, it may be desirable to copy information already entered. An entire equipment row may be highlighted and copied to another row, where copying multiple rows requires the selection of the same number of rows when pasting (this same functionality also applies to editable cells). Note: Entire rows may be selected by clicking on the row number.

The user may analyze up to 20 pieces of equipment at one time, and they may be included in any combination of different or identical equipment types.

3.2.3 Noise Metric and Noise Limit Criteria

While a case is open, the user can choose a noise metric (for baseline levels, noise limits, and calculated results) and enter the noise limit criteria for a local area. The user may edit the Lmax and L10 or Leq day, evening, and night noise limit criteria for a residential, commercial, or industrial area. Daytime, evening, and nighttime may represent any time periods the user wishes, but they are typically defined as 7 AM to 6 PM, 6 PM to 10 PM, and 10 PM to 7 AM, respectively. The criteria, used together with the baseline sound levels, define the noise limits for each receptor. CA/T Noise Limit Criteria are used as a default [1], but users may input their own criteria. The RCNM offers a metric pull-down menu and two or three command buttons to the right of the Receptor input dialogue box.

- Metric Pull-Down Menu

A pull-down menu allows the user to choose between the L10 or Leq metric, as in Figure 9. The chosen metric represents that used for the baseline levels, noise limits, and calculated results. For the noise limits and calculated results, Lmax values are also included.

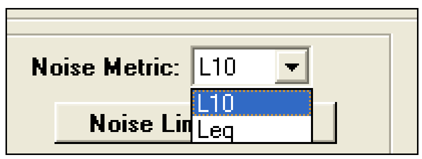

Figure 9. Noise Metric pull-down menu

- Noise Limit Criteria Pop-up Dialogue Box

A pop-up dialogue box allows the user to specify Noise Limit Criteria information for an area being studied in a case, as in Figure 10. The flexibility of the Noise Limit Criteria allows RCNM users to incorporate criteria based on local noise ordinances and baseline levels measured for each receptor.

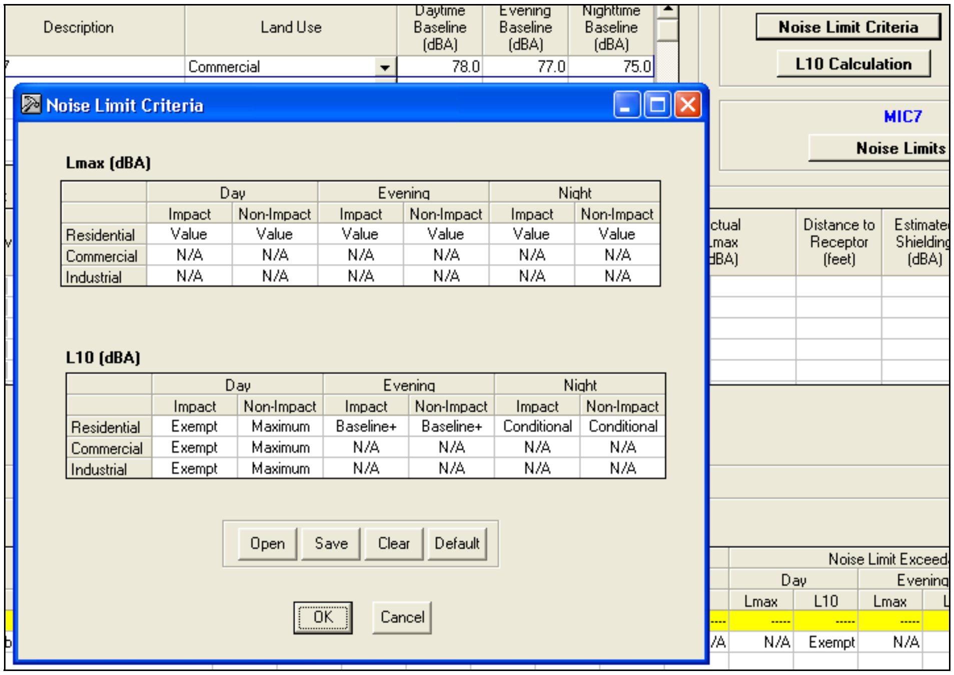

Figure 10. Noise Limit Criteria pop-up dialogue box

The user may populate this dialogue box with Noise Limit Criteria information derived from CA/T Construction Noise Control Spec. 721.560 [1] by clicking on the "Default" command button and clicking "Yes" when asked to load information from the default file, which is stored in the RCNM (see Table 2).

Table 2. Default Noise Limit Criteria

	Daytime (7 AM to 6 PM)		Evening (6 PM to 10 PM)		Nighttime (10 PM to 7 AM)	
Land Use	**L10 Limit (dBA)**	**Lmax Limit (dBA)**	**L10 Limit (dBA)**	**Lmax Limit (dBA)**	**L10 Limit (dBA)**	**Lmax Limit (dBA)**
Residential	maximum of 75 and baseline + 5 for non-impact* and exempt for impact**	85 for non-impact and 90 for impact	baseline + 5	85	if baseline <70 then baseline +5; if baseline ≥70 then baseline + 3	80
Commercial	maximum of 80 and baseline + 5 for non-impact and exempt for impact	N/A	N/A	N/A	N/A	N/A
Industrial	maximum of 85 and baseline+5 for non-impact and exempt for impact	N/A	N/A	N/A	N/A	N/A

* Non-impact equipment is equipment that generates a constant noise level while in operation.

** Impact Equipment is equipment that generates impulsive noise. Impulse Noise is defined as noise produced by the periodic impact of a mass on a surface, of short duration (generally less than one second), high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition.

Otherwise, the user may clear any information present in the dialogue box and specify new data in each cell. Clicking on the "Clear" command button will prompt the user to set all the cells in the dialogue box to Not Applicable (N/A), as in Figure 11. By clicking "Yes," the user will populate all cells with N/A; by clicking "No," the dialogue box will return to the data present before the user clicked "Clear."

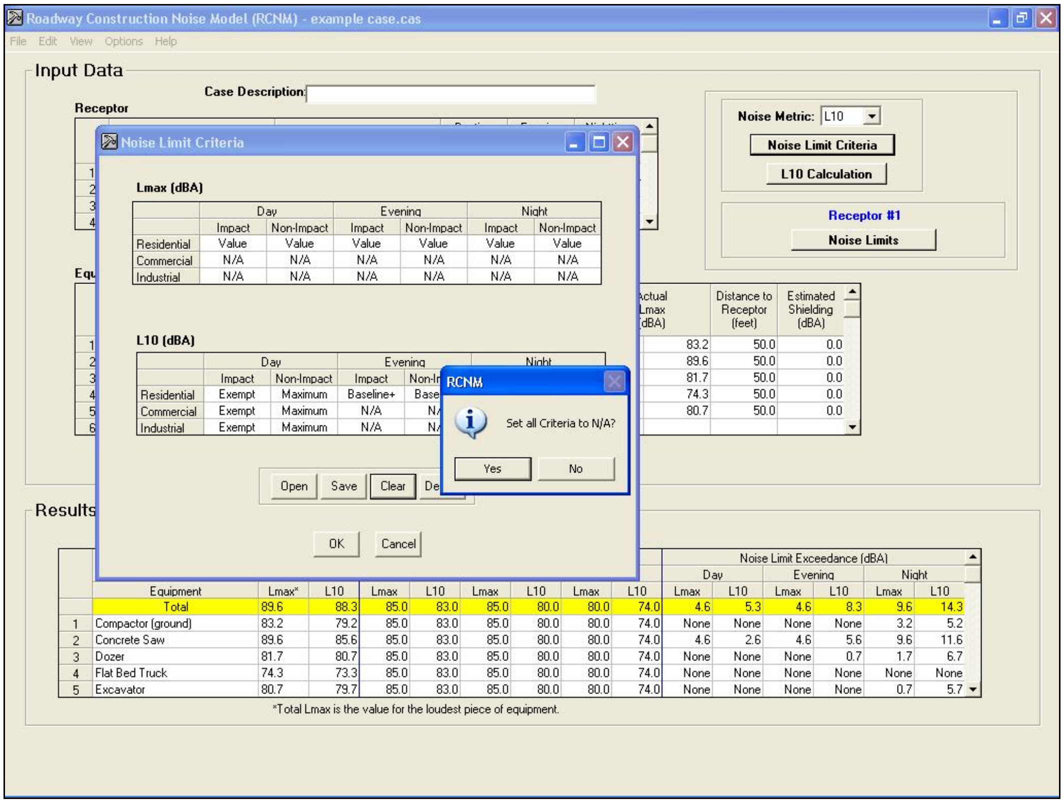

Figure 11. The Noise Limit Criteria "Clear" command button

Clicking on any cell in the Noise Limit Criteria dialogue box reveals a Noise Limit Criteria pull-down menu. Click on this pull-down menu to access the six options, as in Figure 12.

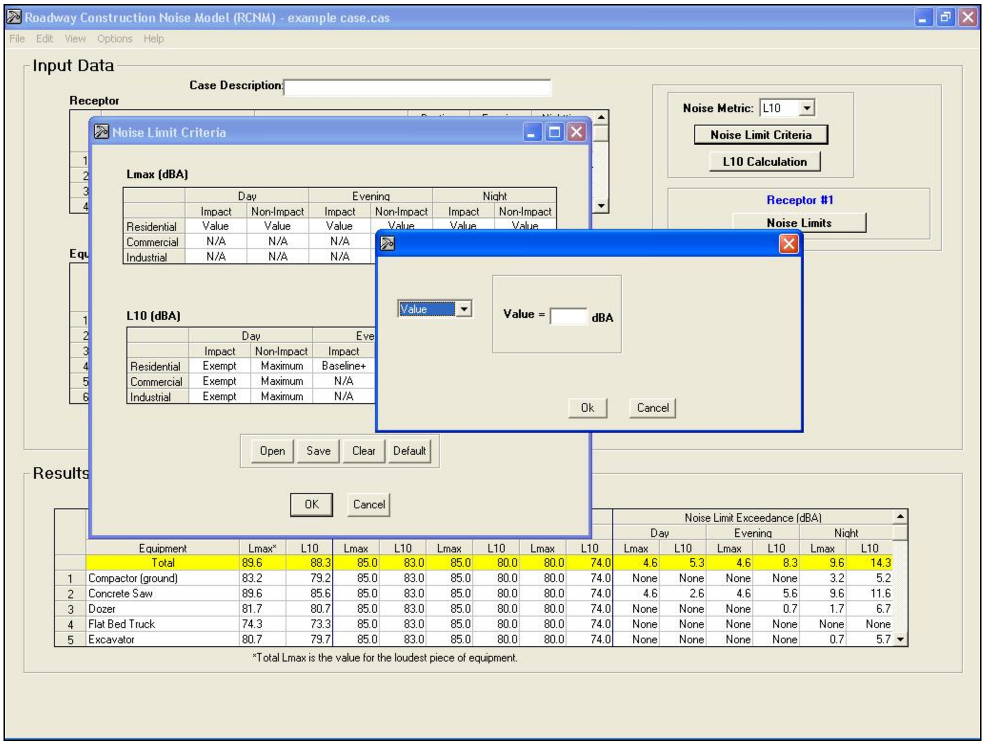

Figure 12. Noise Limit Criteria pull-down menu

Through these six options, the user specifies what Noise Limit Criteria changes, if any, are desirable in each cell. The six cell options are:

i. Exempt (for the specified metric and land use, the equipment is exempt from noise limits)
ii. N/A (for the specified metric and land use, the equipment does not have applicable noise limits)
iii. Value (user is prompted to enter a value for which the noise level should not exceed), as in Figure 13:

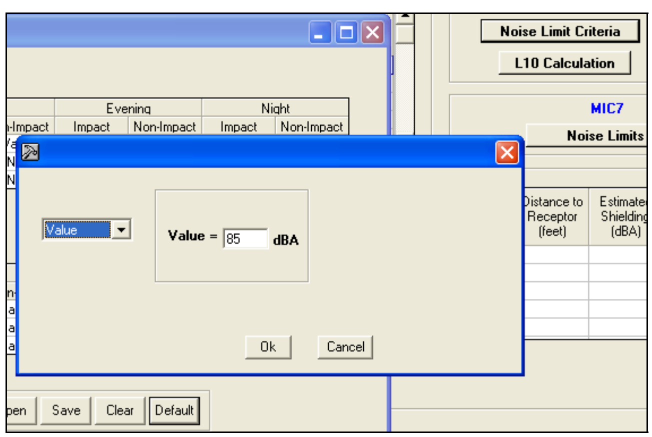

Figure 13. Noise Limit Criteria "Value" dialogue box

iv. Maximum (set value for which a noise level should not exceed to the maximum of two possible levels: A user-defined level or the Baseline level plus some user-defined increment), as in Figure 14:

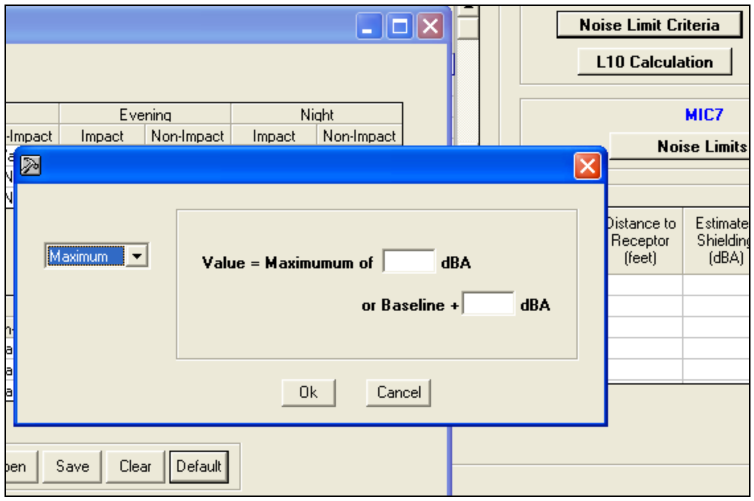

Figure 14. Noise Limit Criteria "Maximum" dialogue box

v. Baseline + (set value for which a noise level should not exceed to the Baseline level plus some user-defined increment), as in Figure 15:

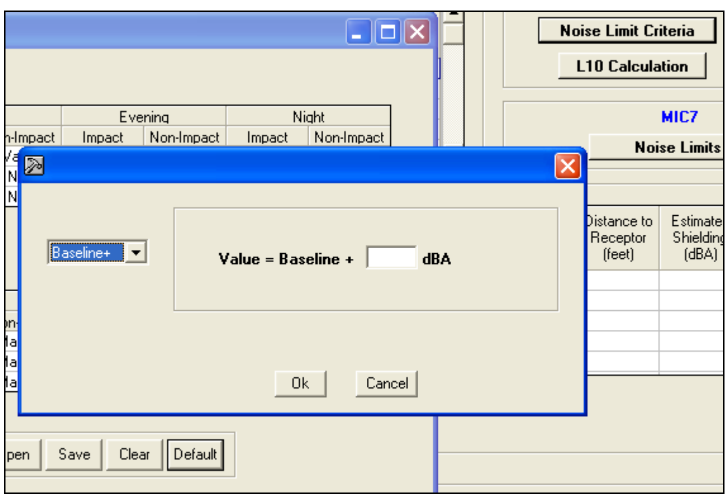

Figure 15. Noise Limit Criteria "Baseline +" dialogue box

vi. Conditional (set conditional value for which a noise level should not exceed; the user is prompted to enter the following information: 1. a comparison value, i.e., "If Baseline < [value], then …"; 2. an increment value to add to the baseline level if the baseline level is *less than* the comparison value; 3. an increment value to add to the baseline level if the baseline level is *greater than or equal to* the comparison value), as in Figure 16:

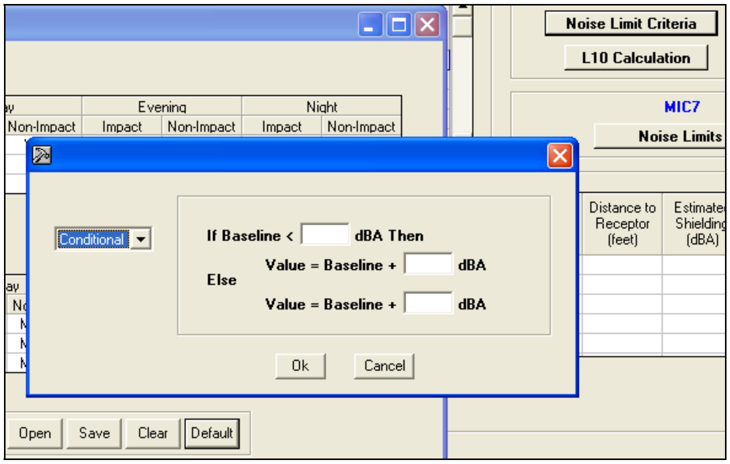

Figure 16. Noise Limit Criteria "Conditional" dialogue box

To see the current value of a cell, simply hold the mouse pointer over the cell. Once the user has specified values for all the cells in the Noise Limit Criteria dialogue box, these criteria can be saved in a criteria file ([name].cri) by clicking on the "Save" command button. The user will be prompted to give the criteria file a name. These criteria can thereafter be loaded into any case by clicking on the "Open" command button.

The user returns to the Noise Limit Criteria dialogue box by clicking "Ok", and returns to the case by clicking "Ok" again.

- L10 Calculation (this button is present if the L10 metric is chosen)

By clicking on the "L10 Calculation" command button, the user can specify the adjustment factor used to calculate L10, as in Figure 17. By clicking the "Default" command button, the user automatically calls for an adjustment factor of 3 dBA, a value empirically derived from extensive CA/T Project data [2].

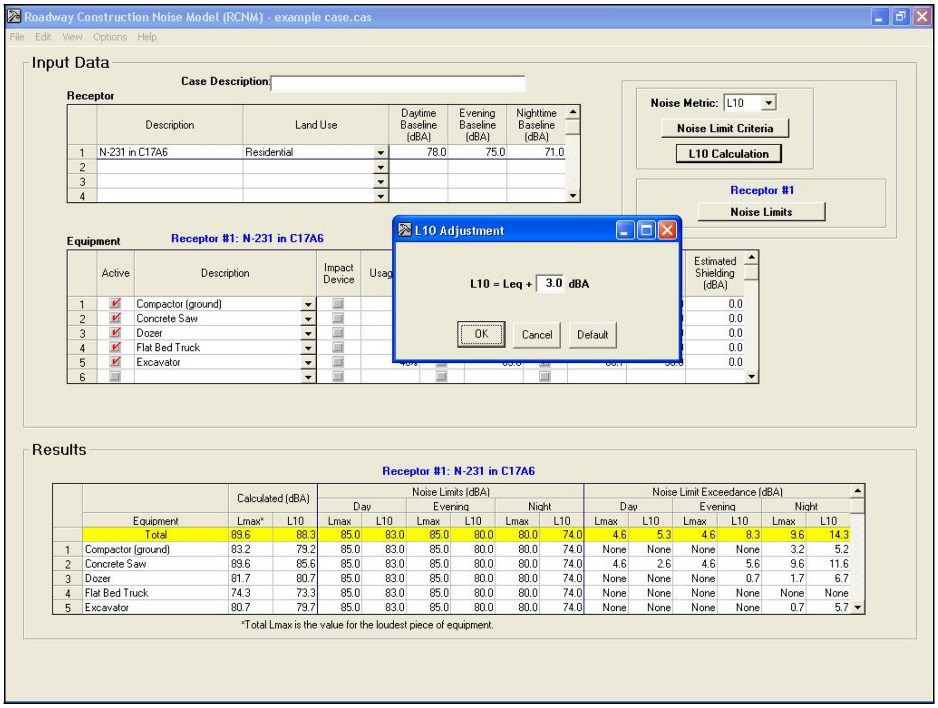

Figure 17. L10 Adjustment dialogue box

- Noise Limits

The "Noise Limits" command button opens a display window that looks exactly like the "Noise Limit Criteria" dialogue box, except that it is not editable, and the only button in the opened window is "Ok". The values in the cells are based on the criteria set in the Noise Limit Criteria window and the baseline levels for the selected receiver, as in Figure 18. (If a receiver is not selected, the dialogue box is unavailable for viewing.)

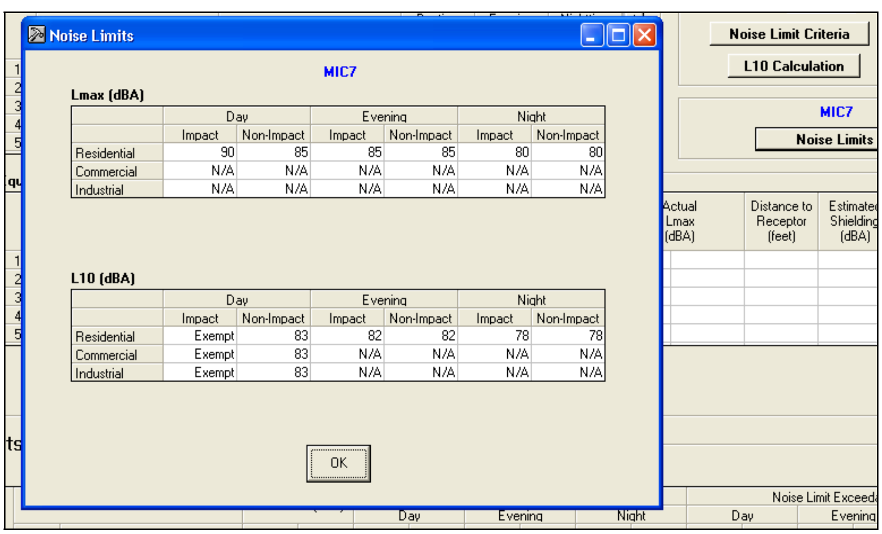

Figure 18. Noise Limits display window

Again, these limits may be changed by the user through the Noise Limit Criteria data entry window.

4 Results

Once the data for one receptor and up to 20 pieces of equipment have been specified in the Input Data portion of the main screen, the RCNM will automatically calculate the Results readout displayed in the bottom portion of the main screen, as in Figure 19. Any changes to the Input Data will automatically cause the RCNM to update the Results. The results for only one receptor will be displayed at a time; results for other receptors can be displayed by selecting the desired receptor in the Receptor window (click in any cell in the desired receptor row). Results for up to 100 receptors can be saved in a case. If Noise Limit Criteria information has been specified, the corresponding results (limits and exceedance values) will be updated as well.

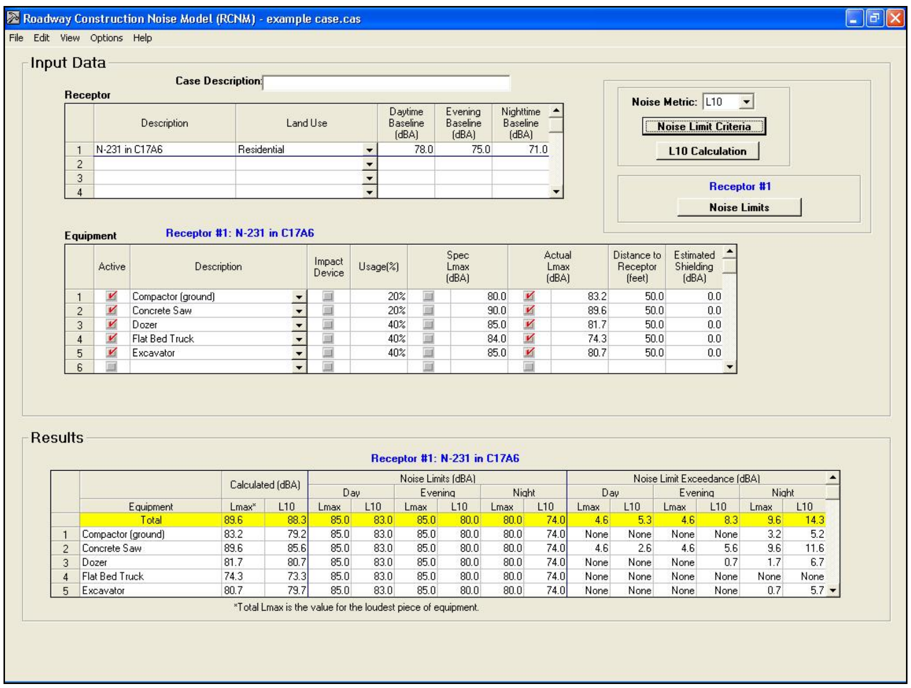

Figure 19. The RCNM main-page Results display

If there is insufficient input data for RCNM to compute a result, then a "Check Input Data" button will appear in the middle of the screen. Clicking on this button will provide the user with an indication of what additional input data are required.

The Results are presented in a read-only spreadsheet that contains the following fields, all applicable to the selected receptor:

- Equipment – the name/description of the equipment type
- Calculated Lmax – the calculated Lmax value for the equipment type. This is calculated from the "Spec" or "Actual" equipment Lmax, distance, and estimated shielding.

- Calculated Leq or L10 – the calculated Leq or L10 value (depending on what is selected in the Noise Metric pull-down menu) for the equipment type. This is calculated from the Calculated Lmax values, equipment usage factors, and selected adjustment factor.
- Day Lmax Noise Limit – the daytime Lmax noise limit for the equipment type.
- Day Leq or L10 Noise Limit – the daytime Leq or L10 noise limit for the equipment type.
- Evening Lmax Noise Limit – the evening Lmax noise limit for the equipment type.
- Evening Leq or L10 Noise Limit – the evening Leq or L10 noise limit for the equipment type.
- Night Lmax Noise Limit – the nighttime Lmax noise limit for the equipment type.
- Night Leq or L10 Noise Limit – the nighttime Leq or L10 noise limit for the equipment type.
- Day Lmax Noise Limit Exceedance – the daytime Lmax noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".
- Day Leq or L10 Noise Limit Exceedance – the daytime Leq or L10 noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".
- Evening Lmax Noise Limit Exceedance – the evening Lmax noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".
- Evening Leq or L10 Noise Limit Exceedance – the evening Leq or L10 noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".
- Night Lmax Noise Limit Exceedance – the nighttime Lmax noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".
- Night Leq or L10 Noise Limit Exceedance – the nighttime Leq or L10 noise limit exceedance for the equipment type. If the criteria limit was not exceeded, the value is "None".

The user may scroll down to view equipment results that are not visible, or the <View> / <Zoom +> menu may be used to zoom in on the Results display only (see Section 3.1.3). There is a row at the top of the Results display, highlighted in yellow, that calculates the total for all equipment combined. This row is always visible during scrolling of the Results spreadsheet. (Calculations for totals are explained in Section 5.3.)

Again, users may export a case's input information and results to a comma separated value (CSV) report file ([name].csv) by choosing the <Export Results> option from the <File> menu. The user can also save the case results to a text file (TXT), which saves the results to a space-separated text format ([name].txt). Results may be saved for a single receptor or all receptors in the case.

5 Calculations in the RCNM

The RCNM uses the primary equation described in the CA/T Construction Noise Control Specification 721.560 [1] for the construction noise calculations.

5.1 Metric Calculation

LmaxCalc = selected_Lmax – 20log(D/50) - shielding (1)

where

selected_Lmax is the "Spec" or "Actual" maximum A-weighted sound level at 50 ft., listed in Table 1 for all pieces of equipment, in dBA,
D is the distance between the equipment and the receptor, in feet,
shielding is the insertion loss of any barriers or mitigation, in dBA (see Appendix A).

Leq = LmaxCalc + 10log(U.F.%/100) (2)

where

U.F.% is the time-averaging equipment usage factor, in percent (see footnote 1 on p 7).

L10 = Leq + 3 dBA adjustment factor (3)

The RCNM calculates L10 by adding 3 dBA to the Leq, where the 3 dBA default L10 adjustment factor was empirically derived by comparing extensive CA/T construction noise data. This adjustment factor may be changed in the RCNM at the user's discretion.

5.2 Exceedance Calculation

Daytime Lmax Exceedance = LmaxCalc – Daytime Lmax Limit (4)

Daytime Leq or L10 Exceedance = Leq or L10 – Daytime Leq or L10 Limit (5)

Evening Lmax Exceedance = LmaxCalc – Evening Lmax Limit (6)

Evening Leq or L10 Exceedance = Leq or L10 – Evening Leq or L10 Limit (7)

Nighttime Lmax Exceedance = LmaxCalc – Nighttime Lmax Limit (8)

Nighttime Leq or L10 Exceedance = Leq or L10 – Nighttime Leq or L10 Limit (9)

5.3 Totals Calculation

The Total values in the Results section are determined in the following manner:

1) Total Leq = 10*log(Σ (individual equipment Leq values[3]))
2) Total L10 = 10*log(Σ (individual equipment L10 values[3]))
3) Total Lmax = Maximum among individual equipment Lmax values
4) Total noise limits and limit exceedances:
    a. Determine whether or not total is impact or non-impact
        i. If all the equipment is non-impact, label the total as non-impact.
        ii. If all the equipment is impact, label the total as impact.
        iii. If the equipment is mixed non-impact and impact, label the total as non-impact.
    b. Determine total noise limits and limit exceedances the same way as with individual pieces of equipment (see Section 5.2), only use the calculated total sound levels (Total Leq or Total L10) and the impact or non-impact label according to the criteria specified in i through iii.

[3] The Leq and L10 levels are energy averages.

6 References

[1] Construction Noise Control Specification 721.560, Central Artery/Tunnel Project, Massachusetts Turnpike Authority, Boston, MA, 2002.

[2] Thalheimer, Erich. "Construction Noise Control Program and Mitigation Strategy at the Central Artery/Tunnel Project". Noise Control Engineering Journal, Vol. 48, No. 5, pp 157-165, September - October 2000.

[3] "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety", Environmental Protection Agency, ONAC 550/9-74-004. Washington, DC, March 1974.

[4] "Power Plant Construction Noise Guide". Bolt, Beranek, and Newman Inc. and Empire State Electric Energy Research Corp., Report No. 3321. New York, NY May 1977.

Appendix A: Best Practices for Calculating Estimated Shielding for Use in the RCNM

This Appendix presents some simplified shielding factors for use in the RCNM. These suggestions are "rules of thumb" based on experience gathered by CA/T construction noise experts working in the field [2].

1) If a noise barrier or other obstruction (like a dirt mound) just barely breaks the line-of-sight between the noise source and the receptor, use 3 dBA.

2) If the noise source is completely enclosed OR completely shielded with a solid barrier located close to the source, use 8 dBA. If the enclosure and/or barrier has some gaps in it, reduce the effectiveness to 5 dBA.

3) If the noise source is completely enclosed AND completely shielded with a solid barrier located close to the source, use 10 dBA.

4) If a building stands between the noise source and receptor and completely shields the noise source, use 15 dBA.

5) If a noise source is enclosed or shielded with heavy vinyl noise curtain material (e.g., SoundSeal BBC-13-2" or equivalent), use 5 dBA.

6) If dilapidated windows are replaced with new acoustical windows, or quality internal or exterior storm sashes, use an incremental improvement of 10 dBA for an overall Outside-to-Inside Noise Reduction (OINR) of 35 dBA.

7) If work is occurring deep inside a tunnel using the "top-down" construction method (i.e. cover the tunnel work with concrete roadway decks to allow surface traffic and then excavate underneath the roof deck), use 12 dBA.

FTA

FEDERAL TRANSIT ADMINISTRATION

Transit Noise and Vibration Impact Assessment Manual

SEPTEMBER 2018

FTA Report No. 0123
Federal Transit Administration

PREPARED BY
John A. Volpe National Transportation Systems Center

U.S. Department of Transportation
Federal Transit Administration

Courtesy of Edwin Adilson Rodriguez, Federal Transit Administration

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Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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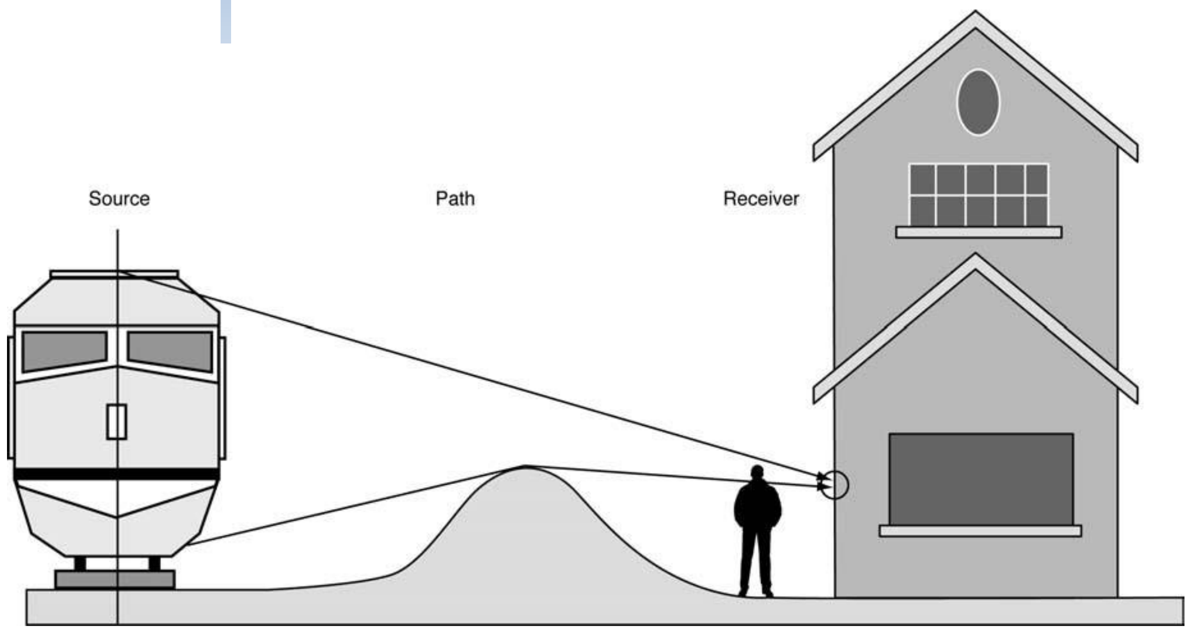

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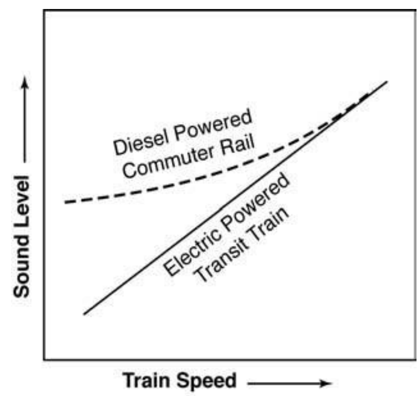

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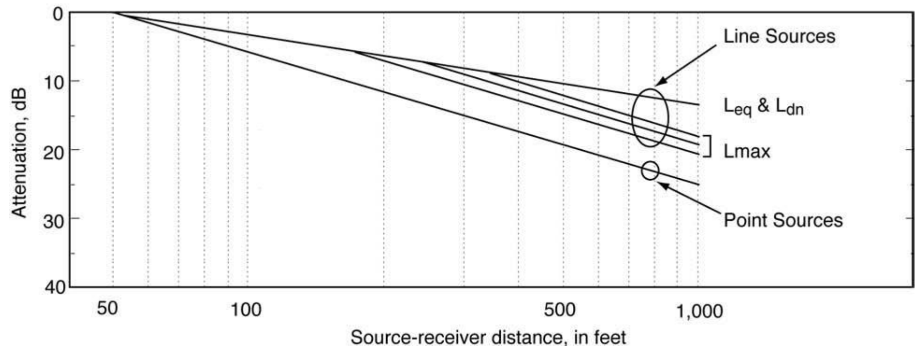

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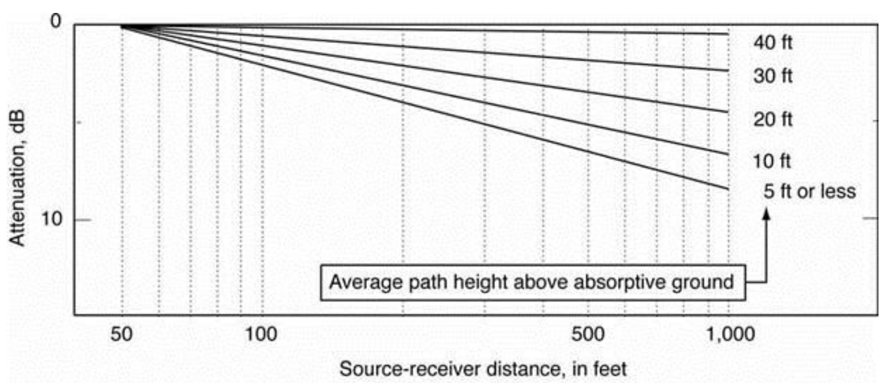

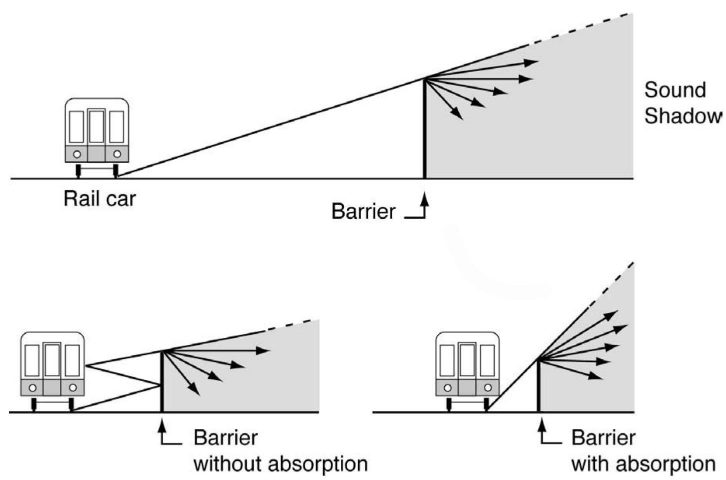
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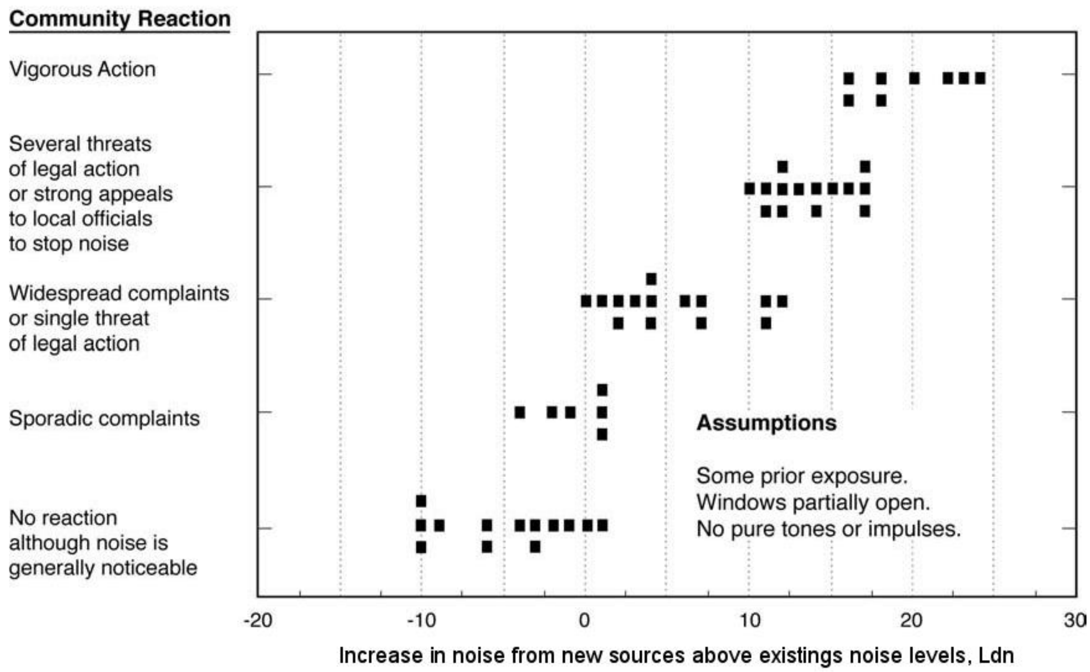
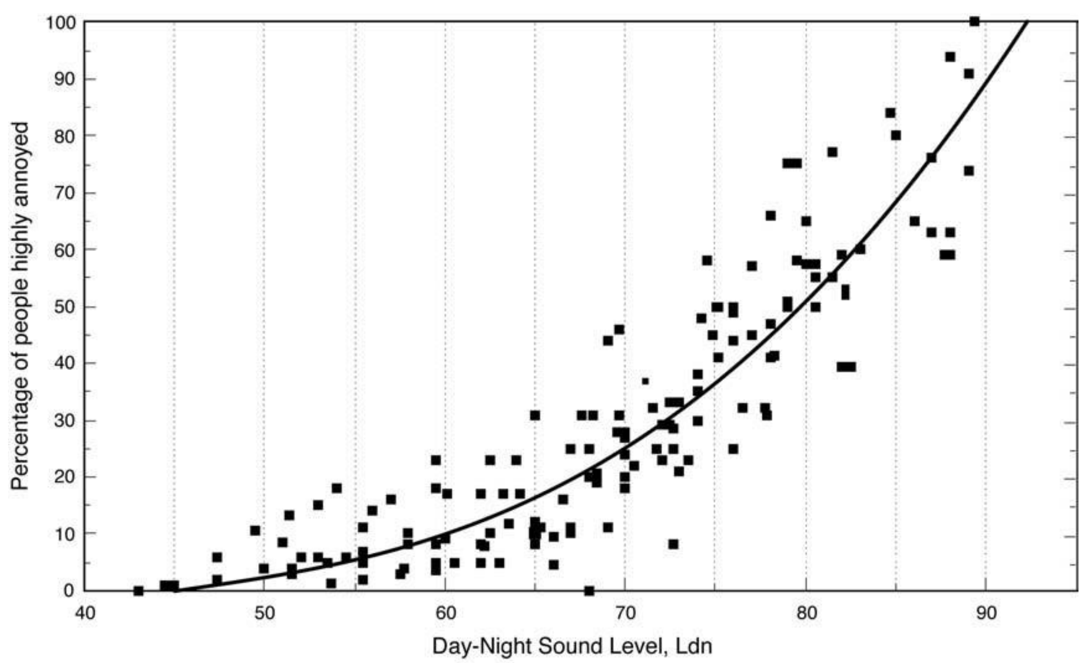
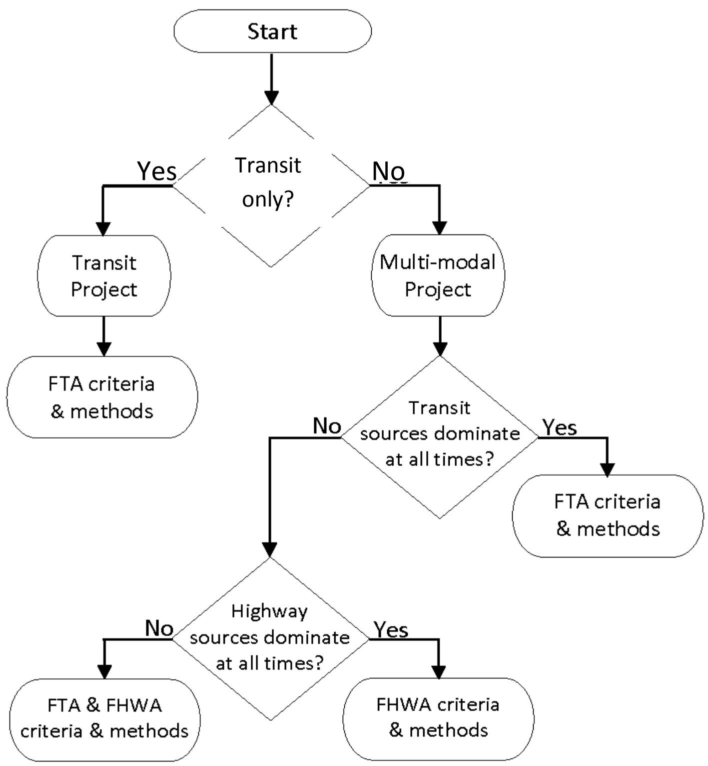
with absorption

Figure 3-7.[12][13]


Community Reaction
Vigorous Action
Several threats of legal action or strong appeals to local officials to stop noise
Widespread complaints or single threat of legal action
Sporadic complaints
No reaction although noise is generally noticeable
Assumptions
Some prior exposure.
Windows partially open.
No pure tones or impulses.
-20
-10
0
10
20
30
Increase in noise from new sources above existings noise levels, Ldn


Percentage of people highly annoyed
100
90
80
70
60
50
40
30
20
10
0
40
50
60
70
80
90
Day-Night Sound Level, Ldn

4


Start
Transit only?
Yes
No
Transit Project
Multi-modal Project
FTA criteria & methods
Transit sources dominate at all times?
No
Yes
FTA criteria & methods
Highway sources dominate at all times?
No
Yes
FTA & FHWA criteria & methods
FHWA criteria & methods

Identify the type of project as transit, multimodal (transit and highway), or other multimodal according to the dominant noise source.

[illegible]

FTA impact criteria are appropriate for transit projects, proceed to Step 2.

[illegible]

FHWA's noise assessment methods are used to inform FTA's NEPA evaluation only for [illegible]

A's procedures [illegible] *(see call out box below* [illegible]

[illegible]

	still be evaluated using FTA's noise criteria for a potential impact.

	Proceed to Step 2.
	to inform FTA's NEPA evaluation. *Contact FHWA directly for assistance using FHWA noise analysis methods and FHWA noise impact criteria.*
	Proceed to Step 2 for FTA criteria. Contact FHWA directly for assistance using FHWA noise analysis methods and FHWA noise impact criteria.

[illegible]

Administration (FRA) “High[illegible]

Impact Assessment” guidance manual.[14]

[illegible]

Determine the appropriate noise-sensitive land use category for the project segment using Table 4-3 and the descriptions below then, proceed to Step 3. FTA criteria are presented by land use.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible] L *	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible] L *	[illegible]

* L [illegible]

[illegible]

- [illegible]

h the integrity of the property's location, *If the project noise source is a new source of transit noise in the community, such as a new project in an area currently without transit, use the criteria as presented in Option A. If the project noise adds to or changes existing transit noise in the community, use the criteria as presented in Option B.*

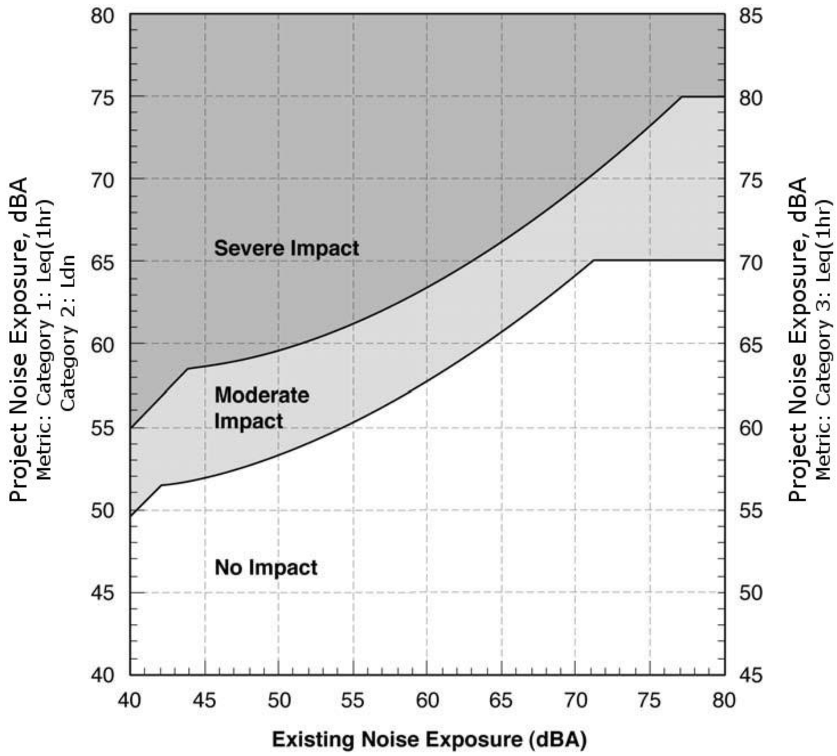
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



Severe Impact
Moderate Impact
No Impact
Project Noise Exposure, dBA
Metric: Category 1: Leq(1hr)
Category 2: Ldn
Project Noise Exposure, dBA
Metric: Category 3: Leq(1hr)
Existing Noise Exposure (dBA)

[illegible]

[illegible]

[illegible]	[illegible]			[illegible]		
	[illegible] ($L_{[illegible]}$) [illegible] (L_d) [illegible]			[illegible] [illegible] ($L_{[illegible]}$)		
$L_{[illegible]}$ b d	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	< [illegible]	[illegible] +[illegible]	> [illegible]	< [illegible]	[illegible] +[illegible]	> [illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
4	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -64	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -66	[illegible]
5	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -6	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -69	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
6	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -74	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -7	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
7	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]
[illegible]	[illegible]	[illegible] -[illegible]	[illegible]	[illegible]	[illegible] -[illegible]	[illegible]

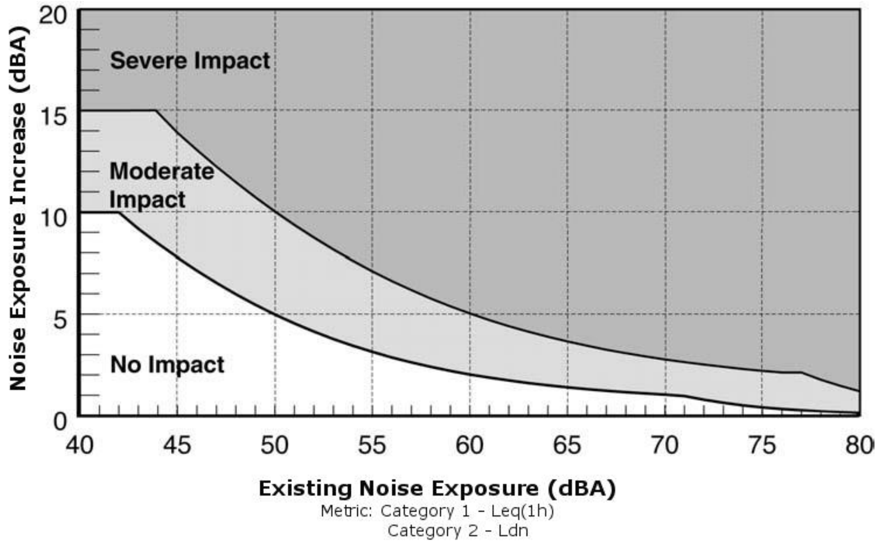
[illegible] : [illegible]

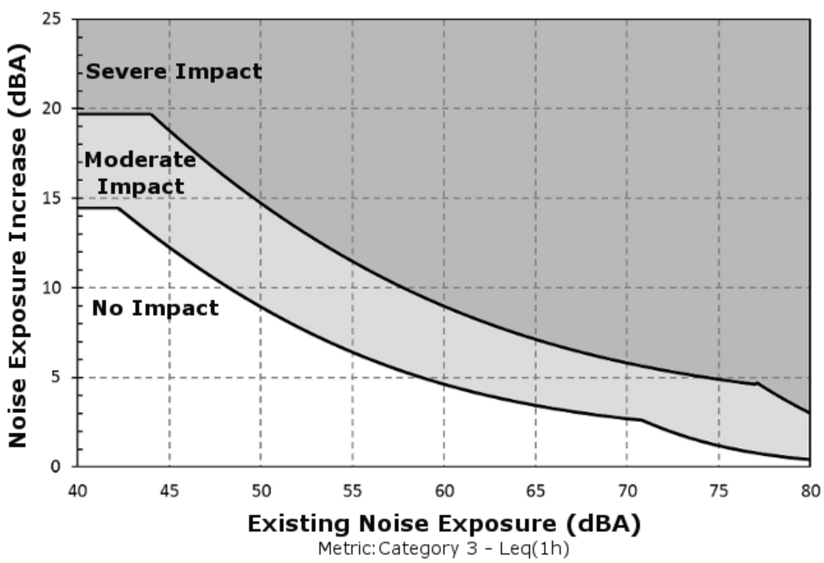
The impact criteria presentation for evaluating existing noise to project noise cumulatively is presented in this option.

[illegible]

“project noise.” For example, if the existing noise dominated by trains was

operation. Here the “project noise” results from moving some trains closer to


Severe Impact
Moderate Impact
No Impact
Noise Exposure Increase (dBA)
Existing Noise Exposure (dBA)
Metric: Category 1 - Leq(1h)
Category 2 - Ldn
0
5
10
15
20
40
45
50
55
60
65
70
75
80


Severe Impact
Moderate Impact
No Impact
Noise Exposure Increase (dBA)
Existing Noise Exposure (dBA)
Metric: Category 3 - Leq(1h)
0
5
10
15
20
25
40
45
50
55
60
65
70
75
80

[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	7
[illegible]	[illegible]	5	5
5	5	[illegible]	3
[illegible]	[illegible]	[illegible]	2
[illegible]	[illegible]	6	1
[illegible]	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	0

Conduct the noise screening procedure and then determine the appropriate noise analysis option.

[illegible]

[illegible]

[illegible] ’s [illegible]

[illegible] – [illegible] a [illegible]. [illegible]

[illegible], [illegible] in [illegible]

A [illegible]

[illegible] a [illegible]

- [illegible]
- [illegible]

Identify the potential for impact using the Noise Screening Procedure described below.

Identify the project type using Table 4-7 and confirm the assumptions in Table 4-8 are appropriate for the project.

Determine the appropriate screening distance considering the type of project and shielding from intervening buildings.

distance (49 CFR § 222).[21]

Apply the screening distances as follows to identify the study area. The study area is intended to be sufficiently large to encompass all potentially impacted locations.

Locate all noise-sensitive land uses within the study area using Table 4-3.

If no noise-sensitive land uses are identified, no further noise analysis is needed. If one or more of the noise-sensitive land uses are in the study area, proceed to Section 4.4 and complete a General Noise Assessment.

[illegible]		[illegible]	
		[illegible]	[illegible]
Fixed-Guideway Systems			
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
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[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
Bus Systems			
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
Ferry Boat Terminals		[illegible]	[illegible]

[illegible]		[illegible]	[illegible] *	[illegible] **
Fixed-Guideway Systems				
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]		[illegible]	[illegible]	[illegible]
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[illegible]		[illegible]	[illegible]	[illegible]
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	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
Bus Systems				
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]
Ferry Boat Terminals		[illegible]	[illegible]	[illegible]

*[illegible]

** [illegible]

4 [illegible]

[illegible]

[illegible]

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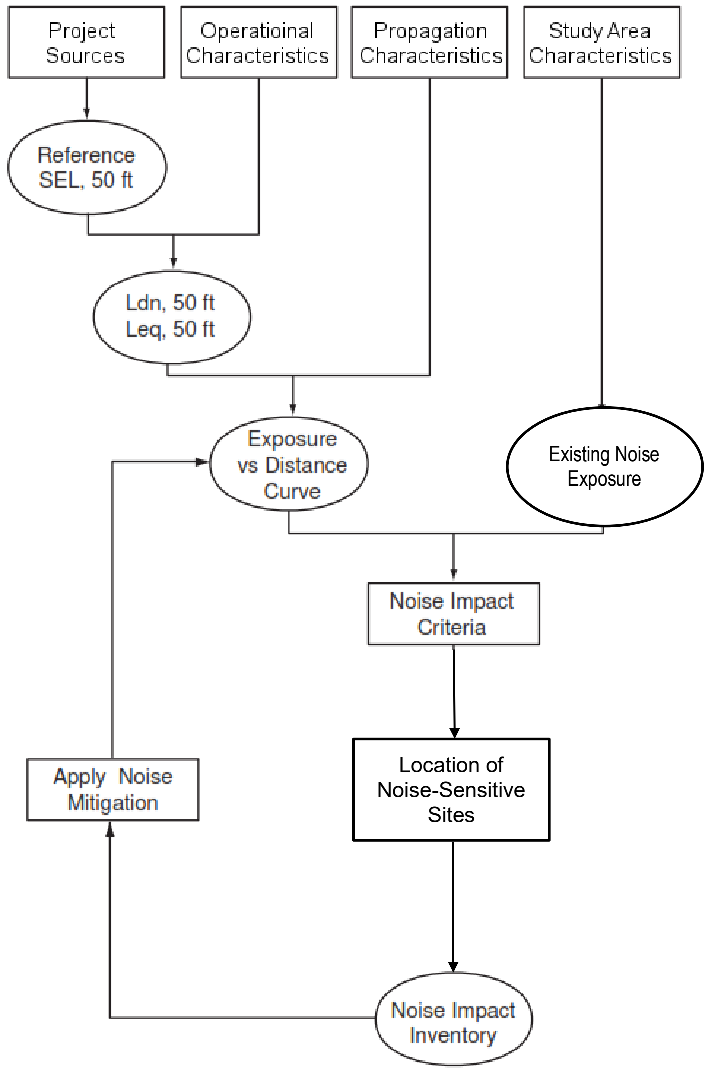
[illegible]

[illegible]



Determine the proximity of noise-sensitive land uses identified in Section 4.3 to the project and to the nearest major roadways and railroad lines.

Determine the general source reference level for each project noise source.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	*Locomotives*	[illegible]	[illegible]
		[illegible]	[illegible]
	Diesel Multiple Unit (DMU)	[illegible]	[illegible]
	Horns	[illegible]	[illegible]
	Cars	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	*Steel Wheel*	[illegible]	[illegible]
	Rubber Tire	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]

[illegible]

[illegible] * L [illegible]	$L_{eq.Loco(1hr)} = SEL_{ref} + 10\,log(N_{Loco}) + Klog(\frac{S}{50}) + 10\,log(V) - 35.6$ [illegible]
[illegible] * L [illegible]	$L_{eq.LHorns(1hr)} = SEL_{ref} + 10\,log(V) - 35.6$ [illegible]
[illegible] † L [illegible]	$L_{eq.RCars(1hr)} = SEL_{ref} + 10\,log(N_{Cars}) + 20log(\frac{S}{50}) + 10\,log(V) - 35.6 + Adj_{track}$ [illegible]
[illegible] L [illegible]	$L_{eq.SCars(1hr)} = SEL_{ref} + 10\,log(N_{Cars}) + 2log(\frac{S}{25}) + 10\,log(V) - 35.6 + Adj_{track}$ [illegible]
[illegible] L [illegible]	$L_{eq.THorns(1hr)} = SEL_{ref} - 10\,log(\frac{S}{50}) + 10\,log(V) - 35.6$ [illegible]
[illegible] †† L [illegible]	$L_{eq.Combo(1hr)} = 10log(10^{(L_{eq.Loco(1hr)}/10)} + 10^{(L_{eq.RCars(1hr)}/10)} + 10^{(L_{eq.SCars(1hr)}/10)} + 10^{(L_{eq.LHorns(1hr)}/10)} + 10^{(L_{eq.THorns(1hr)}/10)})$ [illegible]
[illegible] L_d [illegible]	$L_d = L_{eq(1hr)}$ [illegible]
[illegible] L_n [illegible]	$L_n = L_{eq(1hr)}$ [illegible]
[illegible] L_{dn} [illegible]	$L_{dn} = 10log(15 \times 10^{(L_d/10)} + 9 \times 10^{((L_n+10)/10)}) - 13.8$ [illegible]

N_{Loco} [illegible]
K = [illegible]
S = [illegible]
V = [illegible]
N_{Cars} = [illegible]
Adj_{track} = [illegible]

V_d = [illegible] $= \frac{number\ of\ trains, 7\ a.m.\ to\ 10\ p.m.}{15}$

V_n [illegible] $= \frac{number\ of\ trains, 10\ p.m.\ to\ 7 a.m.}{9}$

N_d [illegible] $= \frac{number\ of\ events\ between\ 7\ a.m.\ to\ 10\ p.m.}{15}$

N_n [illegible] $= \frac{number\ of\ events\ between\ 10\ p.m.\ to\ 7\ a.m.}{9}$

* [illegible] .
* Based on FRA's horn noise model ([illegible]).
† [illegible] .
† † [illegible] .

FTA's

stent with FHWA's

correspond to FHWA's

automobiles.[22]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

	$L_{eq(1hr)} = SEL_{ref} + 10\,log(V) + C_S log(\frac{S}{50}) - 35.6$	
L_d	$L_d = L_{Aeq(1hr)}$	
L_n	$L_n = L_{Aeq(1hr)}$	
L_d	$L_{dn} = 10log(15 \times 10^{(L_d/10)} + 9 \times 10^{((L_n+10)/10)}) - 13.8$	
V		
C_s		
S		
V_d	$= \frac{total\ number\ of\ vehicles, 7\ a.m.\ to\ 10\ p.m.}{15}$	
V_n	$= \frac{total\ number\ of\ vehicles, 10\ p.m.\ to\ 7\ a.m.}{9}$	

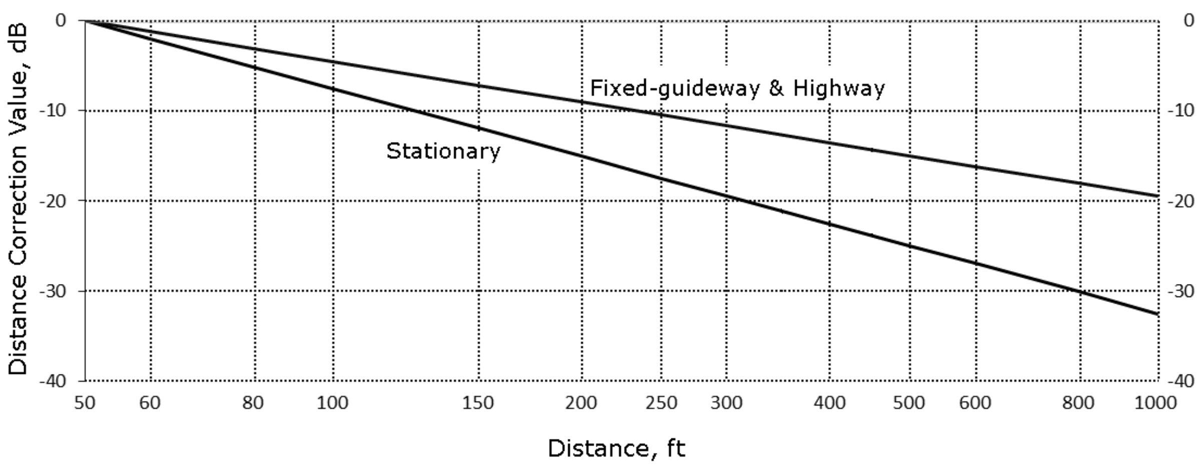
[illegible]	[illegible]	[illegible]
Rail System		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Bus System		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Ferry Terminal		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Parking Garage	[illegible]	[illegible]
Park & Ride Lot	[illegible]	[illegible]

[illegible]

[illegible]	$L_{eq(1hr)} = SEL_{ref} + C_N - 35.6$	[illegible]
[illegible]	$L_d = 10\log((\frac{1}{15})\sum_{7am-10pm} 10^{(L_{Aeq(1hr)}/10)})$	[illegible]
[illegible]	$L_n = 10\log((\frac{1}{9})\sum_{10pm-7am} 10^{(L_{Aeq(1hr)}/10)})$	[illegible]
[illegible]	$L_{dn} = 10\log(15 \times 10^{(L_d/10)} + 9 \times 10^{((L_n+10)/10)}) - 13.8$	[illegible]
[illegible]	[illegible]	
[illegible]	$= C_N$ $= 10\log(\frac{N_T}{20})$ [illegible] $= 10\log(N_T)$ [illegible] $= 10\log(\frac{N_B}{100})$ [illegible] $= 10\log(\frac{N_B}{200} + \frac{N_S}{60})$ [illegible] $= 10\log(\frac{N_B}{20})$ [illegible] $= 10\log(\frac{N_F}{4})$ [illegible] $= 10\log(\frac{N_A}{1000})$ [illegible] $= 10\log(\frac{N_A}{2000} + \frac{N_B}{24})$ [illegible] $= 10\log(\frac{E}{3600})$ [illegible] N_T [illegible] N_B [illegible] N_F [illegible] N_S [illegible] N_A [illegible] E [illegible]	

* [illegible]

Estimate the project noise exposure for locations beyond the reference distance, such as for noise-sensitive land uses.



[illegible]	[illegible]
[illegible]	$C_{distance} = -25\log(\frac{D}{50})$ [illegible]
[illegible]	$C_{distance} = -15\log(\frac{D}{50})$ [illegible]
$D =$ [illegible]	

$$L_{distance} = L_{50} + C_{distance}$$

$L_{distance} = L_{dn}$ [illegible] $L_{eq(1hr)}$ [illegible]

$L_{50} = L_{dn}$ [illegible] $L_{eq(1hr)}$ [illegible]

Combine all sources to predict the total project noise at the receivers using the equations in Table 4-16, once propagation adjustments have been made for the noise exposure from each source separately (fixed-guideway, highway/transit, and stationary).

[illegible]	$L_{eq.total(1hr)} = 10\log(\sum_{all\ sources} 10^{L_{eq}/10})$ [illegible]
[illegible]	$L_{dn.total} = 10\log(\sum_{all\ sources} 10^{L_{dn}/10})$ [illegible]

Measure the existing noise or estimate the existing noise exposure using a simplified procedure.

lightly used railroad (one train per day or less) select the Population Density category. Existing noise levels are presented in Table 4-17. Refer to Section 4.1, Step 3 – Option B, on using the cumulative noise criteria for projects that propose changes to an existing transit system, such as a rehabilitation project.

Option A: Roadways – Major roadways are separated into two categories for a general noise assessment. Roadways that cannot be described by these two categories are not considered major roadways and would use the Population Density method described below. The roadway categories are as follows:

- Interstate highway—roadways with 4 or more lanes that allow trucks
- Other roadway—parkways without trucks and city streets with the equivalent of 75 or more heavy trucks per hour or 300 or more medium trucks per hour

The estimated roadway noise levels in Table 4-17 are based on data for light to moderate traffic on typical highways and parkways using FHWA highway noise prediction procedures. Where a range of distances is given, the noise exposure estimates are given at the larger distance (note that the traffic noise at the smaller distance is underestimated). For highway noise, distances are measured from the centerline of the near lane for roadways with two lanes, while for roadways with more than two lanes the distance is measured from the geometric mean of the roadway. This distance is computed as follows:

$$D_{GM} = \sqrt{(D_N)(D_F)} \qquad \textbf{Eq. 4-23}$$

where:

D_{GM} = distance to the geometric mean in feet
D_N = distance to the nearest lane centerline in feet
D_F = distance to the farthest lane centerline in feet

Option B: Railroad Lines – For railroads, the estimated noise levels are based on an average train traffic volume of 5–10 trains per day at 30–40 mph for main line railroad corridors and the noise levels are provided in terms of L_{dn} only. Distances are referenced to the track centerline, or in the case of multiple tracks, to the centerline of the rail corridor. Because of the intermittent nature of train operations, train noise will affect the $L_{eq(1hr)}$ only during certain hours of the day, and these hours may vary from day to day. Therefore, to avoid underestimating noise impact when using $L_{eq(1hr)}$, it is recommended that sites near rail lines are estimated based on nearby roadways or population density unless very specific train information is available.

Option C: Population Density – In areas away from major roadways, noise from local streets or in neighborhoods is estimated using a relationship determined during a research program by EPA.(24) EPA determined that ambient noise can be related to population density in locations away from transportation corridors, such as airports, major roads and railroad tracks, according to the following relation:

$$L_{dn} = 22 + 10\log(p) \qquad \textbf{Eq. 4-24}$$

L_{dn}

p

[illegible]	[illegible]	[illegible]	Noise Exposure Estimates			
			L_{eq}	L_{eq}	L_{eq}	L_{d}
[illegible] *	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible] †	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
[illegible] ††	[illegible]		- - - - - - -	- - - - -- - -	- - - - - - -	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]

* [illegible]

† [illegible]

†† [illegible]

Inventory the potential noise impacts either by comparing the project and existing noise at each noise-sensitive land use or by developing noise impact contours.

[illegible]

[illegible]

[illegible]

A [illegible]

A [illegible]

A [illegible]

A [illegible]

[illegible]

B [illegible]

B [illegible]

B [illegible]

B [illegible]

B [illegible]

[illegible]

[illegible]

Apply estimates of the noise reduction from proposed mitigation measures (Section 4.4, Step 2), where the assessment shows either severe or moderate impact, and repeat the tabulation of noise impacts.

[illegible]

	[illegible]	[illegible]		[illegible]			[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	7 am – 8 am	[illegible]	[illegible]	3	3	6	6
	8 am – 4 pm	[illegible]	[illegible]	1	1	2	[illegible]
	4 pm – 6 pm	[illegible]	[illegible]	3	3	6	[illegible]
	6 pm – [illegible] pm	[illegible]	[illegible]	1	1	2	8
[illegible]	[illegible] pm – 1[illegible] pm	[illegible]	[illegible]	1	1	2	2
	1[illegible] pm – 5 am	-	-	-	-	-	-
	5 am – 6 am	[illegible]	[illegible]	1	1	2	2
	6 am – 7 am	[illegible]	[illegible]	1	1	2	2

Part 1: Grade-Separated Street Crossing

[illegible]

[illegible]

[illegible]

[illegible] – [illegible] pm

$$V_d = \frac{42\ trains}{15\ hours} = 2.8\ trains/hour$$

[illegible] [illegible] pm – [illegible]

$$V_n = \frac{6\ trains}{9\ hours} = 0.7\ trains/hour$$

Use Eq. 4-1 and Eq. 4-3 to calculate the daytime $L_{eq(1hr)}$ at 50 ft for the locomotives and rail cars.

$$\begin{aligned} L_{d.Locos} &= SEL_{ref} + 10log(N_{Locos}) + Klog(\frac{S}{50}) + 10log(V_d) - 35.6 \\ &= 92 + 10log(1) - 10log(\frac{40}{50}) + 10log(2.8) - 35.6 \\ &= 61.8\ dBA \text{ at 50 ft} \end{aligned}$$

$$\begin{aligned} L_{d.RCars} &= SEL_{ref} + 10log(N_{Cars}) + 20log(\frac{S}{50}) + 10log(V_d) - 35.6 \\ &= 82 + 10log(3) + 20log(\frac{40}{50}) + 10log(2.8) - 35.6 \\ &= 53.7\ dBA \text{ at 50 ft} \end{aligned}$$

Calculate the total daytime L_d for the locomotive and rail cars using Eq. 4-7.

$$\begin{aligned} L_{d.Combo} &= 10log(10^{L_{d.Loco}/10} + 10^{L_{d.RCars}/10}) \\ &= 10log(10^{61.8/10} + 10^{53.7/10}) \\ &= 62.4\ dBA \text{ at 50 ft} \end{aligned}$$

Calculate the nighttime $L_{eq(1hr)}$ at 50 ft for the locomotives and rail cars.

$$L_{n.Locos} = SEL_{ref} + 10\log(N_{Locos}) + K\log(\frac{S}{50}) + 10\log(V_n) - 35.6$$
$$= 92 + 10\log(1) - 10\log(\frac{40}{50}) + 10\log(0.7) - 35.6$$
$$= 55.8\ dBA \text{ at 50 ft}$$

$$L_{n.RCars} = SEL_{ref} + 10\log(N_{Cars}) + 20\log(\frac{S}{50}) + 10\log(V_n) - 35.6$$
$$= 82 + 10\log(3) + 20\log(\frac{40}{50}) + 10\log(0.7) - 35.6$$
$$= 47.7\ dBA \text{ at 50 ft}$$

Calculate the total nighttime L_n for the locomotive and rail cars using Eq. 4-8.

$$L_{n.Combo} = 10log(10^{L_{n.Locos}/10} + 10^{L_{n.RCars}/10})$$
$$= 10log(10^{55.8/10} + 10^{47.7/10})$$
$$= 56.4\ dBA \text{ at 50 ft}$$

Calculate L_{dn} at 50 ft for the project using Eq. 4-9.

$$L_{dn.Combo} = 10log\ (15 \times 10^{(L_{d.Combo}/10)} + 9 \times 10^{((L_{n.Combo}+10)/10)}) - 13.8$$

Estimate Existing Noise Exposure

Estimate existing noise at noise-sensitive sites. Since the existing alignment is on an abandoned railroad, the dominant existing noise source can be described by a generalized noise level to characterize a large area. Use Table 4-17 and population density of 25,000 people per square mile to determine the existing noise level. Unobstructed residences range from 100 to 200 ft from the rail line.

According to Table 4-17: L_{dn} = 60 dBA

Determine Noise Level and Distance for the Onset Of Impact

Determine the noise level for the onset of moderate and severe impact using Figure 4-2 and the existing noise level of 60 dBA. Note that this project is land use category 2 and the appropriate metric is L_{dn}.

Existing Noise L_{dn}	Onset of Moderate Impact L_{dn}	Onset of Severe Impact L_{dn}
60 dBA	58 dBA	64 Dba

Determine the distance from the project noise sources to the noise impact contours using the fixed-guideway curve in Figure 4-6 (or the equations in Table 4-15) and the project impact thresholds obtained above. The project noise level at 50 ft is approximately 64 dBA.

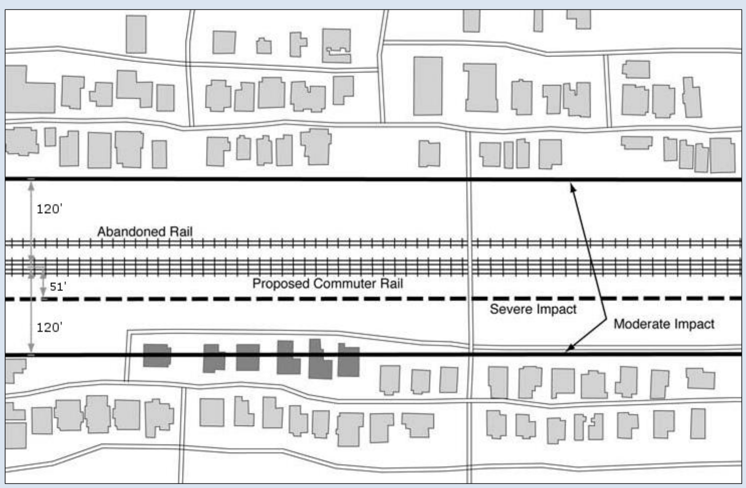
Moderate impact (58 dBA)

$$58 - 64 = -6\ dB$$

According to Figure 4-6, the distance correction is approximately -6 dB at 120 ft.
Severe Impact (64 dBA)

$$64 - 64 = 0\ dB$$

Project Level L_{dn}	Onset of Moderate Impact Distance	Onset of Severe Impact Distance
64 dBA	120 ft	51 ft



4-7

Part 2: At-Grade Crossing with Horn Blowing

4-9 4-10

$$
\begin{aligned}
L_{d.LHorns} &= SEL_{ref} + 10\log(V_d) - 35.6 \\
&= 110 + 10\log(2.8) - 35.6 \\
&= 78.9\ dBA
\end{aligned}
$$

$$L_{n.LHorns} = SEL_{ref} + 10\log(V_n) - 35.6$$
$$= 110 + 10\log(0.7) - 35.6$$
$$= 72.9\ dBA$$

Calculate the L_{dn} at 50 ft from train horns using Eq. 4-9 :

$$L_{dn.LHorns} = 10\log(15 \times 10^{\left(L_{d.LHorns}/10\right)} + 9 \times 10^{\left(\left(L_{n.LHorns}+10\right)/10\right)})\text{-}13.8$$
$$= 81\ dBA$$

[illegible]

E_d [illegible]

E_n [illegible]

[illegible] 4-[illegible] :

$$L_{d.WBell} = SEL_{ref} + 10\log\left(\frac{E_d}{3600}\right) - 35.6$$
$$= 109 + 10\log\left(\frac{56}{3600}\right) - 35.6$$
$$= 55.3\ dBA$$

$$L_{n.WBell} = SEL_{ref} + 10\log\left(\frac{E_n}{3600}\right) - 35.6$$
$$= 109 + 10\log\left(\frac{14}{3600}\right) - 35.6$$
$$= 49.3\ dBA$$

[illegible]

$$L_{dn.WBell} = 10\log(15 \times 10^{\left(L_{d.WBell}/10\right)} + 9 \times 10^{\left(\left(L_{n.WBell}+10\right)/10\right)})\text{-}[illegible]$$
$$= 57.3\ dBA$$

[illegible]

[illegible]

[illegible]

[illegible] L_d	[illegible] L_d	[illegible] L_d
[illegible] A	[illegible] A	[illegible] A

[illegible] 4-6 [illegible] 4-5) [illegible]

$$58 - (81 - 6) = -17\ dB$$

[illegible] t

$$64 - (81 - 6) = -11\ dB$$

[illegible] t

L_d [illegible]	[illegible]	[illegible]
[illegible]	[illegible] f	[illegible] f

[illegible]

[illegible]

A [illegible] system [illegible] way [illegible] t. [illegible] first [illegible] -day [illegible] ly L [illegible], [illegible] from the [illegible] of [illegible] 4-[illegible] 45 mph [illegible] 5-mi [illegible] ys in [illegible] th [illegible] 2-[illegible] ys

[illegible]

SEL_{ref} [illegible]

Nd [illegible]

Nn [illegible]

S [illegible]

V_d [illegible]

V_n [illegible]

[illegible] 4-9 [illegible] 4-10 [illegible] L [illegible]

[illegible] 4-3 [illegible] -[illegible] noise [illegible].

$$L_{d.RCars}(h) = SEL_{ref} + 10\,log(N_{cars}) + 20\log(\frac{S}{50}) + 10\,log(V) - 35.6$$

$$= 82 + 10\,log(4) + 20\log(\frac{45}{50}) + 10\,log(24) - 35.6$$

$$= 65\ \text{[illegible]}$$

4-3 noise

$$L_{n.RCars}(h) = SEL_{ref} + 10\,log(N_{cars}) + 20\log(\frac{S}{50}) + 10\,log(V) - 35.6$$

$$= 82 + 10\,log(2) + 20\log(\frac{45}{50}) + 10\,log(6) - 35.6$$

$$= 56$$

4-6

f .

$$65 - 5 = \; 60\,dBA\ at\ 125\,ft$$

$$56 - 5 = \; 51\,dBA\ at\ 125\,ft$$

5

9 -2, .

-6

s

SEL_{ref}

S

V_d

V_n

Use 4-2 f .

C_S

$$L_{d.Bus} = SEL_{ref} + 10\,log(V_d) + C_S\log(\frac{S}{50}) - 35.6$$

$$= 82 + 10\,log(22.9) + 15log(\frac{25}{50}) - 35.6$$

$$= 55$$

$$L_{n.Bus} = SEL_{ref} + 10\,log(V_n) + C_S\log(\frac{S}{50}) - 35.6$$

$$= 82 + 10\,log(12.9) + 15log(\frac{25}{50}) - 35.6$$

$$= 53$$

f 4-3 .

$$L_{dn.Bus} = 10\log(15 \times 10^{(L_{d.Bus}/10)} + 9 \times 10^{((L_{n.Bus}+10)/10)}) - 13.8$$

$$= 60$$

4-7.

L_d =

4-2

L_d.

L_d	L_d	L_d
[illegible]	[illegible]	[illegible]

4-6 4-5

$$54 - 60 = -6\ dB$$

4-6 -6

$$59 - 60 = -1\ dB$$

4-6 -1

L_d		
[illegible]	[illegible]	[illegible]

L_d		
[illegible]	[illegible]	[illegible]

[illegible] 4-8.

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	7 am – 9 am	[illegible]
[illegible]	4 pm – 6 pm	[illegible]
[illegible]	9 am – 4 pm	[illegible]
[illegible]	6 pm – [illegible] pm	[illegible]
[illegible]	6 am – 7 am	[illegible]
[illegible]	[illegible] pm – [illegible] am	4

[illegible] am – [illegible] pm)

$$V_d = \frac{273\ buses}{15\ hours} = 18.2\ buses/hour$$

[illegible] pm – 7 am)

$$V_n = \frac{27\ buses}{9\ hours} = 3\ buses/hour$$

[illegible] 4-3 [illegible] 4-4 [illegible].

$$\begin{aligned} L_{d.BTCenter} &= SEL_{ref} + C_N - 35.6 \\ &= 101 + 10\log(\frac{18.2}{20}) - 35.6 \\ &= 65\ dBA \end{aligned}$$

$$L_{n.BTCenter} = SEL_{ref} + C_N - 35.6$$

$$= 101 + 10\log(\frac{3}{20}) - 35.6$$

$$= 57\ dBA$$

4-7.

$$L_{dn.BTCenter} = 10\log(15 \times 10^{(L_{d.BTCenter}/10)} + 9 \times 10^{((L_{n.BTCenter}+10)/10)})$$

$$= 66\ dBA$$

4-7.

4-7

4-2

L_d	L_d	L_d
[illegible]	[illegible]	[illegible]

4-6.

$$56 - 66 = -10\ dB$$

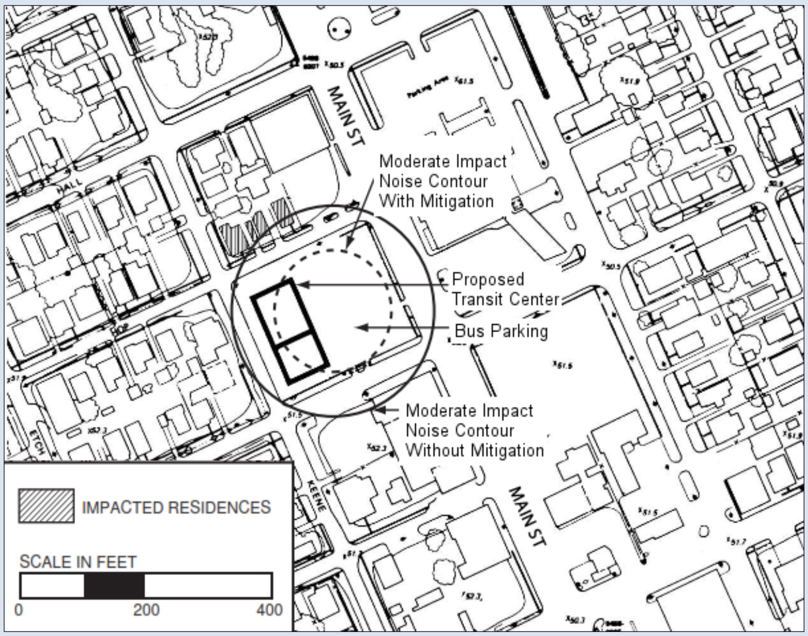
4-6,

$$62 - 66 = -4\ dB$$

4-6,

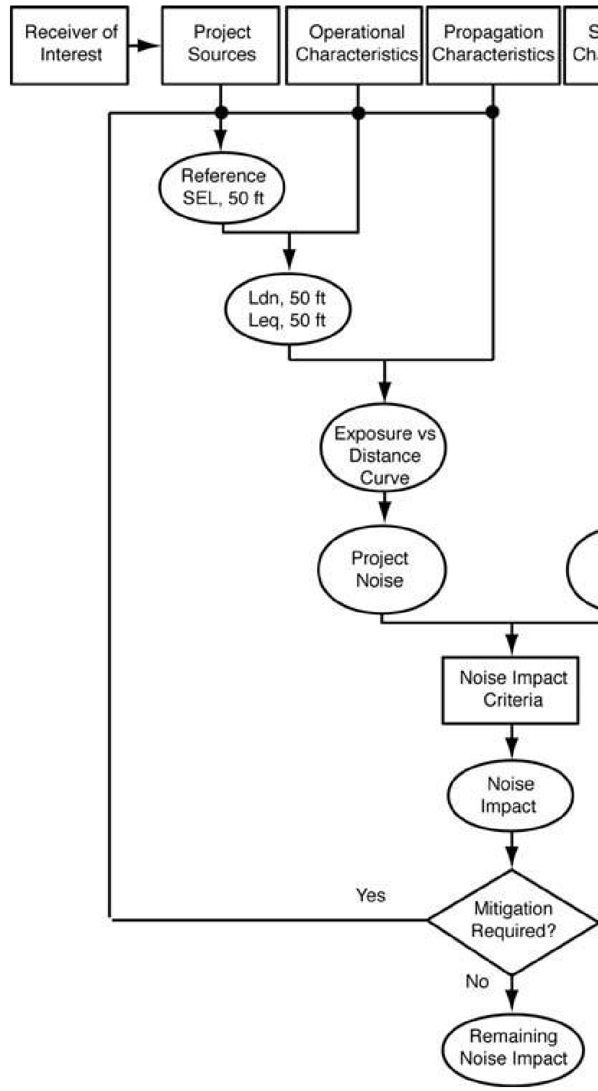
L_d		
[illegible]	[illegible]	[illegible]

4-8



MAIN ST
Moderate Impact
Noise Contour
With Mitigation
HALL
Proposed
Transit Center
Bus Parking
Moderate Impact
Noise Contour
Without Mitigation
KEENE
MAIN ST
IMPACTED RESIDENCES
SCALE IN FEET
0
200
400

4-8

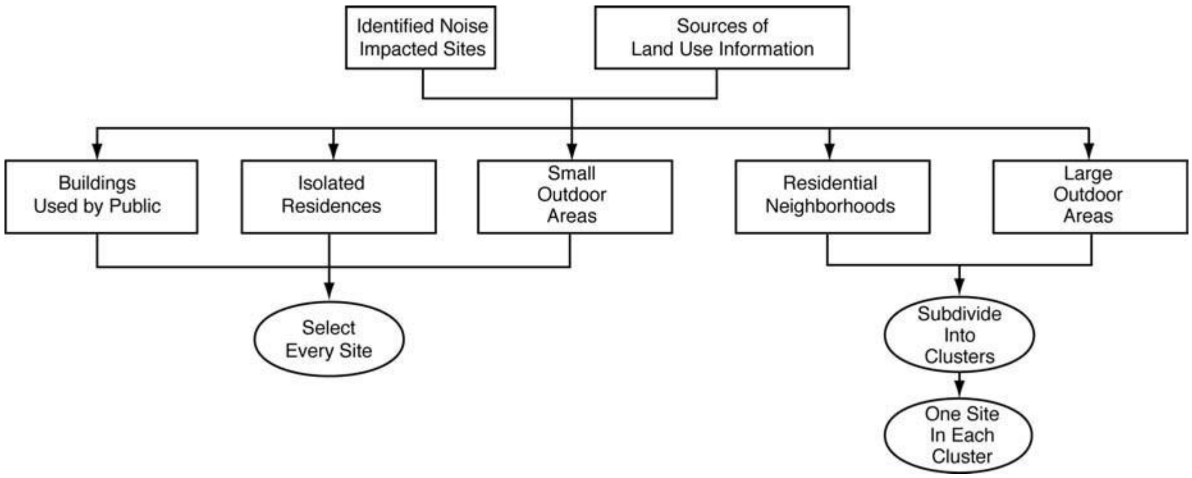


[illegible]

Select the noise-sensitive receivers of interest, the number of which will depend upon the land use in the vicinity of the proposed project and the extent of the study area defined by the Noise Screening Procedure in Section 4.3 and the results of the General Noise Assessment in Section 4.4.

[illegible]

a. [illegible]
b. [illegible]
c. [illegible]



Identified Noise Impacted Sites
Sources of Land Use Information
Buildings Used by Public
Isolated Residences
Small Outdoor Areas
Residential Neighborhoods
Large Outdoor Areas
Select Every Site
Subdivide Into Clusters
One Site In Each Cluster

[illegible]

- [illegible]

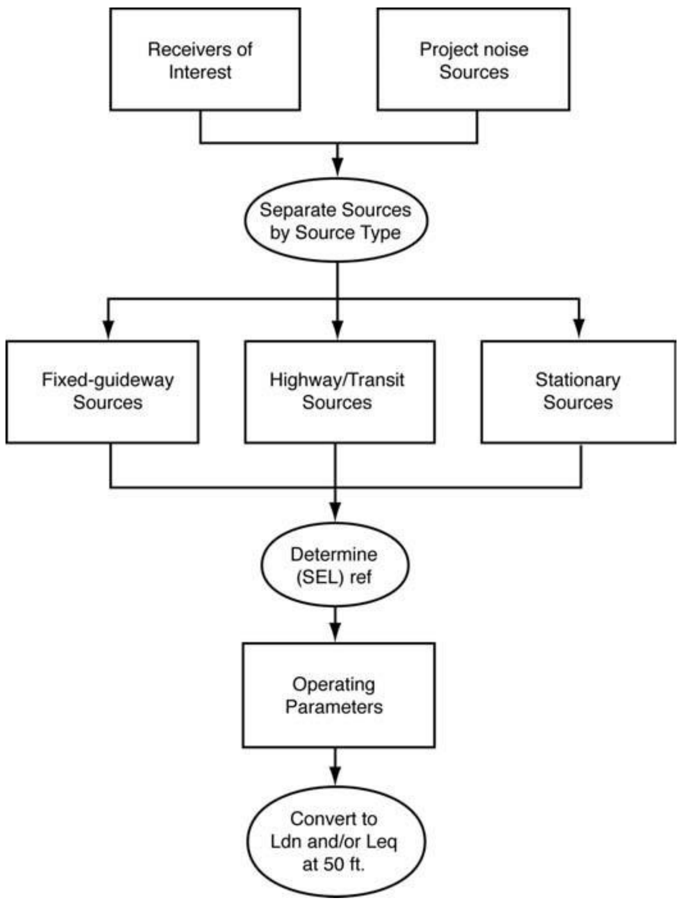
[illegible] *land uses of interest* [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

relatively large areas.

Identify the major project noise sources near the noise-sensitive receivers of interest, group them by source type, and determine reference levels to compute project noise at 50 ft, as shown in Figure 4-11.



[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
		[illegible]	No
	[illegible]	[illegible]	Yes
		[illegible]	No
[illegible]	[illegible]	[illegible]	Yes
		[illegible]	No
	[illegible]	[illegible]	Yes
[illegible]	[illegible]	[illegible]	Yes
	[illegible]	[illegible]	No
[illegible]	[illegible]	[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
	[illegible]	[illegible]	Yes
		[illegible]	No
		[illegible]	No
	[illegible]	[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
		[illegible]	No
		[illegible]	No
		[illegible]	No
[illegible]	[illegible]	[illegible]	Yes
		[illegible]	Yes
		[illegible]	No
	[illegible]	[illegible]	No
[illegible]	[illegible]	[illegible]	Yes
[illegible]	[illegible]	[illegible]	Yes
		[illegible]	Yes
		[illegible]	Yes
		[illegible]	
		[illegible]	Yes
		[illegible]	
	[illegible]	[illegible]	Yes
	[illegible]	[illegible]	Yes
		[illegible]	No
		[illegible]	No
		[illegible]	No
		[illegible]	No

2b

2

f .

A .

[illegible]	[illegible]	[illegible] L_{max}, [illegible]	[illegible] *
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] – [illegible]	[illegible]	[illegible]	[illegible]
[illegible] – [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible] – [illegible]	[illegible]	[illegible]	[illegible]
[illegible] – [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	†	[illegible]	
[illegible]	[illegible]	[illegible]	

** [illegible] For streetcar speeds above 25 mph, use the "Rail Cars" reference level and 50 mph for the reference speed.

$$SEL_{Ref} = 113 - 3 \times \left(\frac{D_P}{660}\right)$$

D_P = [illegible]

2

3

powered locomotives and DMU's only[iv]

4

5

[illegible] * $L_{[illegible]}$ [illegible]	$$L_{eq.Loco(1hr)} = SEL_{ref} + 10\,log(N_{Loco}) + C_T + K log(\frac{S}{50}) + 10\,log(V) - 35.6$$	[illegible]
[illegible] * $L_{[illegible]}$ [illegible]	$$L_{eq.LHorns(1hr)} = SEL_{ref} + 10\,log(V) - 35.6$$	[illegible]
[illegible] † $L_{[illegible]}$ [illegible]	$$L_{eq.RCars(1hr)} = SEL_{ref} + 10\,log(N_{Cars}) + 20\log(\frac{S}{50}) + 10\,log(V) - 35.6 + Adj_{track}$$	[illegible]
[illegible] $L_{[illegible]}$ [illegible]	$$L_{eq.SCars(1hr)} = SEL_{ref} + 10\,log(N_{Cars}) + 2\log(\frac{S}{25}) + 10\,log(V) - 35.6 + Adj_{track}$$	[illegible]
[illegible] * $L_{[illegible]}$ [illegible]	$$L_{eq.THorns(1hr)} = SEL_{ref} - 10\,log(\frac{S}{50}) + 10\,log(V) - 35.6$$	[illegible]
[illegible] †† $L_{[illegible]}$ [illegible]	$$L_{eq.Combo(1hr)} = 10\log(10^{(L_{eq.Loco(1hr)}/10)} + 10^{(L_{eq.RCars(1hr)}/10)} + 10^{(L_{eq.SCars(1hr)}/10)} + 10^{(L_{eq.LHorns(1hr)}/10)} + 10^{(L_{eq.THorns(1hr)}/10)}$$	[illegible]
[illegible] L_d [illegible]	$L_d = L_{eq(1hr)}$ [illegible]	[illegible]
[illegible] L_n [illegible]	$L_n = L_{eq(1hr)}$ [illegible]	[illegible]
[illegible] L_{dn} [illegible]	$$L_{dn} = 10\log(15 \times 10^{(L_d/10)} + 9 \times 10^{((L_n+10)/10)}) - 13.8$$	[illegible]

N_{Loco} = [illegible]

C_T $= 0\ for\ T < 6$
$2(T-5)\ for\ T \geq 6$
[illegible]

K = [illegible] ∓

N_{Cars} = [illegible]
V [illegible]
S [illegible]
Adj_{track} [illegible]

V_d = [illegible]

$$= \frac{number\ of\ trains, 7\ a.m. to\ 10\ p.m.}{15}$$

V_n [illegible]

$$= \frac{number\ of\ trains, 10\ p.m. to\ 7a.m.}{9}$$

N_d [illegible]

$$= \frac{number\ of\ events\ between\ 7\ a.m. to\ 10\ p.m.}{15}$$

N_n [illegible]

$$= \frac{number\ of\ events\ between\ 10\ p.m. to\ 7\ a.m.}{9}$$

* [illegible] * Based on FRA's horn noise model [illegible]
† [illegible] †† [illegible]
∓ [illegible]

SEL_{ref}

N_{Cars}

N_{Loco}

S

T

V_d $= 40\ trains/15\ hours = 2.667\ trains\ per\ hour$

V_n $= 2\ trains/9\ hours = 0.222\ trains\ per\ hour$

4-2

$$L_{d.Locs(1hr)} = SEL_{ref} + 10\,log(N_{Loco}) + C_T + K log(\frac{S}{50}) + 10\,log(V_d) - 35.6$$
$$= 92 + 10\,log(1) + 6 + (-10) log(\frac{43}{50}) + 10\,log(2.667) - 35.6$$
$$= 67.3\ dBA$$

$$L_{d.RCars(1hr)} = SEL_{ref} + 10\,log(N_{Cars}) + 20 log\left(\frac{S}{50}\right) + 10\,log(V_d) - 35.6 + Adj_{track}$$
$$= 82 + 10\,log(6) + 20 log\left(\frac{43}{50}\right) + 10\,log(2.667) - 35.6 + 5$$
$$= 62.1\ dBA$$

$$L_{d.LHorn(1hr)} = SEL_{ref} + 10\,log(V_d) - 35.6$$
$$= 113 + 10\,log(2.667) - 35.6$$
$$= 81.7\ dBA$$

$$L_{d.Combo(1hr)} = 10 log\left[10^{\left(L_{d.Locos(1hr)}/10\right)} + 10^{\left(L_{d.RCars(1hr)}/10\right)} + 10^{\left(L_{d.LHorn(1hr)}/10\right)}\right]$$
$$= 81.9\ dBA$$

$$= 10 log\left[10^{\left(L_{d.Locos(1hr)}/10\right)} + 10^{\left(L_{d.RCars(1hr)}/10\right)}\right]$$
$$= 68.4\ dBA$$

$L_{n.Locos(1hr)}$

$L_{n.RCars(1hr)}$

$L_{n.LHorn(1hr)}$

$L_{n.Combo(1hr)}$

$$L_{dn.Combo} = 10 log\left[15 \times 10^{\left(L_{d.Combo}/10\right)} + 9 \times 10^{\left((L_{n.Combo}+10)/10\right)}\right] - 13.8$$

= 81.6 [illegible]

= 68.1 [illegible]

[illegible] FTA’s procedures that involve highway vehicles.

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7	[illegible]
[illegible] *	8	[illegible]	[illegible]

* [illegible]

[illegible]

[illegible]

1 [illegible]

- [illegible]
- [illegible]
- [illegible]

2 [illegible]

- [illegible]
- [illegible]

3 [illegible]

- [illegible]
- [illegible]
- [illegible]
  - [illegible]
  - [illegible]
- [illegible]

4 [illegible]

5 [illegible]

[illegible]

L_{eq} [illegible]	$L_{eq(1hr)} = SEL_{ref} + 10\,log(V) + C_{emissions} - 10\log(\frac{S}{50}) - 35.6$	4-4
[illegible] L_d [illegible]	$L_d = L_{eq(1hr)}$ [illegible] $_d$	4-5
[illegible] L_n [illegible]	$L_n = L_{eq(1hr)}$ [illegible] $_n$	4-6
L_{dn} [illegible]	$L_{dn} = 10log(15 \times 10^{(L_d/10)} + 9 \times 10^{((L_n+10)/10)}) - 13.8$	4-7
[illegible]	= [illegible] = [illegible]	

V = [illegible]

$C_{emissions}$ = $25\log(\frac{S}{50})$ [illegible]

$31\log(\frac{S}{50})$ [illegible]

1.6 [illegible]

$40\log(\frac{S}{50})$ [illegible]

S [illegible]

V_d = [illegible]

$$= \frac{total\ vehicle\ volume, 7\ a.m. to\ 10\ p.m.}{15}$$

V_n [illegible]

$$= \frac{total\ vehicle\ volume, 10\ p.m. to\ 7\ a.m.}{9}$$

[illegible]

A [illegible]

SEL_{ref} = [illegible] A

S [illegible]

V = [illegible]

[illegible] 4-3 [illegible] L_{eq} [illegible]

$$L_{d.Bus} = SEL_{ref} + 10\,log(V) + C_{emissions} - 10\log(\frac{S}{50}) - 35.6$$

$$= 82 + 10\,log(30) + 6 + 25 \times log(\frac{40}{50}) - 10\log(\frac{40}{50}) - 35.6$$

$$= 59.7\ dBA$$

$$V_d = 200\ buses/15\ hours = 13.33\ buses\ per\ hour$$
$$V_n = 20\ buses/9\ hours = 2.22\ buses\ per\ hour$$

$$L_{d.Bus} = 82 + 10\,log(13.33) + 6 + 25 \times log(\frac{40}{50}) - 10\log(\frac{40}{50}) - 35.6$$
$$= 56.2\ dBA$$

$$L_{n.Bus} = 82 + 10\,log(2.22) + 6 + 25 \times log(\frac{40}{50}) - 10\log(\frac{40}{50}) - 35.6$$
$$= 48.4\ dBA$$

$$L_{dn.Bus} = 10log(15 \times 10^{\left(L_{d.Bus}/_{10}\right)} + 9 \times 10^{\left((L_{n.Bus}+10)/_{10}\right)}) - 13.8$$
$$= 57.2\ dBA$$

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

* [illegible]

** [illegible]

[illegible]

1. [illegible]
   - [illegible]
   - [illegible]

2. [illegible]
   - [illegible]
   - [illegible]

3. [illegible]
   - [illegible]
   - [illegible]
   - [illegible]
     - [illegible]

4

5

L_{h}	$L_{eq(1hr)} = SEL_{ref} + 10\,log(N) + 10\log(\frac{E}{3600}) - 35.6$	4-8
L_d	$L_d = L_{eq(1hr)}$ N_d	4-9
L_n	$L_n = L_{eq(1hr)}$ N_n	4-0
L_d	$L_{dn} = 10\log(15 \times 10^{\left(L_d/10\right)} + 9 \times 10^{\left((L_n+10)/10\right)}) - 13.8$	4-4

N =

E

N_d (7 a.m. p.m.)

$= \frac{number\ of\ events\ between\ 7\ a.m.\ to\ 10\ p.m.}{15}$

N_n (0 p.m. 7 a.m.)

$= \frac{number\ of\ events\ between\ 10\ p.m.\ to\ 7\ a.m.}{9}$

[illegible]

$$SEL_{ref} \quad [illegible] \; A$$
$$E \quad [illegible]$$
$$N \quad [illegible]$$

[illegible] 4-2 [illegible] L [illegible]

$$L_{d.Cross} = SEL_{ref} + 10log(N) + 10log\left(\frac{E}{3600}\right) - 35.6$$
$$= 109 + 10log(22) + 10log(\frac{25}{3600}) - 35.6$$
$$= 65.2\ dBA$$ [illegible]

[illegible]

$$N_d = 200\ /15\ hours = 13.3\ events\ per\ hour$$
$$N_n = 12\ /9\ hours = 1.33\ events\ per\ hour$$

[illegible]

$$L_{d.Cross} = 109 + 10log(13.3) + 10log(\frac{25}{3600}) - 35.6$$
$$= 63.1\ dBA$$ [illegible]

$$L_{n.Cross} = 109 + 10log(1.33) + 10log(\frac{25}{3600}) - 35.6$$
$$= 53.1\ dBA$$ [illegible]

[illegible]

$$L_{dn} = 10log(15 \times 10^{\left(L_{d.Cross}/_{10}\right)} + 9 \times 10^{\left((L_{n.Cross}+10)/_{10}\right)}) - 13.8$$
$$= 63.1\ dBA$$ [illegible]

[illegible]

[illegible]

Determine the combined propagation characteristics between each source and receiver of interest.

[illegible] *Calculate the project noise exposure at distances other than 50 ft, such as at receiver locations, as a function of distance accounting for shielding and ground effects along the path* [illegible]

1. [illegible]

2. [illegible]

3. [illegible]

4. [illegible]

$$L_{distance} = L_{50ft} + C_{distance} \quad \text{4-2}$$

where:

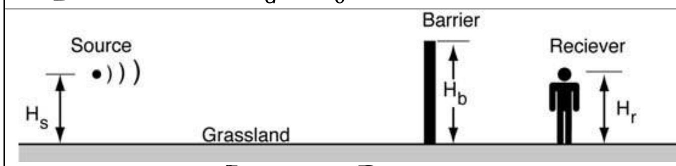
$L_{distance}$ = L_{dn} or $L_{Aeq(1hr)}$ [illegible]

L_{50ft} = L_{dn} or $L_{Aeq(1hr)}$ [illegible]

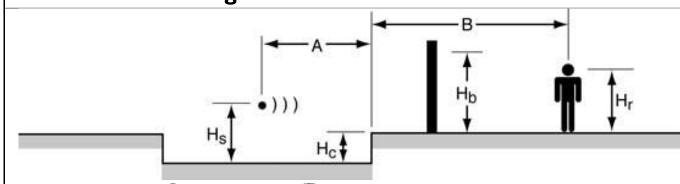
5. [illegible]

$$G = \begin{cases} 0.66, & H_{eff} \leq 5 \\ 0.75\left(1 - \frac{H_{eff}}{42}\right), & 5 < H_{eff} < 42 \\ 0, & H_{eff} \geq 42 \end{cases}$$

$$G = 0$$

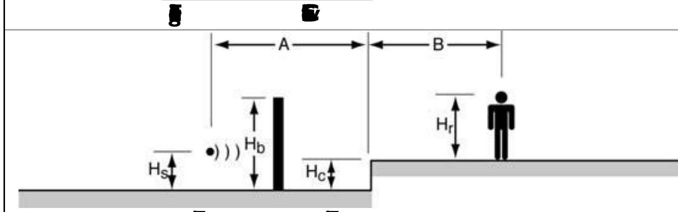


$$H_{eff} = \frac{H_s + 2H_b + H_r}{2}$$



$$H_{eff} = \frac{H_s + 2H_b + H_c + H_r}{2} \qquad for\ B \leq \frac{A}{2}$$

$$for\ B > \frac{A}{2}$$



$$H_{eff} = \frac{H_s + H_c + H_r}{2} \qquad for\ H_b \leq H_c$$

$$H_{eff} = \frac{H_s + 2H_b - H_c + H_r}{2} \qquad for\ H_b > H_c$$

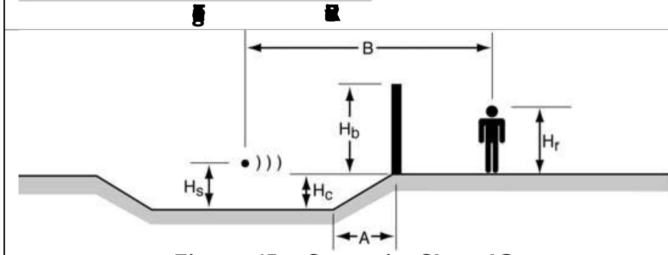


Figure 45 Source in Sloped Cut

$$for\ A \leq \frac{B}{2}$$

$$H_{eff} = \frac{H_s + 2H_b + H_c + H_r}{2} \qquad for\ A > \frac{B}{2}$$

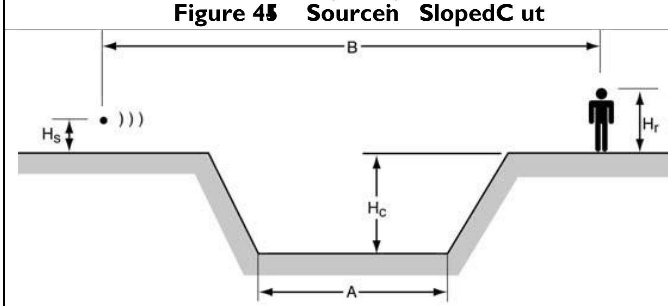


Figure 46 Source and Receiver Separated by Trench

$$H_{eff} = \frac{H_s + H_r}{2} \qquad for\ A \leq \frac{B}{2}$$

$$H_{eff} = \frac{H_s + 2H_c + H_r}{2} \qquad for\ A > \frac{B}{2}$$

H_s

	*
e	$C_{distance} = -20\log(\frac{D}{50}) - 10G\log(\frac{D}{50})$ 4-5
-	$C_{distance} = -10\log(\frac{D}{50}) - 10G\log(\frac{D}{42})$ 4-6
- - p	$C_{distance} = -10\log(\frac{D}{50}) - 10G\log(\frac{D}{29})$ 4-7
D = d , f	
G = g 4-2	

f A

–

-

-e

A

$L_{eq.Loco}\ (8 - 9am)$ = 7 A

$L_{dn.Loco}$ = A

H_r

H_b = 0 ft (for a "no noise barrier" case)

H_s (-)

4-2 .

$$H_{eff} = \frac{H_s + 2H_b + H_r}{2}$$

$$= \frac{8 + 0 + 5}{2}$$

4-3 .

$$G = 0.75(1 - \frac{H_{eff}}{42})$$

$$= 0.63$$

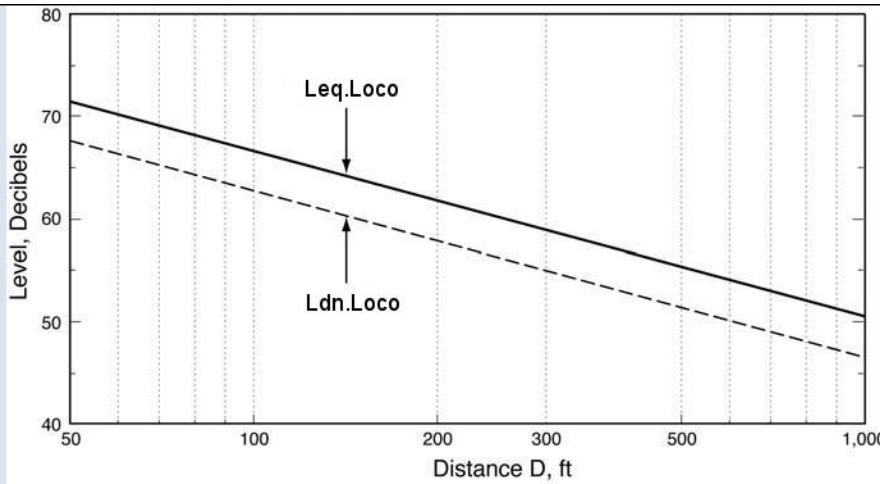
4-5 s .

$$L_{eq.Loco} = 72 - 10\log(\frac{D}{50}) - 6.3\log(\frac{D}{42})$$

$$L_{dn.Loco} = 68 - 10\log(\frac{D}{50}) - 6.3\log(\frac{D}{42})$$

Pb (4-7).

.



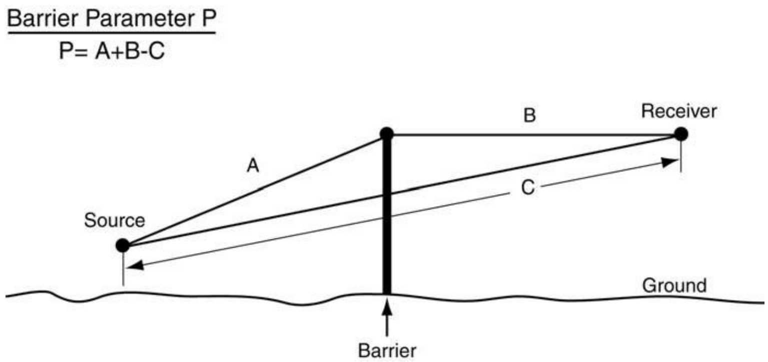
4-17

$$A_{shielding} = \max\{IL_{barrier}\ or\ A_{buildings}\ or\ A_{trees}\} \qquad 4\text{-}28$$

$IL_{barrier}$	4-28
$A_{buildings}$	4-29
A_{trees}	4-30

	$$IL_{barrier} = \max\{0\ or\ (A_{barrier} - 10(G_{NB} - G_B)\log(\frac{D}{50}))\}$$	4-29
$A_{barrier}$	$= \min\{12\ or\ [5.3\log(P) + 6.7]\}$	
	$= \min\{15\ or\ (5.3\log(P) + 9.7)\}$	
	$= \min\{15 or (20\log(\frac{2.51\sqrt{P}}{\tanh(4.46\sqrt{P})}) + 5)\}$	the line of
P	4-38)*	
D		
G_{NB}	=	4-28)
G_B	=	4-28)

*



[illegible] % [illegible]	$A_{buildings} = \min\{10\ or\ [1.5\ (R-1)+5]\}$ Eq 4-[illegible]
Gp in the [illegible] of bul din gs co [illegible] ue 3 to 65% of the le ngth he row	$A_{buildings} = \min\{10\ or\ [1.5\ (R-1)+3]\}$ Eq 4-5
Gp in the row of bul dig o nt ue moe than 65% of the gth the row	$A_{buildings} = 0$
R [illegible]	

A [illegible] 0 f of tre in ene [illegible] eh [illegible] a d ree [illegible] o [illegible] l ne-of-g ht [illegible] en [illegible] ad reie [illegible] the [illegible] 5 o mob [illegible] e the ne-of-[illegible]	$A_{trees} = \min\left\{10\ or\ \frac{W}{20}\right\}\ where\ W \geq 100ft$ $= 0\ where\ W < 100ft$ Eq 4-[illegible]
[illegible] -of- [illegible] e t	

–

1 [illegible] -f[illegible]

2 [illegible] 15 f [illegible] e the ne-of-[illegible]

H_s

H_r

A

B

C

4-[illegible] .

$$H_{eff.NoBarrier} = \frac{H_s + 2H_b + H_r}{2}$$

$$= \frac{8 + 0 + 5}{2}$$

$= $ [illegible]

$$H_{eff.Barrier} = \frac{H_s + 2H_b + H_r}{2}$$

$$= \frac{8 + 15 + 5}{2}$$

$=$ [illegible] ft

[illegible] 4-3 [illegible].

$$G_{NoBarrier} = 0.75\left(1 - \frac{H_{eff}}{42}\right)$$

$$= 0.63$$

$$G_{Barrier} = 0.75\left(1 - \frac{H_{eff}}{42}\right)$$

$$= 0.37$$

[illegible] 4-2 [illegible] 4-8 [illegible].

$$P = A + B - C$$

$$= 0.96 \text{ ft}$$

$$A_{barrier} = \min\{15 \text{ or } (20\log(\frac{2.51\sqrt{P}}{\tanh(4.46\sqrt{P})}) + 5)\}$$

$=$ [illegible]

$$= \min\{15 \; or \; 12.8\}$$

$=$ [illegible]

$$IL_{barrier} = \max\{0 \text{ or } (A_{barrier} - 10(G_{NoBarrier} - G_{Barrier})\log(\frac{D}{50}))\}$$

$$= 12.8 - 10(0.63 - 0.37)\log(\frac{170}{50})$$

$=$ [illegible]

[illegible]

[illegible] 4-0 [illegible].

$$A_{trees} = \min\{10 \; or \; \frac{W}{20}\}$$

$= 5$ [illegible]

[illegible]

[illegible], [illegible].

$$A_{shielding} = \max\{IL_{barrier} \; or \; A_{buildings} \; or \; A_{trees}\}$$

$$= \max\{11.4 \; or \; 0 \; or \; 5\}$$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible] *
[illegible]	$L_{DistShield} = L - 20\log(\frac{D}{50}) - 10Glog(\frac{D}{50}) - A_{shielding}$ Eq 4-3
[illegible]	$L_{DistShield} = L - 10\log(\frac{D}{50}) - 10Glog(\frac{D}{42}) - A_{shielding}$ Eq 4-[illegible]
[illegible]	$L_{DistShield} = L - 10\log(\frac{D}{50}) - 10Glog(\frac{D}{29}) - A_{shielding}$ Eq 4-5

$L = L_{dn}$ or L_{eq}

D = [illegible]

G = [illegible]

$A_{shielding}$ = [illegible]

[illegible]

Combine all sources to predict the total project noise at the receivers using the equations in Table 4-32 after propagation adjustments have been made for the noise exposure from each source separately.

[illegible]

[illegible]	$L_{eq.total(1hr)} = 10\log(\sum_{all\ sources} 10^{L_{Aeq(1hr)}/10})$ Eq 4-6
[illegible]	$L_{dn.total} = 10\log(\sum_{all\ sources} 10^{L_{dn}/10})$ Eq 4-7

[illegible]

[illegible]

$L_{eq.Commuter}$ [illegible] A

$L_{dn.Commuter}$ [illegible] A

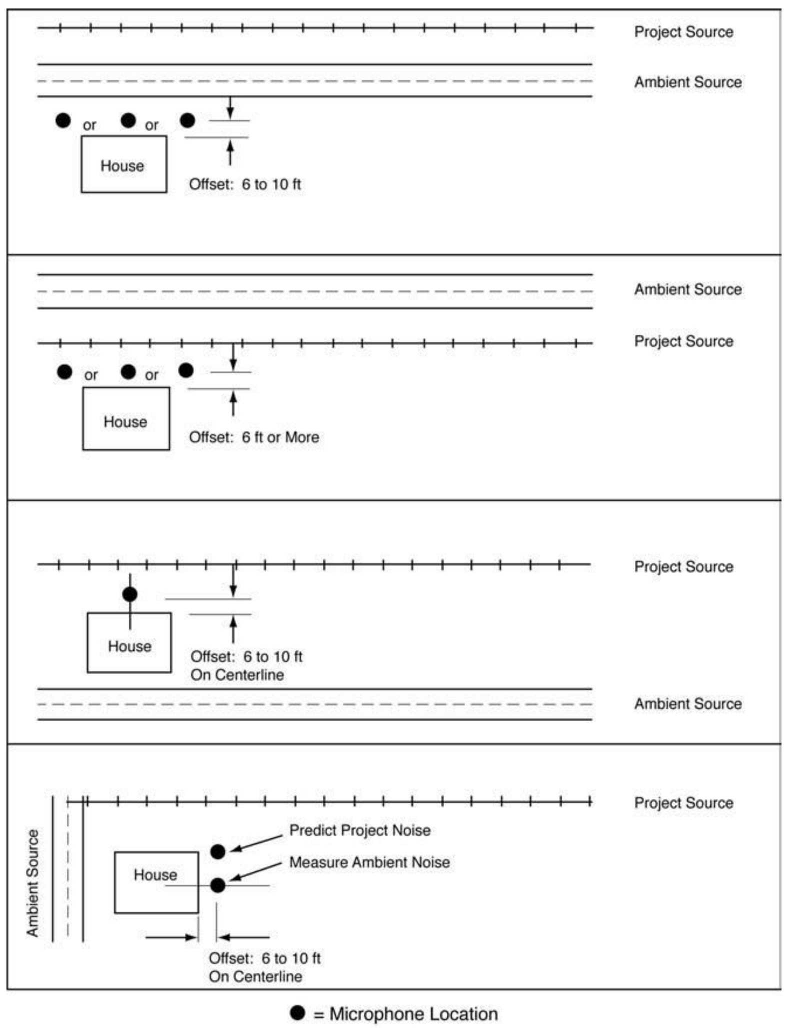
A [illegible]

$L_{eq.LightRail}$ [illegible] A

$L_{dn.LightRail}$

$$
\begin{aligned}
L_{eq.total} &= 10\log(10^{(72/10)} + 10^{(69/10)}) \\
&= 73.8 \\
L_{dn.total} &= 10\log(10^{(68/10)} + 10^{(70/10)}) \\
&= 72.1
\end{aligned}
$$

Choose the appropriate method for characterizing noise and then determine the existing noise at each identified noise-sensitive receiver.


Project Source
Ambient Source
or
or
House
Offset: 6 to 10 ft
Ambient Source
Project Source
or
or
House
Offset: 6 ft or More
Project Source
House
Offset: 6 to 10 ft
On Centerline
Ambient Source
Project Source
Ambient Source
Predict Project Noise
Measure Ambient Noise
House
Offset: 6 to 10 ft
On Centerline
= Microphone Location

[illegible]
— [illegible]
[illegible]
[illegible] [illegible] d [illegible]
[illegible]
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[illegible]
[illegible]

[illegible] — [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

require FHWA's noise

to inform FTA's evaluation

HWA's Traffic Noise M

[illegible]

[illegible] (3) [illegible]

[illegible] — [illegible]

[illegible] — [illegible]

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[illegible]		[illegible]
[illegible] †		[illegible]
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	[illegible]	0 -[illegible]
[illegible] *		6-[illegible]
[illegible] *		[illegible]
[illegible] Fa[illegible] Di[illegible] Fa[illegible] P[illegible]		[illegible]
[illegible] R[illegible] Sy[illegible] *		[illegible]
R[illegible] R[illegible] *		[illegible]
[illegible]		0 [illegible]
[illegible] G[illegible] *		[illegible]
[illegible] *		[illegible]
[illegible] -[illegible] *		[illegible]
[illegible]		6-[illegible]
[illegible]		[illegible]

† [illegible] — [illegible]

* [illegible].

[illegible].

- [illegible]
  - [illegible] – [illegible]
    [illegible]

    [illegible]
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    [illegible] s [illegible]
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  - [illegible] – [illegible]
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and vibration levels at a “like-new” level o

[illegible]

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[illegible] (3) [illegible] a

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[illegible]

[illegible] (2) [illegible]
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  [illegible] (3) [illegible]

[illegible]

[illegible] (iv) [illegible]

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- [illegible]
- [illegible]
  - [illegible]

[illegible]

[illegible]

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iv [illegible]

[illegible]

[illegible]	[illegible]
[illegible]	6-[illegible]
[illegible]	3-5 [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible] *	[illegible]
[illegible] *	[illegible]
[illegible]	[illegible]
[illegible]	[illegible] 4-[illegible]

* [illegible]

[illegible]

[illegible] B [illegible]

[illegible] t. [illegible] a [illegible]

[illegible] (8) [illegible]

[illegible], [illegible] a [illegible]

- [illegible] — [illegible] n a [illegible] 6 [illegible]

- [illegible] — [illegible] e [illegible]

[illegible]

[illegible]

- [illegible]

- [illegible]

- [illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	5-[illegible]
[illegible]	5-[illegible]

- [illegible]

closest to either the source or the receiver. See Section 3.3 for more information on noise barriers.

- **Building Insulation** – In cases where noise barriers are not feasible—such as multi-story buildings, buildings very close to the ROW, or grade crossings—the only practical noise mitigation measure may be to provide sound insulation for the buildings. In these cases, the need for mitigation at locations where impact has been identified will depend on the use (outdoor vs. indoor), any existing outdoor to indoor reduction in noise levels, and the feasibility of constructing effective noise barriers for second stories and above.

  Depending on the quality of the original building façade, especially windows and doors, sound insulation treatments can improve the noise reductions from transit noise by 5 to 20 dB. To be considered cost-effective, a treatment should provide a minimum reduction of 5 dB in the interior of the building and meet the L_{dn} 45 dBA interior criterion. For more information, see Section 4.1.

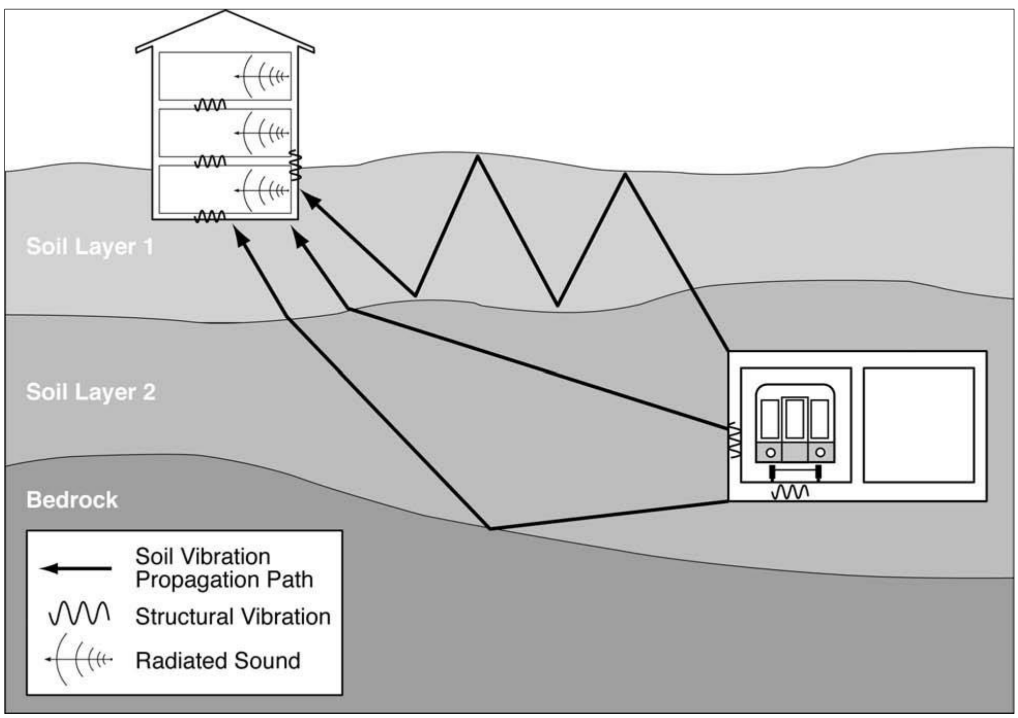
  In many cases, especially in locations with high ambient noise levels, the existing sound insulation of a building may already meet the 45 dBA L_{dn} interior noise criterion. It is recommended that sound insulation testing be conducted to determine if the existing sound insulation is sufficient or what additional measures would be required to meet the interior criterion. Effective treatments include:
  - Caulking and sealing gaps in the building façade; and
  - Installation of new doors and windows that are specially designed to meet acoustical transmission-loss requirements:
    - Exterior doors facing the noise source should be replaced with well-gasketed, solid-core wood doors and well-gasketed storm doors.
    - Acoustical windows are typically made of multiple layers of glass with air spaces between to provide noise reduction. Acoustical performance ratings are published in terms of Sound Transmission Class (STC) for these windows. It is recommended to use a minimum STC rating of 39 on any window exposed to the noise source.

  These treatments are beneficial for heat insulation as well as for sound insulation, but acoustical windows are typically non-operable and central ventilation or air conditioning is needed. Residents' preferences should be considered.

  If needed, additional building sound insulation can be provided by sealing vents and ventilation openings and relocating them to a side of the building away from the noise source. In cases where the noise sources is low-frequency noise from diesel locomotives, it may be necessary to increase the mass of the building façade for wood-frame houses by adding a layer of sheathing to the exterior walls.

5

simple “vibration,” and low



- [illegible]
- [illegible]

5 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
A-[illegible]	[illegible]	A-[illegible]

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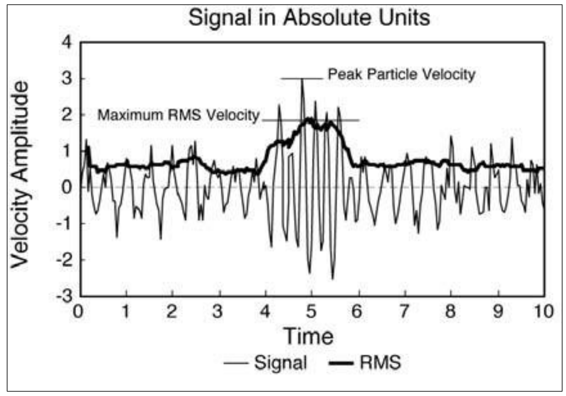
- [illegible]
- [illegible]
- [illegible]

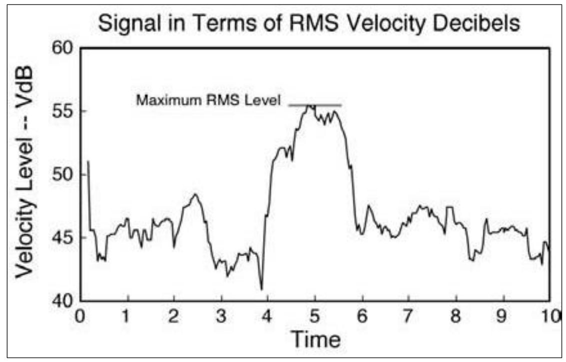


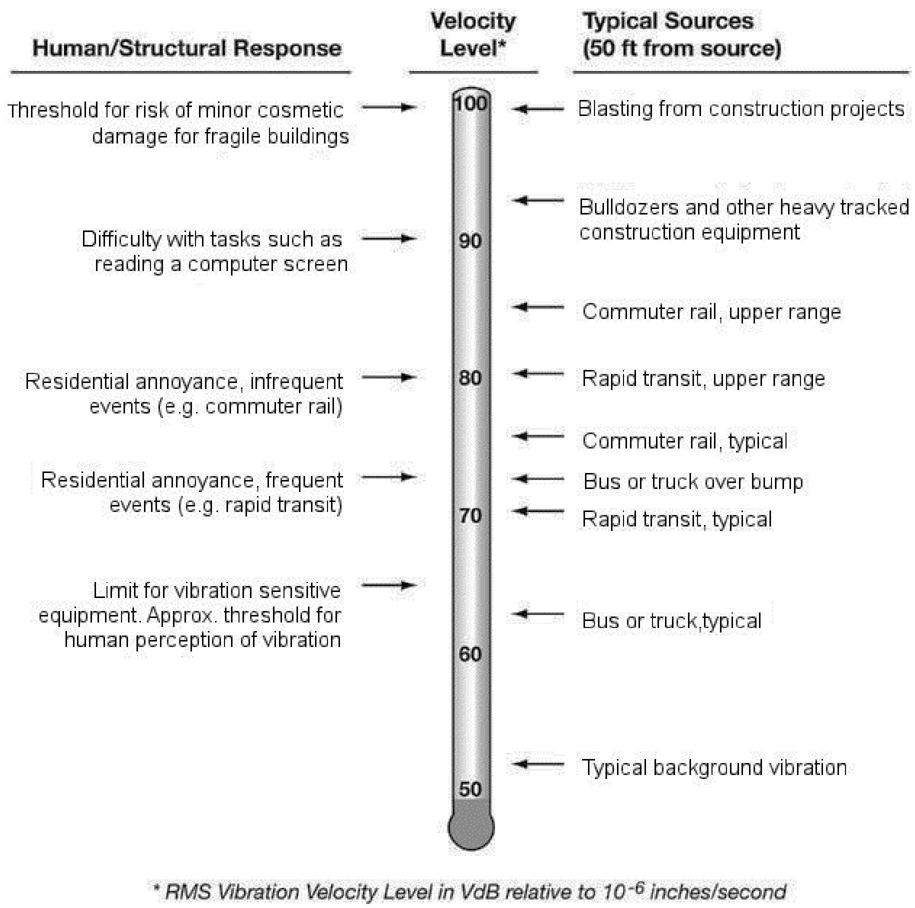
$$L_v = 20 \log\left(\frac{v}{v_{ref}}\right) \qquad (5\text{-}1)$$

L_v

v

v_{ref}


Signal in Terms of RMS Velocity Decibels
Velocity Level -- VdB
Maximum RMS Level
60
55
50
45
40
0
1
2
3
4
5
6
7
8
9
10
Time


Human/Structural Response
Velocity Level*
Typical Sources (50 ft from source)
Threshold for risk of minor cosmetic damage for fragile buildings
Difficulty with tasks such as reading a computer screen
Residential annoyance, infrequent events (e.g. commuter rail)
Residential annoyance, frequent events (e.g. rapid transit)
Limit for vibration sensitive equipment. Approx. threshold for human perception of vibration
100
90
80
70
60
50
Blasting from construction projects
Bulldozers and other heavy tracked construction equipment
Commuter rail, upper range
Rapid transit, upper range
Commuter rail, typical
Bus or truck over bump
Rapid transit, typical
Bus or truck,typical
Typical background vibration
* RMS Vibration Velocity Level in VdB relative to 10-6 inches/second

[illegible]
[illegible]
[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible] ▪ [illegible] ▪ [illegible] ▪ [illegible]

[illegible]

[illegible]

[illegible]

[illegible] the FRA “High-Speed Ground Transportation Noise and Vibration Impact Assessment” [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

3 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

4 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

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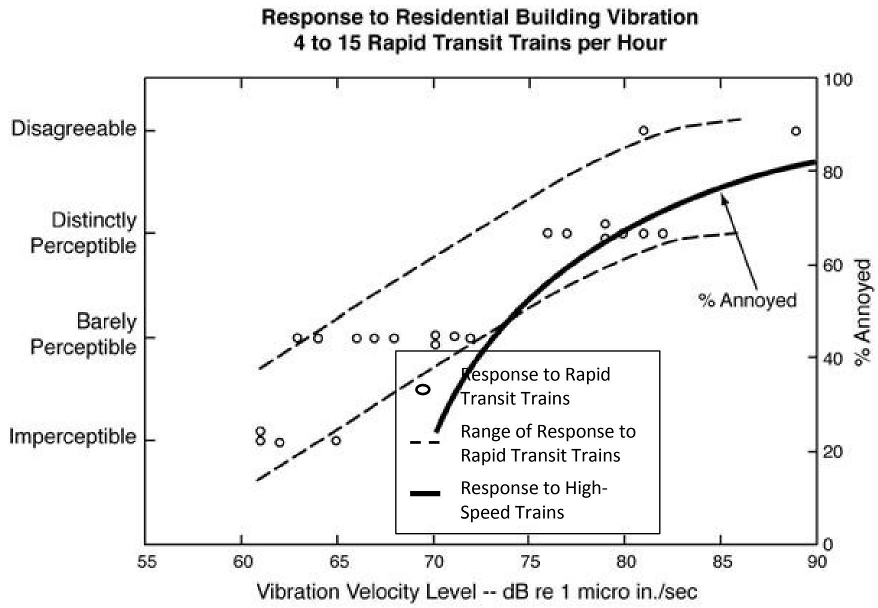
[illegible]

2 acknowledges that "human response to vibration in buildings is very complex." It further indicates that the degree of



Response to Residential Building Vibration
4 to 15 Rapid Transit Trains per Hour
Disagreeable
Distinctly Perceptible
Barely Perceptible
Imperceptible
% Annoyed
Response to Rapid Transit Trains
Range of Response to Rapid Transit Trains
Response to High-Speed Trains
55
60
65
70
75
80
85
90
Vibration Velocity Level -- dB re 1 micro in./sec
100
80
60
40
20
0
% Annoyed

[illegible]

[illegible]	[illegible]		[illegible]
	[illegible]	[illegible] *	
[illegible]	[illegible]	[illegible]	[illegible] : [illegible] . Mid -[illegible] : [illegible] [illegible] .
[illegible]	[illegible]	[illegible]	[illegible] e: [illegible] . Mid -[illegible] : [illegible] .
[illegible]	[illegible]	[illegible]	[illegible] . Mid - [illegible] : [illegible] .

*[illegible]

* [illegible]

6

standards.[46][47]

Conduct the vibration screening procedure and then determine the appropriate vibration analysis option:

Determine the appropriate land use category for the receiver of vibration impacts of the project or project segment.

-	[illegible]	[illegible]
1	[illegible]	[illegible] l research operations. The building's degree of sensitivity to vibration is [illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]

[illegible]

Determine the appropriate frequency of events for the project or project segment.

[illegible]

[illegible]	[illegible]			[illegible]		
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]*	[illegible]*	[illegible]*	[illegible]*	[illegible]*	[illegible]*
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* [illegible] manufacturer's [illegible]

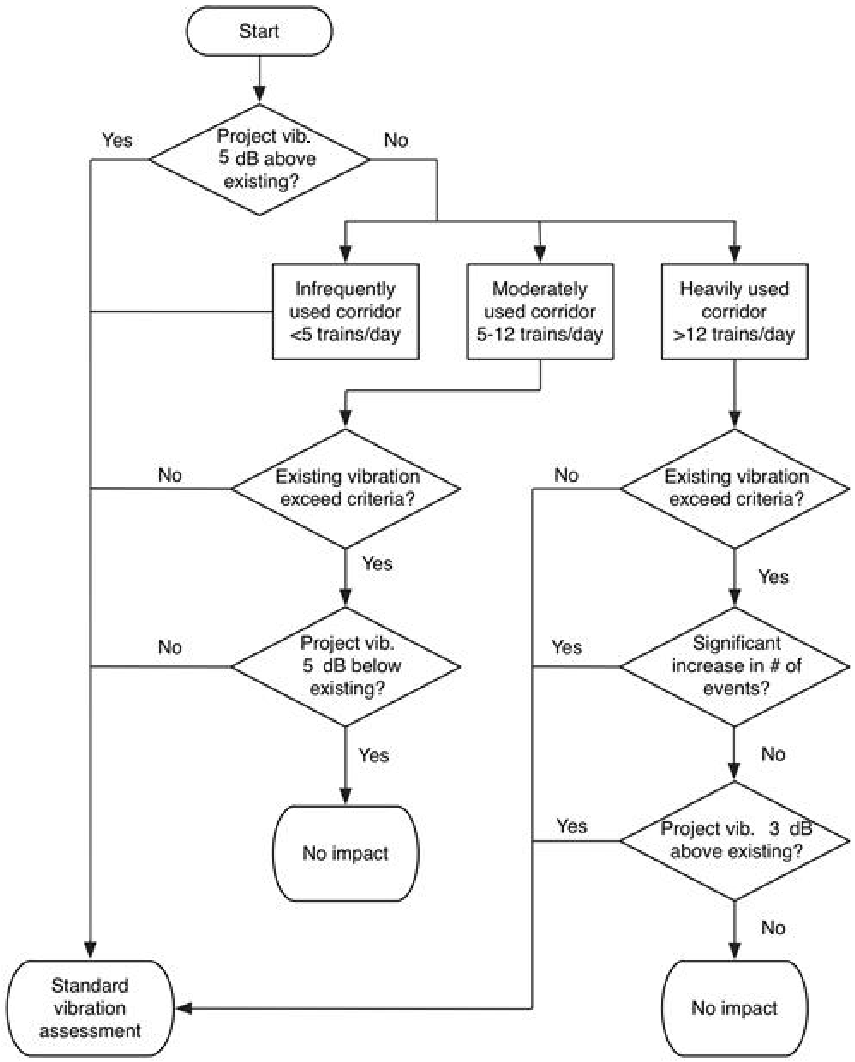
[illegible]

[illegible]	[illegible]		[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible] ([illegible] – [illegible])	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	5 – [illegible]	[illegible]
[illegible]	[illegible]	[illegible]

* [illegible]

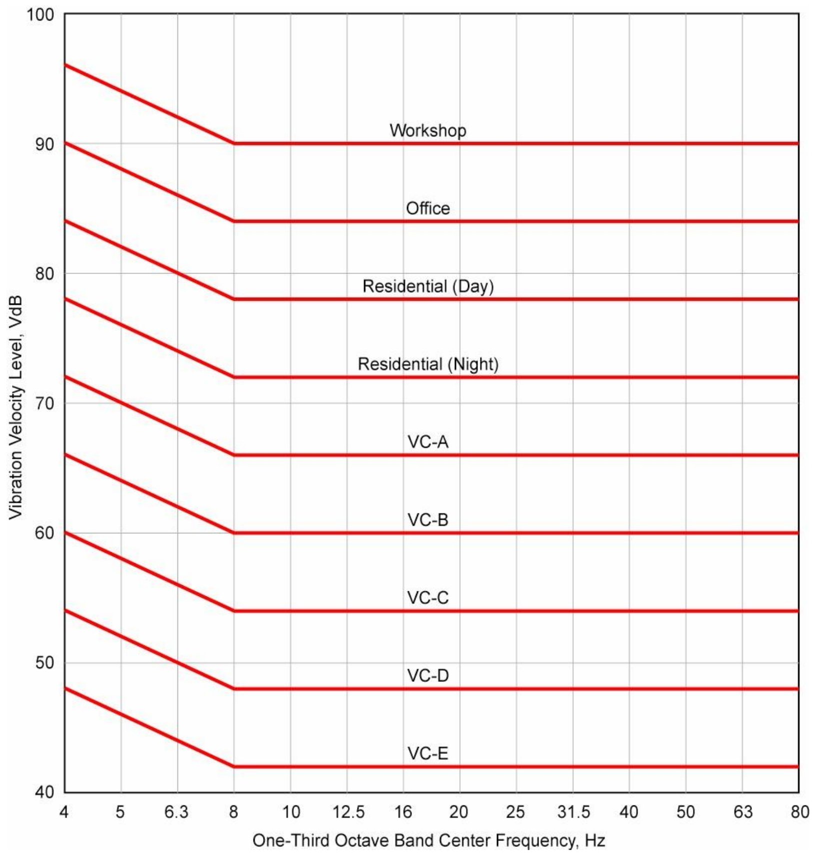


[illegible] [k] [illegible]

[illegible]

[k] Vibration is abbreviated as "vib." in this flowchart.

Choose the appropriate criteria based on Figure 6-2 and Table 6-6.



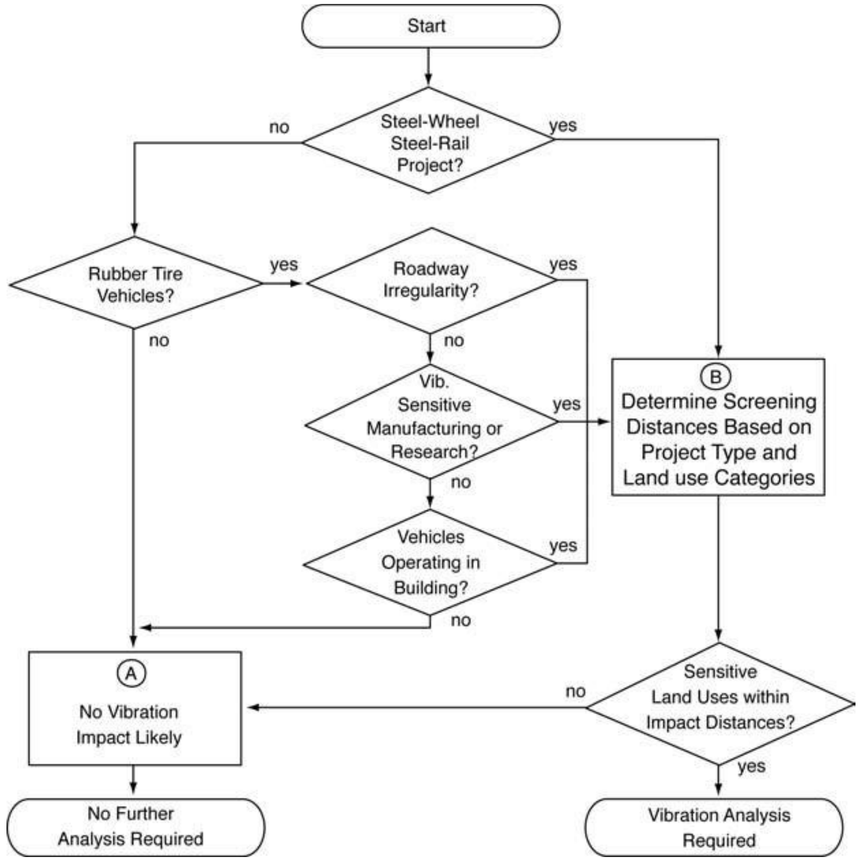
[illegible]

[illegible]

[illegible]	[illegible] ,*	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
VC-A	[illegible]	[illegible]
VC-B	[illegible]	[illegible]
VC-C	[illegible]	[illegible]
VC-D	[illegible]	[illegible]
VC-E	[illegible]	[illegible]

* [illegible]

Determine the potential for impact using the Vibration Screening Procedure by identifying any vibration-sensitive land uses (Table 6-1) within the appropriate screening distance.



Determine the project type and the next step based on the guidelines below.

–

.

d

proceed to Step 2.

; *proceed to Step 2*

. *Proceed to Step 2*

Determine the project type according to Table 6-7.

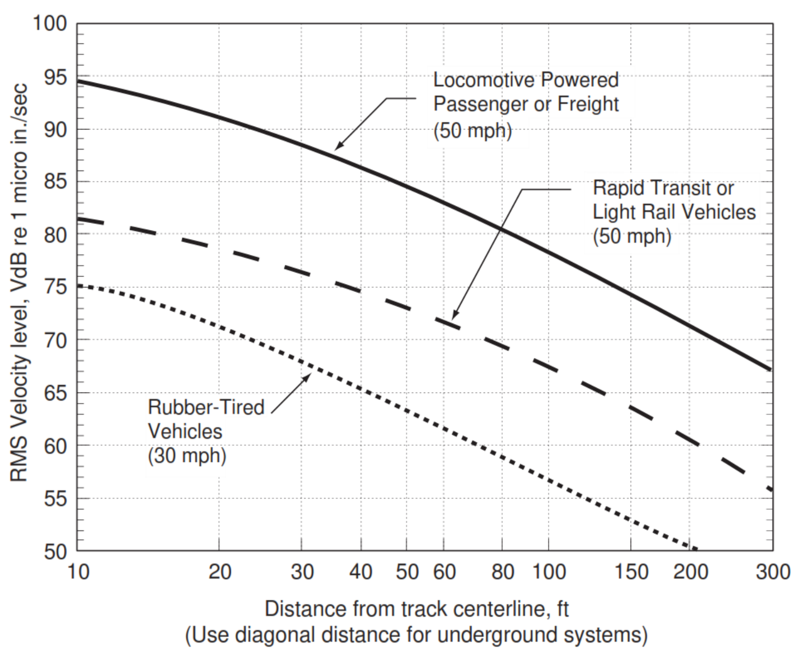
[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]

Determine the appropriate screening distances based on land use and project type according to Table 6-8.

[illegible]	[illegible]		
	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	-

Evaluate for impact using the General Vibration Assessment procedure if the Vibration Screening Procedure (Section 6.3) identified vibration-sensitive receivers within the screening distance of the transit vibration source.

Select a standard vibration curve to represent general vibration characteristics for the source.



Locomotive Powered
Passenger or Freight
(50 mph)
Rapid Transit or
Light Rail Vehicles
(50 mph)
Rubber-Tired
Vehicles
(30 mph)
RMS Velocity level, VdB re 1 micro in./sec
100
95
90
85
80
75
70
65
60
55
50
10
20
30
40
50
60
80
100
150
200
300
Distance from track centerline, ft
(Use diagonal distance for underground systems)

[illegible]	[illegible]	
[illegible]	$L_v = 92.28 + 14.81\log(D) - 14.17\log(D)^2 + 1.65\log(D)^3$	[illegible] 6-1
[illegible]	$L_v = 85.88 - 1.06\log(D) - 2.32\log(D)^2 - 0.87\log(D)^3$	[illegible] 6-2
[illegible]	$L_v = 66.08 + 34.28\log(D) - 30.25\log(D)^2 + 5.40\log(D)^3$	[illegible] 6-3
L_v = [illegible] D = [illegible]		

[illegible]

Apply project-specific adjustments to the standard vibration curve.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] 6-4.
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible] 20	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

In addition to the comments in Table 6-11, use the following guidelines to select the appropriate adjustment factors. Some adjustments in the same category are not cumulative (additive) and only the greatest applicable adjustment should be applied. The adjustments that are not additive are noted in Table 6-11 and in the descriptions below. Note that some adjustments are not additive across multiple categories and are noted in the comments of Table 6-11. For example, the adjustment for a vehicle with stiff primary suspension is 8 dB, and the adjustment for wheel flats is 10 dB. If the vehicle has a stiff primary suspension and has wheel flats, the projected vibration levels should be increased by 10 dB, not 18 dB.

In addition, some vibration control measures are targeted for specific frequency ranges. The shape of the actual vibration spectra should be considered so that an appropriate vibration control measure may be selected.

- **Speed** – The levels of ground-borne vibration and noise vary, approximately, as 20 times the logarithm of speed. This means that doubling train speed will increase the vibration levels approximately 6 dB, and halving train speed will reduce the levels by 6 dB. The adjustments in Table 6-11 have been tabulated for reference vehicle speeds of 30 mph for rubber-tired vehicles and 50 mph for steel-wheel vehicles. Use the following relationship to calculate the adjustments for other speeds.

  $$Adj_{speed}\,(dB) = 20\log\left(\frac{speed}{speed_{ref}}\right) \qquad \textbf{Eq. 6-4}$$

  Variation with speed has been observed to be as low as $15\log\left(\frac{speed}{speed_{ref}}\right)$, but unless specific speed data for vibration for a vehicle has been obtained, use Eq. 6-4.

- **Vehicle Parameters** – The most important factors for the vehicles are the suspension system, wheel condition, and wheel type. Most new heavy rail and light rail vehicles have relatively soft primary suspensions. However, a stiff primary suspension (vertical resonance frequency greater than 15 Hz) can result in higher levels of ground-borne vibration than soft primary suspensions. Vehicles, for which the primary suspension consists of rubber or neoprene around the axle bearing, usually have a very stiff primary suspension with a vertical resonance frequency greater than 40 Hz or more.

  Deteriorated wheel condition is another factor that increases vibration levels. It can be assumed that a new system has vehicles with wheels in good condition. When older vehicles are used on new track, it is important to consider the condition of the wheels, and it may be appropriate to include an adjustment for the wheel condition.

  Resilient wheels will reduce vibration levels at frequencies greater than the effective resonance frequency of the wheel. When this resonance

[illegible]

[illegible] 2 [illegible] [illegible]

[illegible]	[illegible]			[illegible]
[illegible]	-[illegible]			[illegible]
[illegible]				
[illegible]	[illegible]		-[illegible]	[illegible]
	[illegible]		-[illegible]	
	[illegible]		-[illegible]	
[illegible]				
[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	Di[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	-[illegible]		h [illegible]

[illegible]

- [illegible] — [illegible]

[illegible]

[illegible]

- [illegible]
  - [illegible]
    - [illegible]
    - [illegible]
- A [illegible]

[illegible]

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- [illegible]
- [illegible]
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[illegible]

[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]	[illegible] *
[illegible]	[illegible]		[illegible]

* [illegible]

[illegible]

- [illegible]
- [illegible] 5 B 6 [illegible] 2 B [illegible] B .

[illegible]

[illegible] 4 [illegible]

[illegible]			-[illegible]
[illegible]	[illegible]		[illegible]
	[illegible]	-B	[illegible]
	[illegible]	-B	[illegible]
	[illegible]	-B	[illegible]

[illegible]

[illegible] 6

[illegible]

Take inventory of vibration-sensitive land uses with impact and determine if a Detailed Vibration Analysis is required.

L_v).

6-9

$L_v = 65\ VdB$

6-1 .

$$Source\ Speed\ Adjustment = 20\log\left(\frac{40}{50}\right) = -1.9\ dB$$

$$L_v = 65 - 1.9 = 63.1\ VdB$$

[illegible] 2

$$Efficient\ propagation = +10\ dB$$

$$Coupling\ to\ building\ foundation\ (wood\ frame) = -5\ dB$$

$$L_v = 63.1 + 10 - 5 = 68.1\ VdB$$

[illegible] 3 .

$$Amplification\ due\ to\ resonance\ of\ floor = +6\ dB$$

$$First\ floor\ attenuation = -2\ dB$$

$$L_v = 68.1 + 6 - 2 = 72.1\ VdB$$

[illegible] 6-2) [illegible] 6-3). [illegible]

6 [illegible]

Evaluate for impact using the Detailed Vibration Analysis procedure, if appropriate (Section 6.1).

[illegible]

[illegible]

Conduct measurements to survey and document the existing vibration conditions.

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible] (5) [illegible]

[illegible]

[illegible]

[illegible]

- [illegible] – [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]

- [illegible] – [illegible]
  - [illegible]
  - [illegible]

  [illegible]

  [illegible]

- [illegible] – [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]

Estimate ground-borne vibration and noise at sites where significant impact is probable and assess for impact.

[illegible]

[illegible]

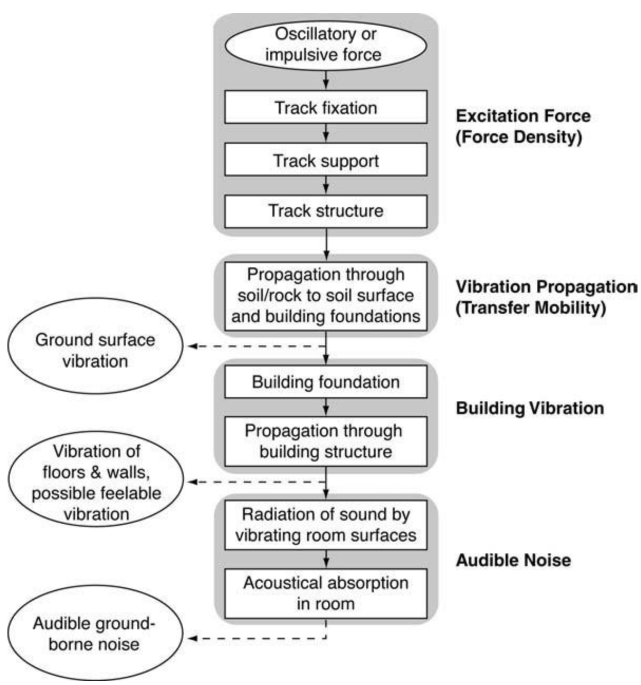
[illegible]

[illegible]

- [illegible]

  [illegible]

- [illegible]



Oscillatory or impulsive force
Track fixation
Track support
Track structure
Excitation Force (Force Density)
Propagation through soil/rock to soil surface and building foundations
Vibration Propagation (Transfer Mobility)
Ground surface vibration
Building foundation
Propagation through building structure
Building Vibration
Vibration of floors & walls, possible feelable vibration
Radiation of sound by vibrating room surfaces
Acoustical absorption in room
Audible Noise
Audible ground-borne noise

$$L_v = FDL + LSTM + C_{build}$$ **6-5**

$$L_A = L_v + K_{rad} + K_{A-wt}$$ **6-6**

where:

L_v =

FDL =

$LSTM$ =

C_{build}

L_A

K_{rad}

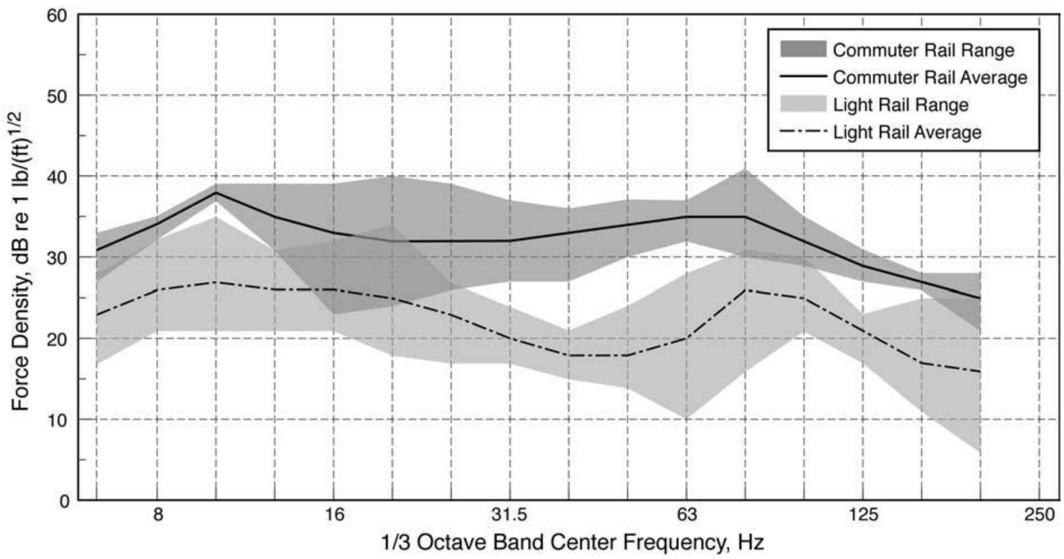
K_{A-wt}

$$FDL = L_v - LSTM \qquad (6\text{-}7)$$

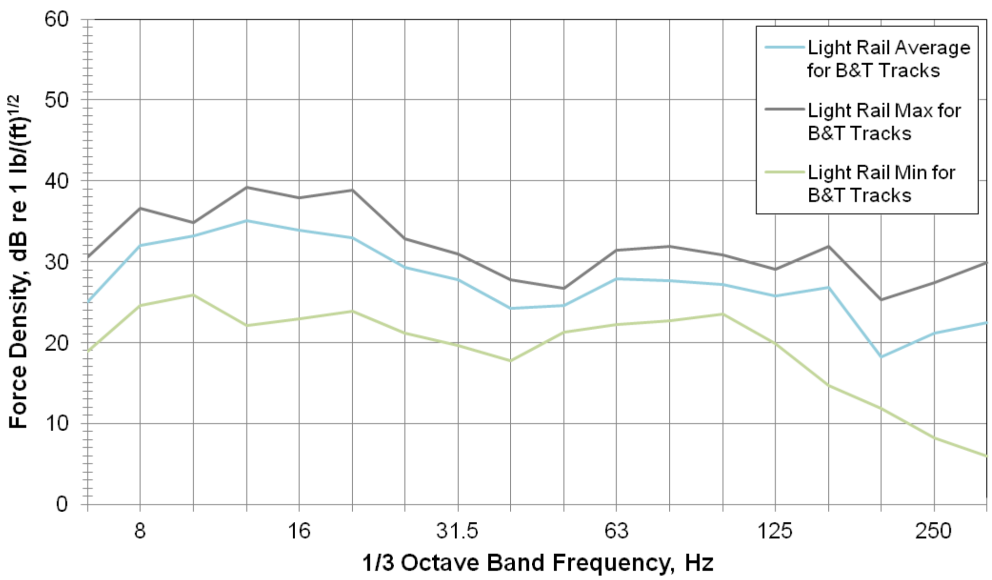
FDL

L_v

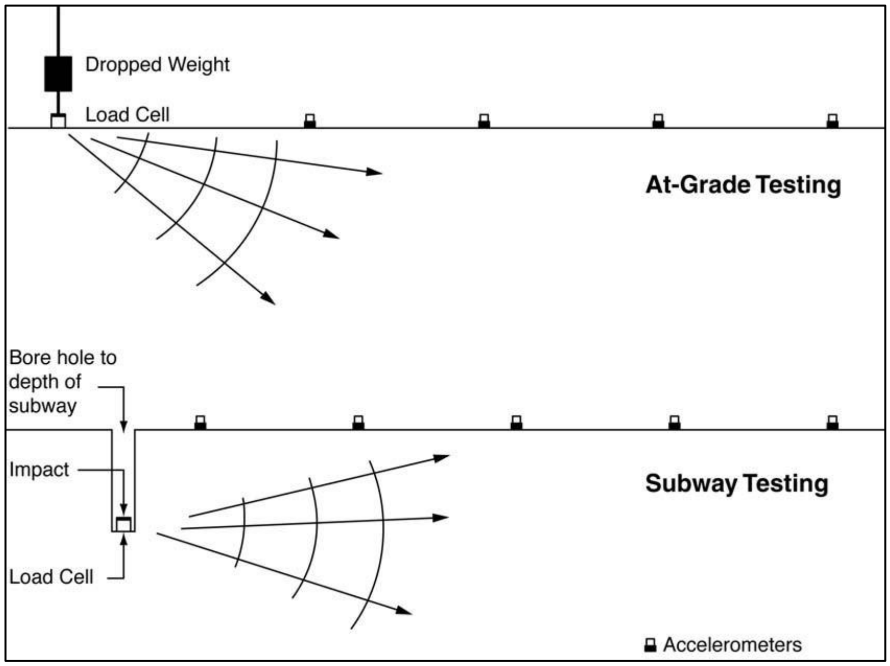
$LSTM$

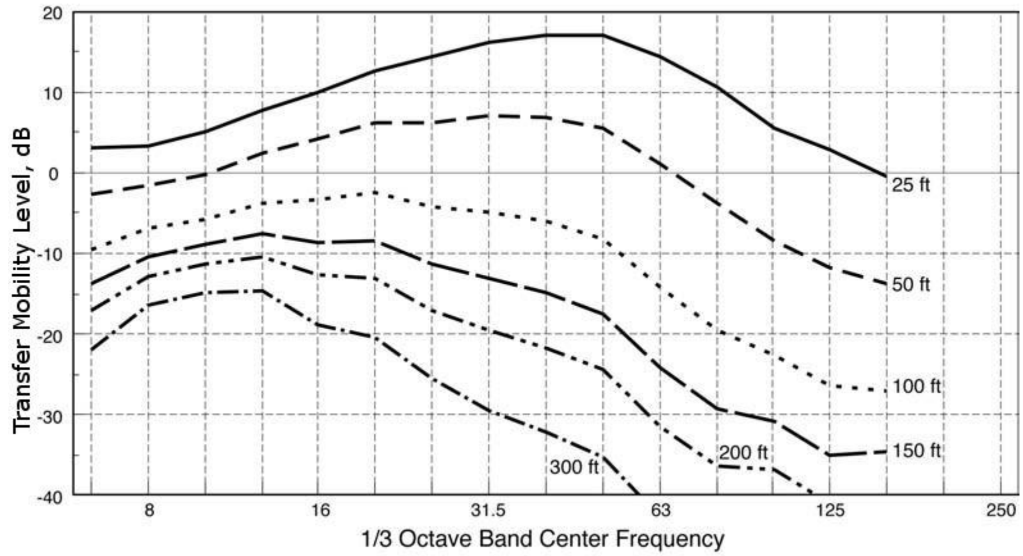


Commuter Rail Range
Commuter Rail Average
Light Rail Range
Light Rail Average
Force Density, dB re 1 lb/(ft)$^{1/2}$
1/3 Octave Band Center Frequency, Hz
0
10
20
30
40
50
60
8
16
31.5
63
125
250

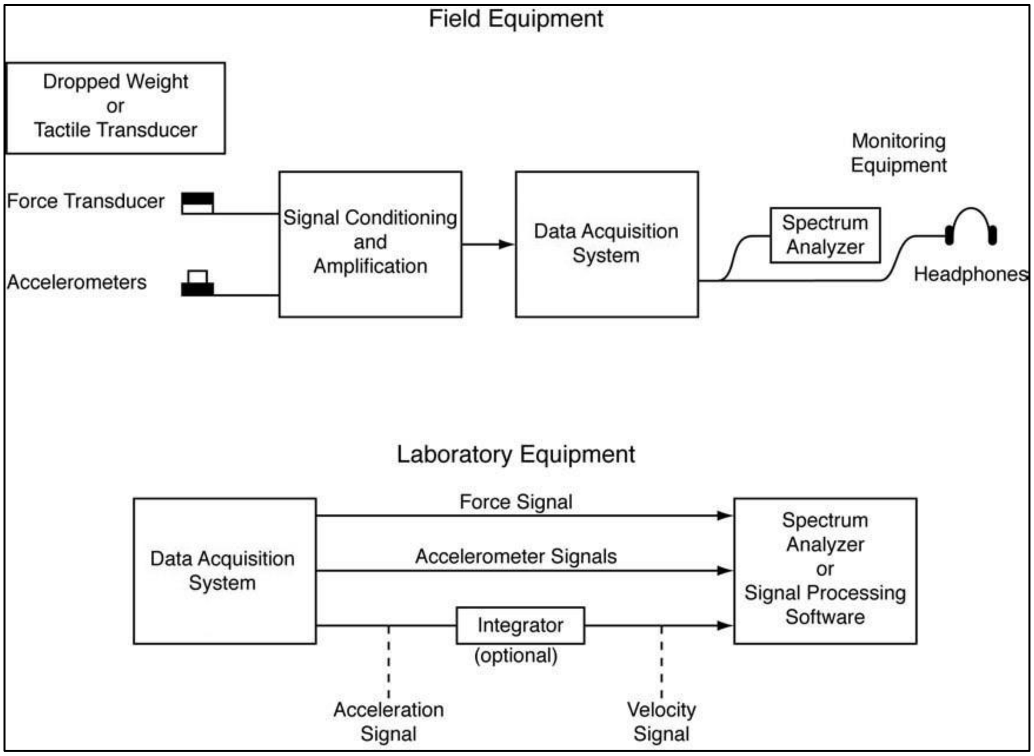


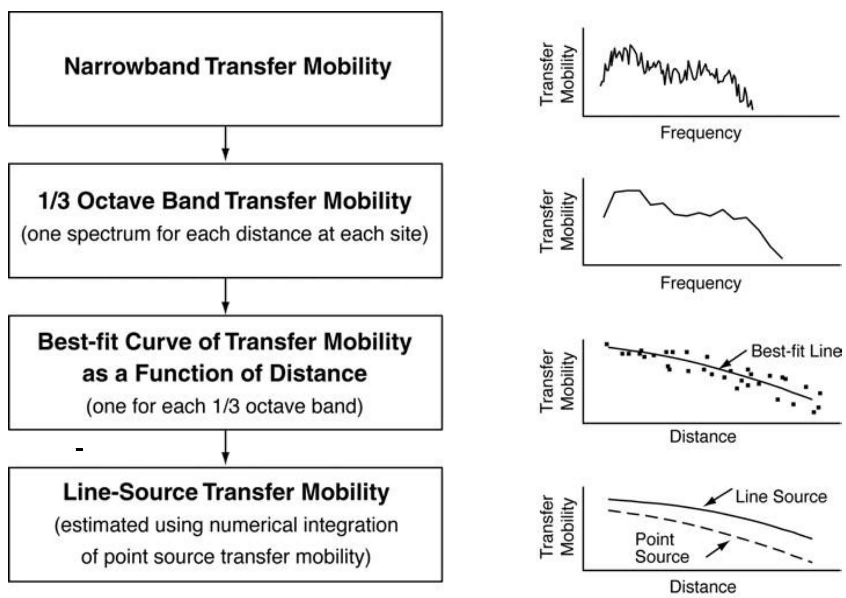
Light Rail Average for B&T Tracks
Light Rail Max for B&T Tracks
Light Rail Min for B&T Tracks
Force Density, dB re 1 lb/(ft)$^{1/2}$
1/3 Octave Band Frequency, Hz
0
10
20
30
40
50
60
8
16
31.5
63
125
250


Dropped Weight
Load Cell
At-Grade Testing
Bore hole to depth of subway
Impact
Load Cell
Subway Testing
Accelerometers



Transfer Mobility Level, dB
1/3 Octave Band Center Frequency
20
10
0
-10
-20
-30
-40
8
16
31.5
63
125
250
25 ft
50 ft
100 ft
150 ft
200 ft
300 ft


Field Equipment
Dropped Weight
or
Tactile Transducer
Force Transducer
Accelerometers
Signal Conditioning
and
Amplification
Data Acquisition
System
Monitoring
Equipment
Spectrum
Analyzer
Headphones
Laboratory Equipment
Data Acquisition
System
Force Signal
Accelerometer Signals
Integrator
(optional)
Acceleration
Signal
Velocity
Signal
Spectrum
Analyzer
or
Signal Processing
Software



Narrowband Transfer Mobility
1/3 Octave Band Transfer Mobility
(one spectrum for each distance at each site)
Best-fit Curve of Transfer Mobility as a Function of Distance
(one for each 1/3 octave band)
Line-Source Transfer Mobility
(estimated using numerical integration of point source transfer mobility)
Transfer Mobility
Frequency
Transfer Mobility
Frequency
Transfer Mobility
Best-fit Line
Distance
Transfer Mobility
Line Source
Point Source
Distance

“A Prediction Procedure for Rail Transp

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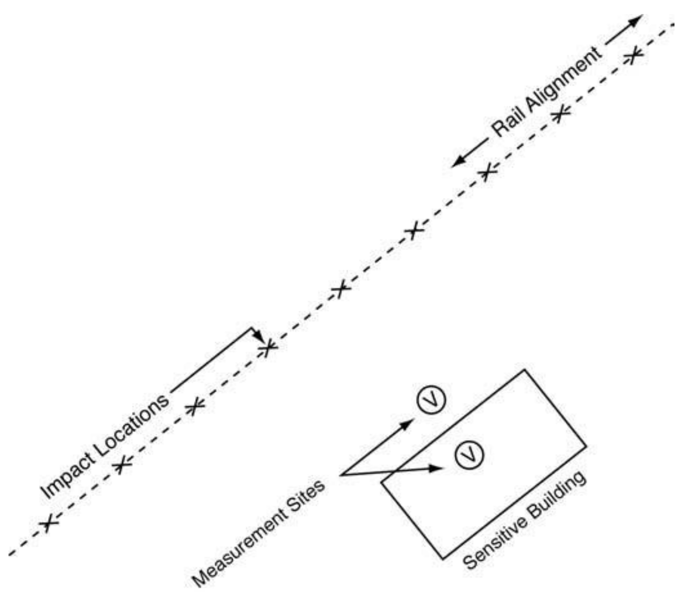
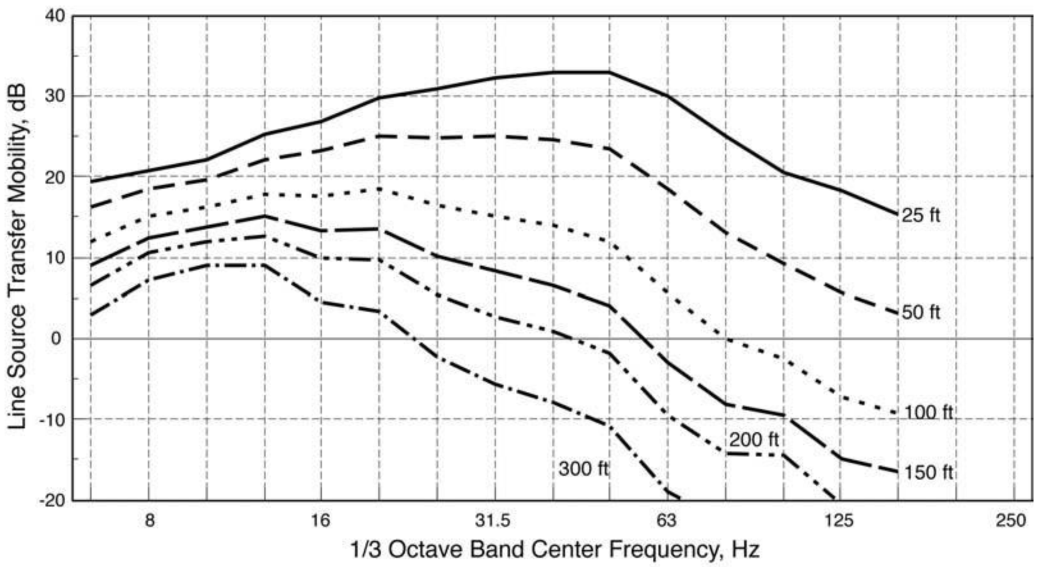


Simpson’s rule is a method for approximating


Line Source Transfer Mobility, dB
40
30
20
10
0
-10
-20
8
16
31.5
63
125
250
1/3 Octave Band Center Frequency, Hz
25 ft
50 ft
100 ft
150 ft
200 ft
300 ft

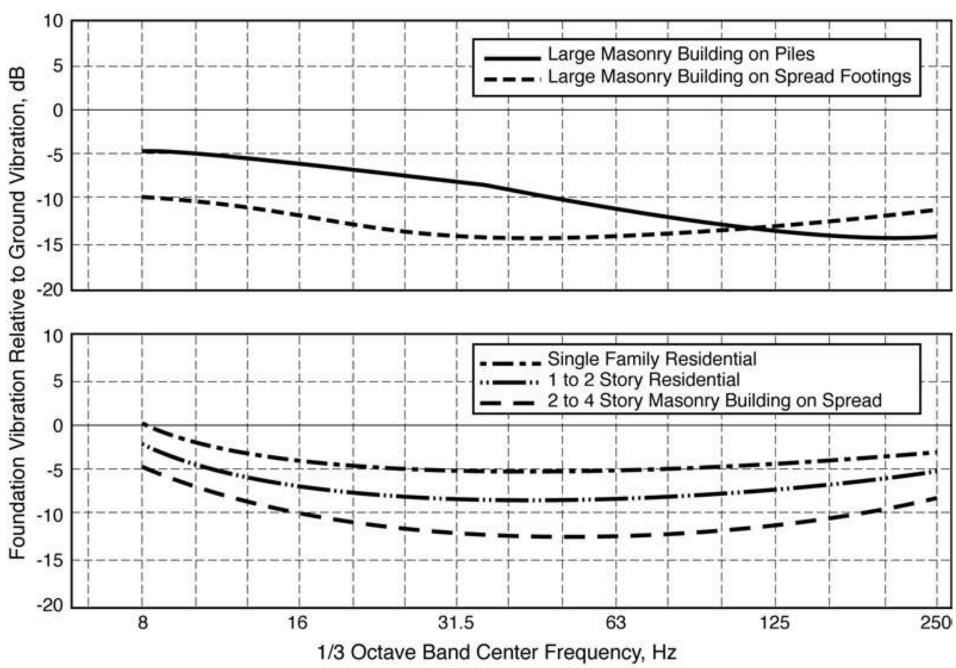
$$L_A \approx L_V + K_{A-wt} - 5 \qquad \text{6-8}$$

where

L_A = A-

L_v

K_{A-wt} A



Take inventory of vibration-sensitive land uses with impact.

Select practical vibration control measures that will be effective at the dominant vibration frequencies and compatible with the given transit structure and track support system.

noise and vibration levels at a “like-new” level or reduce both in

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Determine the appropriate level of assessment based on the scale and type of the project and depending on the stage of environmental review.

Use a qualitative construction noise assessment to estimate construction noise for appropriate projects per Section 7.1, Step 1b.

Po

Use a quantitative construction noise assessment to estimate construction noise for appropriate projects per Section 7.1, Step 1b.

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$$L_{eq.equip} = L_{emission} + 10\log(Adj_{Usage}) - 20\log(\frac{D}{50}) - 10G\log(\frac{D}{50})$$

wh :

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screening tool, "Ro ,"

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($L_{dn.equip(30day)}$)

Compare the predicted noise levels from the Quantitative Construction Noise Assessment with impact criteria to assess impact from construction noise for each phase of construction.

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Evaluate the need for mitigation and select appropriate mitigation measures.

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Determine the appropriate level of assessment based on the scale and type of the project and the stage of environmental review.

Use a qualitative construction vibration assessment to estimate vibration for appropriate projects per Section 7.2, Step 1b.

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Use a quantitative construction vibration assessment to estimate vibration for appropriate projects per Section 7.2, Step 1b.

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$$PPV_{equip} = PPV_{ref} \times (\frac{25}{D})^{1.5}$$

PPV_{equip}

PPV_{ref}

D

$$L_{v.distance} = L_{vref} - 30log(\frac{D}{25}) \quad \text{7-3}$$

where:

$L_{v.distance}$

L_{vref}

D

Compare the predicted vibration levels from the Quantitative Construction Vibration Assessment with impact criteria to assess impact from construction vibration.

Table 7-5 Construction Vibration Damage Criteria

Building/ Structural Category	PPV, in/sec	Approximate L_v*
I. Reinforced-concrete, steel or timber (no plaster)	0.5	102
II. Engineered concrete and masonry (no plaster)	0.3	98
III. Non-engineered timber and masonry buildings	0.2	94
IV. Buildings extremely susceptible to vibration damage	0.12	90

*RMS velocity in decibels, VdB re 1 micro-in/sec

Compare the L_v determined in Section 7.2, Step 3 to the criteria for the General Vibration Assessment in Section 6.2 to assess annoyance or interference with vibration-sensitive activities due to construction vibration.

Step 5: Determine Construction Vibration Mitigation Measures

Evaluate the need for mitigation and select appropriate mitigation measures where potential human impacts or building damage from construction vibration have been identified according to Section 7.2, Step 4.

5a. Determine the appropriate approach for construction vibration mitigation considering equipment location and processes.

- **Design considerations and project layout**
  - Route heavily-loaded trucks away from residential streets. Select streets with the fewest homes if no alternatives are available.
  - Operate earth-moving equipment on the construction lot as far away from vibration-sensitive sites as possible.

- **Sequence of operations**
  - Phase demolition, earth-moving, and ground-impacting operations so as not to occur in the same time period. Unlike noise, the total vibration level produced could be substantially less when each vibration source operates separately.
  - Avoid nighttime activities. Sensitivity to vibration increases during the nighttime hours in residential neighborhoods.

- **Alternative construction methods**
  - Carefully consider the use of impact pile-driving versus drilled piles or the use of a sonic/vibratory pile driver or push pile driver where those processes might create lower vibration levels if geological conditions permit their use.
    - Pile-driving is one of the greatest sources of vibration associated with equipment used during construction of a project. The source levels in Table 7-4 indicate that sonic pile drivers may provide substantial reduction of vibration levels compared to impact pile drivers. But, there are some additional vibration effects of sonic pile drivers that may limit their use in sensitive locations.
    - A sonic pile driver operates by continuously shaking the pile at a fixed frequency, literally vibrating it into the ground. Continuous operation at a fixed frequency may, however, be more

noticeable to nearby residents, even at lower vibration levels. Furthermore, the steady-state excitation of the ground may induce a growth in the resonant response of building components. Resonant response may be unacceptable in cases of fragile buildings or vibration-sensitive manufacturing processes. Impact pile drivers, however, produce a high vibration level for a short time (0.2 seconds) with sufficient time between impacts to allow any resonant response to decay.

- Select demolition methods involving little to no impact, where possible. For example, sawing bridge decks into sections that can be loaded onto trucks results in lower vibration levels than impact demolition by pavement breakers. Milling generates lower vibration levels than excavation using clam shell or chisel drops.
- Avoid vibratory rollers and packers near sensitive areas.

5b. Describe and commit to a mitigation plan that will be developed and implemented during the engineering and construction phase when the information available during the project development phase will not be sufficient to define specific construction vibration mitigation measures. The objective of the plan should be to minimize construction vibration damage using all reasonable and feasible means available. The plan should include the following components:

- A procedure for establishing threshold and limiting vibration values for potentially affected structures, based on an assessment of each structure's ability to withstand the loads and displacements due to construction vibrations
- A commitment to develop a vibration monitoring plan during the engineering phase and to implement a compliance monitoring program during construction

8

Choose the appropriate noise and vibration analysis information to include based on the level of environmental review and the associated documentation.

Include information in the following sections of the environmental document separating out the noise and vibration information.

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The loudness of a sound is described by the sound wave's amplitude of pressure fluctuations above and

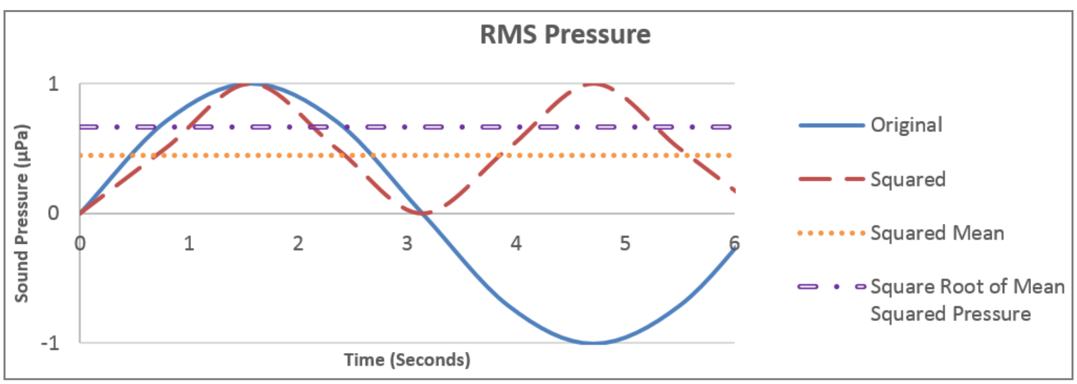
$$P_{rms} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} P_i^2}$$

P_{rms}

P_i

N

$i = 1$



"sound pressure level" in decibels (dB). The 'B' i

$$L_p = 10log_{10}(\frac{p_{rms}^2}{p_{ref}^2}); or$$

$$L_p = 20log_{10}(\frac{P_{rms}}{P_{ref}})\ dB \qquad -2$$

L_P dB

P_{rms}

P_{ref}

$$L_p = 10log_{10}(\frac{{P_1}^2 + {P_2}^2 + \cdots + {P_n}^2}{P_{ref}^2}) \qquad -3$$

L_P

$P_1, P_{2,} P_n$

P_{ref}

$$L_p = 10log_{10}(2\frac{p_{rms}^2}{p_{ref}^2})$$

$$= 10log_{10}(\frac{p_{rms}^2}{p_{ref}^2}) + 10log_{10}(2)$$

$$= 10log_{10}(\frac{p_{rms}^2}{p_{ref}^2}) + 3$$

$$L_p = 10log_{10}(\sum_{i=1}^{N} 10^{(L_i/10)})$$

L_p

N

i

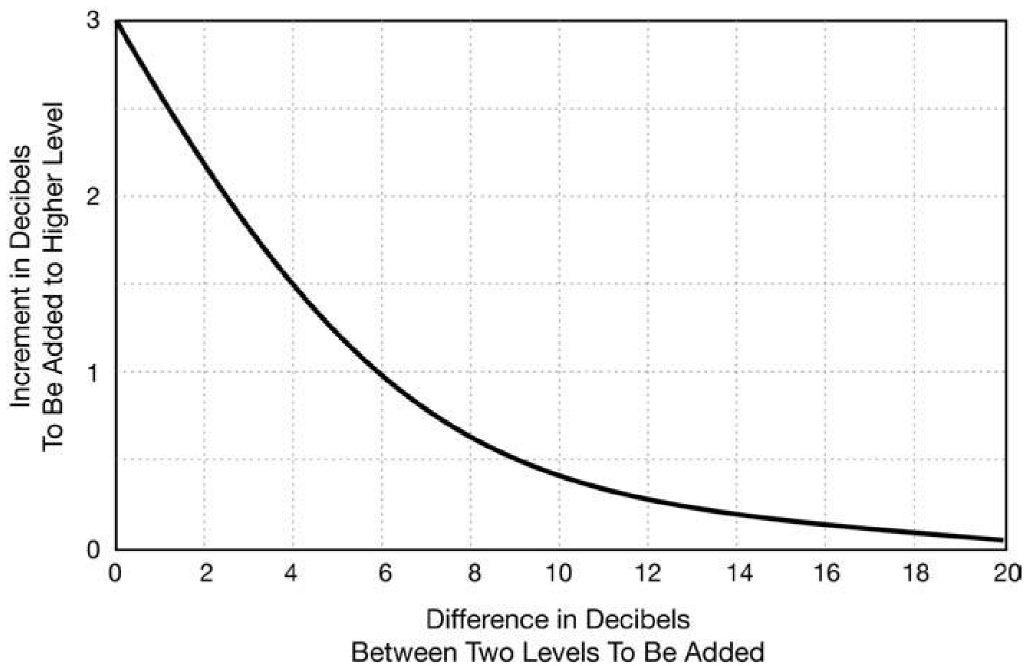
L_i

L_P

L_1, L_2, L_n

$$L_p = 10log_{10}(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}} + \cdots + 10^{\frac{L_n}{10}})$$ -4

L_1, L_2, L_n



Example B-1 Decibel Addition – Identical Buses

Decibel Addition

What is the combined sound pressure level of two identical buses if the noise from one bus resulted in a sound pressure level of 70 dB?

Since a doubling of identical sound sources results in a 3-dB increase:

$$\begin{aligned} L_p &= 70 + 3 \\ &= 73\ dB \end{aligned}$$

Example B-2 Decibel Addition – Two Sources

Decibel Addition

What is the combined sound pressure level of 64 dB and 60 dB?

Using Eq. B-4:

$$\begin{aligned} L_p &= 10log_{10}(10^{64/10} + 10^{60/10}) \\ &= 65.5\ dB \end{aligned}$$

Using Figure B-2:
The x-axis values represent the difference between the two sound levels, 64 and 60 dB. The difference between the sound levels in this example is 4. The point on the curve corresponding to 4 on the x-axis is 1.5. The y-axis values represent the increment that is added to the higher level.

$$\begin{aligned} L_p &= 64 + 1.5 \\ &= 65.5\ dB \end{aligned}$$

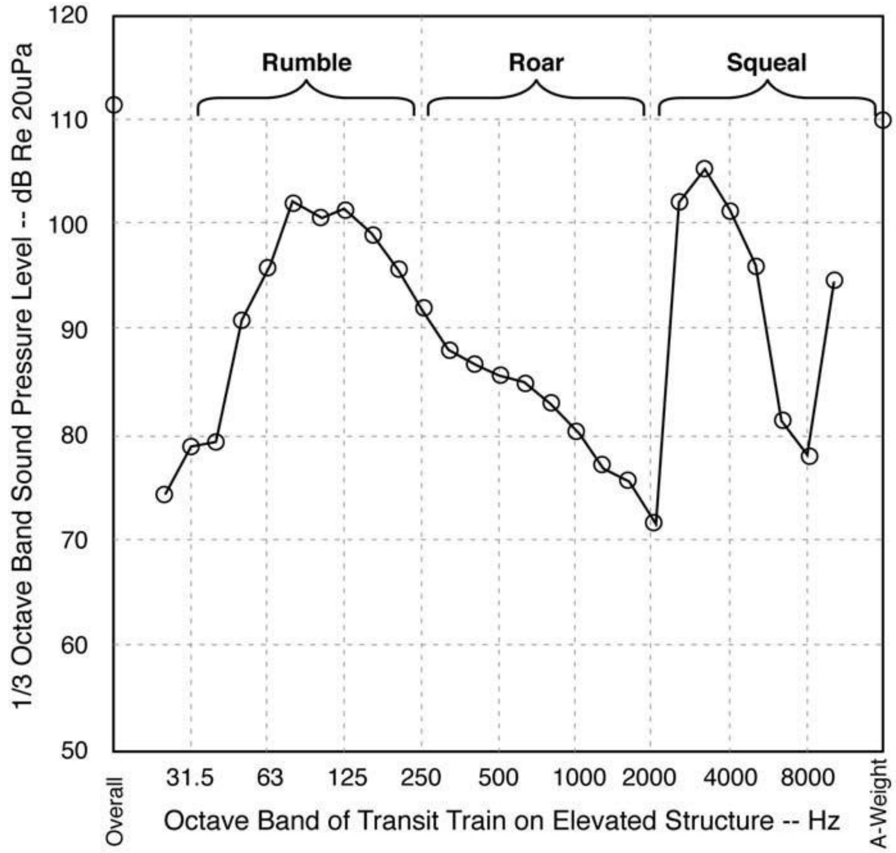
B.1.2 Frequency

Sound is a fluctuation of air pressure. The number of times the fluctuation occurs in one second is called its frequency. In acoustics, frequency is quantified in cycles per second, or Hertz (Hz). The hearing for a typical human covers the frequency range from 20 Hz to 20,000 Hz.

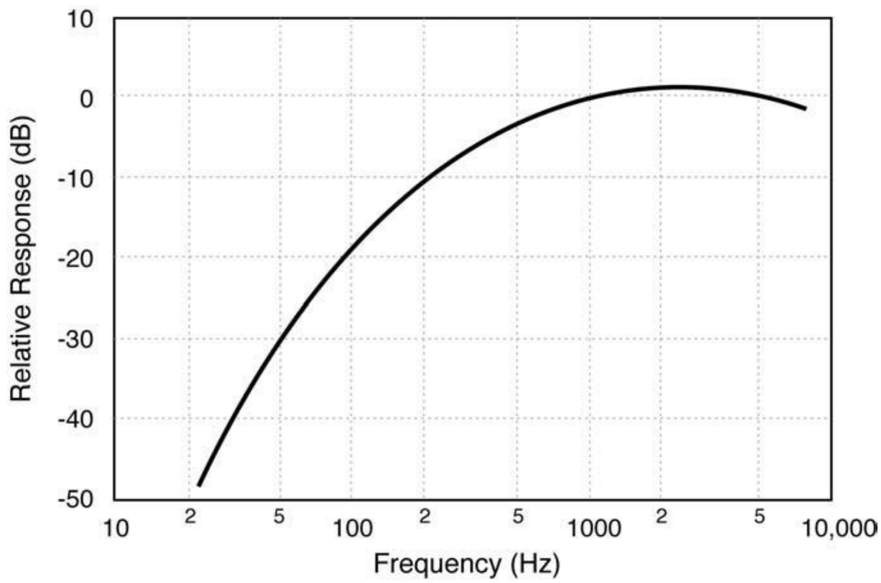
Some sounds, like whistles, are associated with a single frequency; this type of sound is called a pure tone. However, most often, noise is made up of many frequencies, called a spectrum. Analyzing a noise spectrum allows for identification of dominant frequency ranges and can assist in identifying noise sources. Often a frequency spectrum is divided into standardized frequency bands for analysis. Most commonly, the frequency bands for transit analyses are octave bands (where the interval between two divisions is a frequency ratio of 2) and one-third octave bands (where the interval between center frequencies is a ratio of 1.25).(73)

If the spectrum associated with a transit noise source is dominated by many low-frequency components, the noise will have a characteristic like the rumble of thunder; this is often associated with noise from a subway. Mid-range frequencies are often associated with wheel/rail noise, and high frequencies may be associated with wheel squeal due to sharp curves on a track.

The spectrum in Figure B-3 illustrates the full range of acoustical frequencies that can occur near a transit system. In this example, the noise spectrum was measured near a train on an elevated steel structure with a sharp curve.



Rumble
Roar
Squeal
1/3 Octave Band Sound Pressure Level -- dB Re 20uPa
120
110
100
90
80
70
60
50
Overall
31.5
63
125
250
500
1000
2000
4000
8000
A-Weight
Octave Band of Transit Train on Elevated Structure -- Hz



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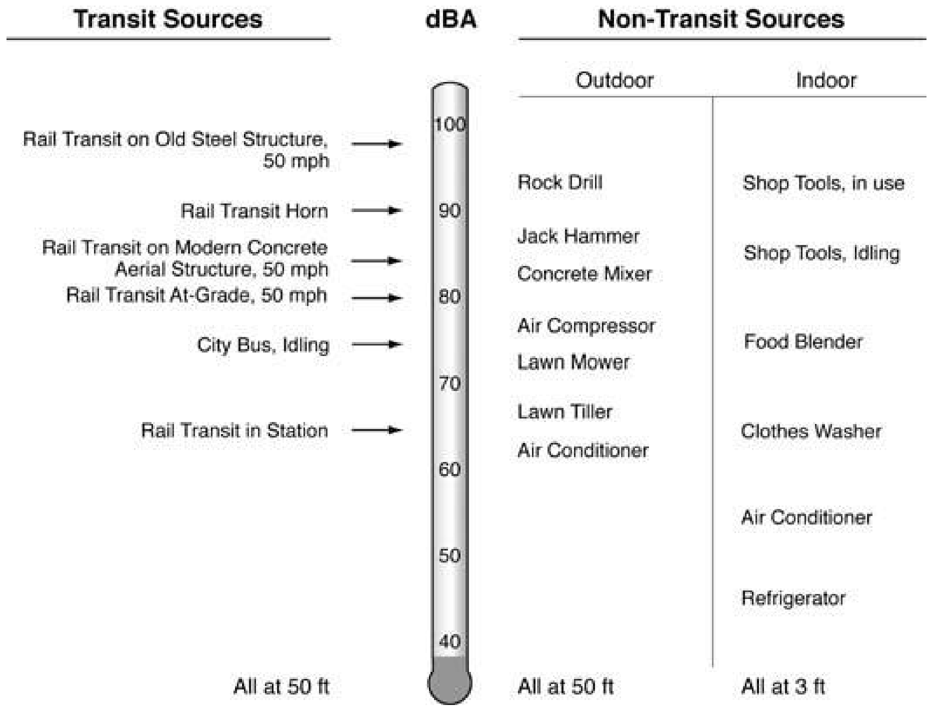

Transit Sources
dBA
Non-Transit Sources
Outdoor
Indoor
Rail Transit on Old Steel Structure, 50 mph
Rail Transit Horn
Rail Transit on Modern Concrete Aerial Structure, 50 mph
Rail Transit At-Grade, 50 mph
City Bus, Idling
Rail Transit in Station
All at 50 ft
100
90
80
70
60
50
40
Rock Drill
Jack Hammer
Concrete Mixer
Air Compressor
Lawn Mower
Lawn Tiller
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All at 50 ft
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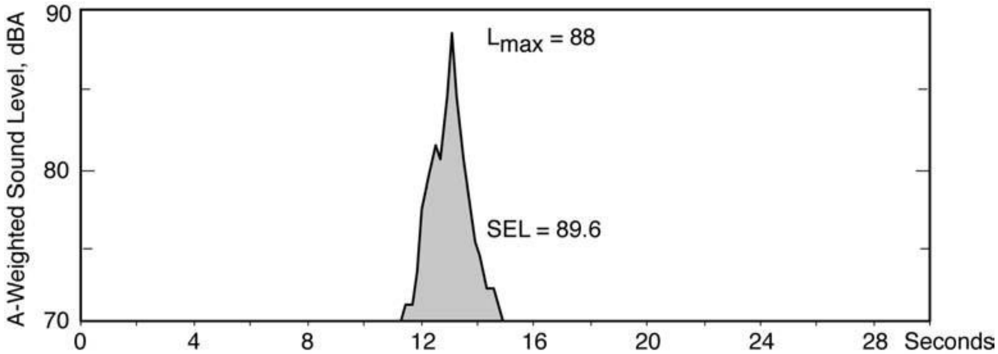
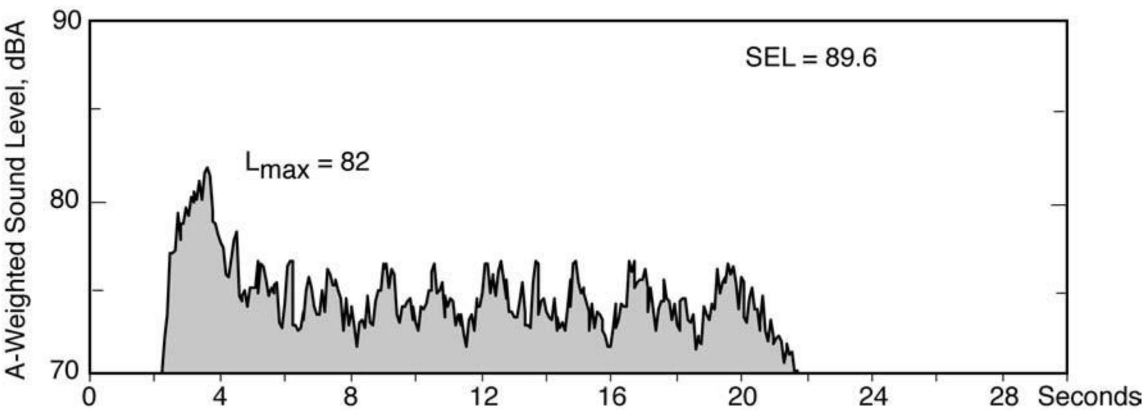
Clothes Washer
Air Conditioner
Refrigerator
All at 3 ft



A-Weighted Sound Level, dBA
90
80
70
0
4
8
12
16
20
24
28
Seconds
Lmax = 88
SEL = 89.6



A-Weighted Sound Level, dBA
90
80
70
0
4
8
12
16
20
24
28
Seconds
SEL = 89.6
Lmax = 82

Conceptually, the sound exposure level can be expressed as:

$$SEL = 10log_{10}(\frac{Total\ sound\ energy}{during\ the\ event})$$

Mathematically, the sound exposure level is computed as follows:

$$SEL = 10log_{10}(\sum_{i=1}^{N} 10^{(L_i/10)}) \quad \textbf{Eq. B-6}$$

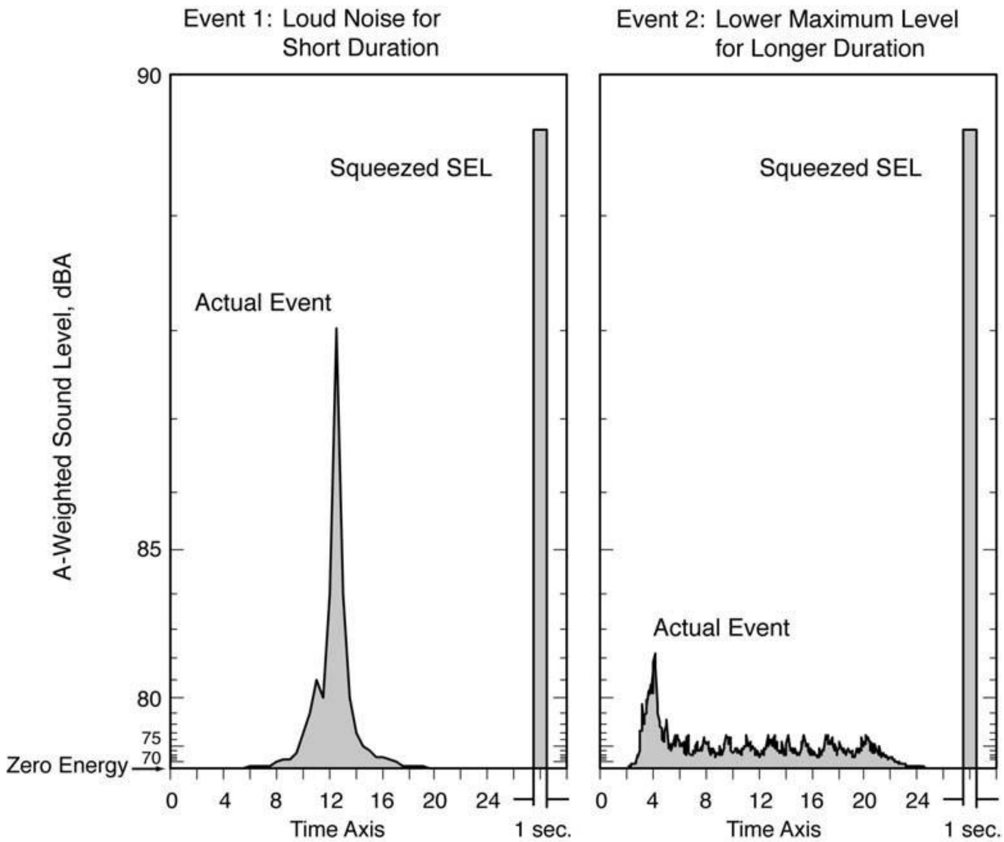
where

SEL = Sound exposure level, dBA
N = number of samples
i = index of summation
L_i = individual A-weighted sound level, dBA

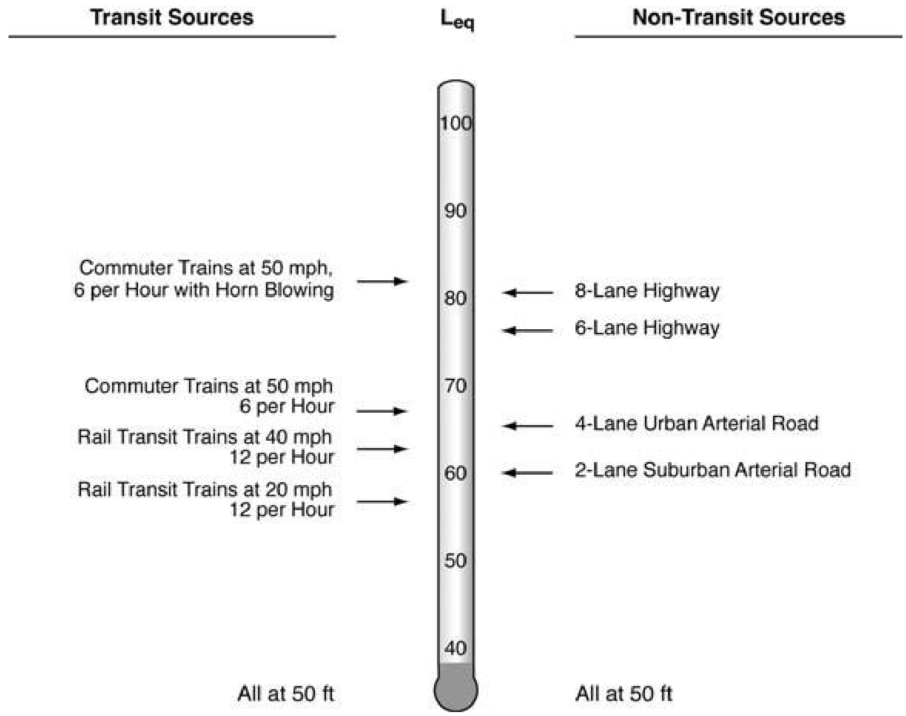
The events shown in Figure B-6 and Figure B-7 are compared graphically in Figure B-8 using a logarithmic vertical scale. The shaded zones in these figures indicate noise exposure over time. The actual event shows the noise exposure over the time of the event, and the equivalent SEL shows the total noise exposure normalized to one second. Note that events 1 and 2 in Figure B-8 have different time periods and noise levels throughout the event, but the same resulting SEL.

SEL is used in transit noise analyses because it:

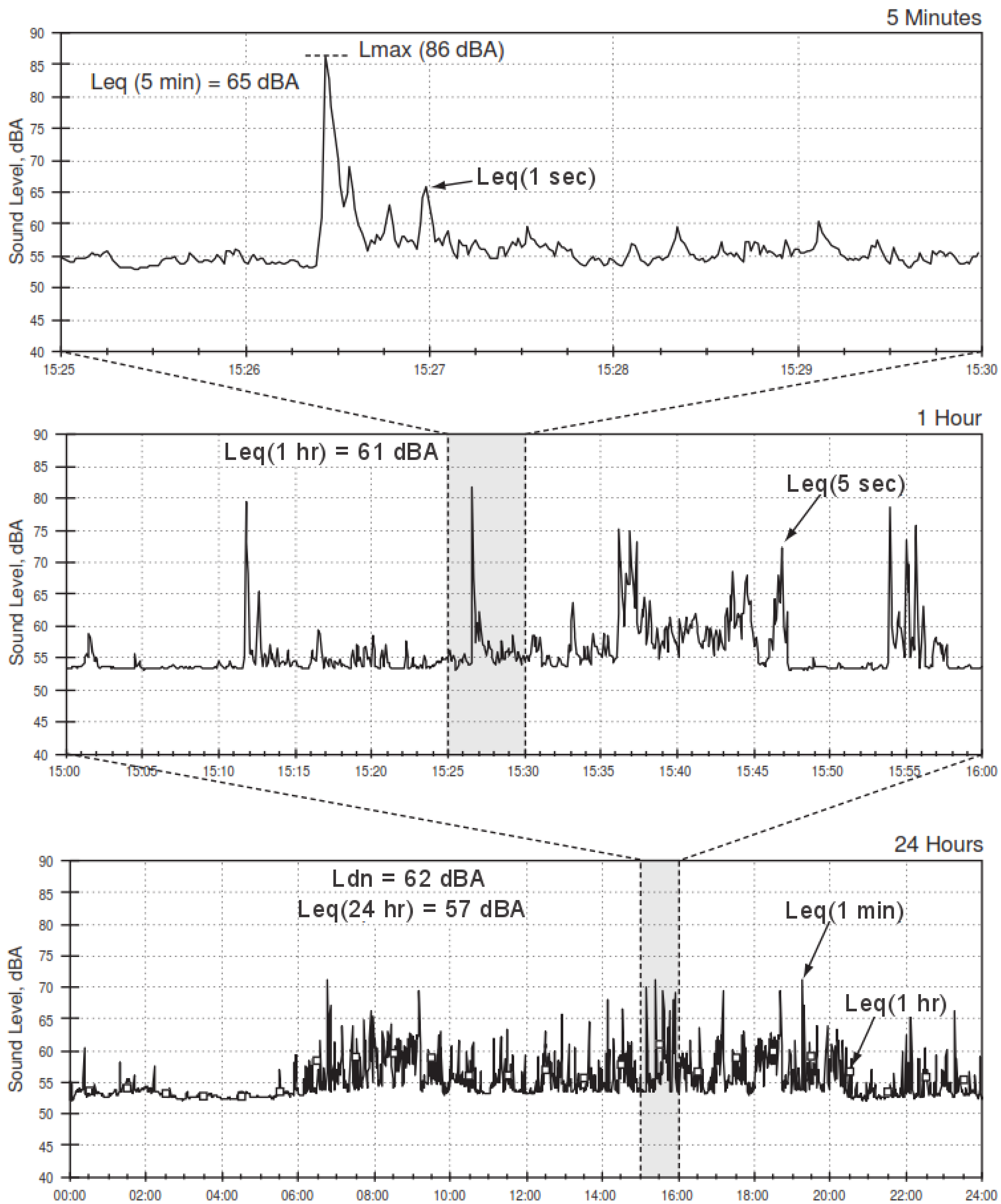
1. Accounts for both the duration and amplitude of an event,
2. Allows a uniform assessment method for both transit-vehicle passbys and fixed-facility noise events, and
3. Can be used to calculate the one-hour and 24-hour cumulative metrics for comparison across different transportation modes.



as the actual varying sound energy during the time period "t". For most transit noise analyses, an A-



Transit Sources
L_{eq}
Non-Transit Sources
100
90
80
70
60
50
40
Commuter Trains at 50 mph, 6 per Hour with Horn Blowing
Commuter Trains at 50 mph 6 per Hour
Rail Transit Trains at 40 mph 12 per Hour
Rail Transit Trains at 20 mph 12 per Hour
All at 50 ft
8-Lane Highway
6-Lane Highway
4-Lane Urban Arterial Road
2-Lane Suburban Arterial Road
All at 50 ft



Typical A-weighted Sound Level Variation over a 24-Hour Period

$$L_{eq}(t) = 10log_{10}(\frac{Total\ Sound\ Energy}{Time\ Period})$$

$$L_{eq}(t) = 10log_{10}(\frac{1}{T}\sum_{i=1}^{N} 10^{(L_i/10)})$$

L(t) = [illegible] od "t" [illegible]

T = [illegible] L [illegible])

N [illegible] L [illegible])

i [illegible]

L_i [illegible]

[illegible] a [illegible]

$$L_{eq}(1h) = 10log_{10}[Total\ Sound\ Energy\ in\ 1\ hr] - 35.6 \quad -7$$

[illegible]

35.6 = [illegible]

[illegible]

[illegible] L [illegible]

$$L_{eq}(1h) = 10log_{10}(\genfrac{}{}{0pt}{}{Energy\ Sum\ of}{all\ SELs}) - 35.6$$

[illegible]

$$L_{eq}(t) = 10log_{10}(\frac{1}{T}\sum_{i=1}^{N} 10^{(SEL_i/10)}) \quad -8$$

[illegible]

L(t) = [illegible] iod "t" [illegible]

T = [illegible] L [illegible])

N [illegible] L [illegible])

i [illegible]

SEL [illegible]

[illegible] L [illegible]

[illegible] L :

- [illegible] – [illegible]
- [illegible]
- [illegible]

- Is used by the Federal Highway Administration in assessing highway-traffic noise impact.(Thus, this noise metric can be used for directly comparing and contrasting highway, transit, and multimodal alternatives).

B.1.4.5 Day-Night Sound Level (L_{dn}): 24-Hour Exposure from All Events

The metric for cumulative 24-hour exposure is the Day-Night Sound Level, [(49)] abbreviated here as L_{dn}. It is a single, A-weighted decibel value that accounts for total sound energy from all sound sources over 24 hours and is expressed in the unit, dBA. Events between 10 p.m. and 7 a.m. are increased by 10 dB to account for people's greater nighttime sensitivity to noise.

Figure B-11 shows examples of typical L_{dn}'s, both for transit and non-transit sources, ranging from 50 to 80 dB, where 50 is considered a quiet 24-hour period and 80 a loud 24-hour period. Note that these L_{dn}'s depend upon the number of events during day and night separately, including each event's duration, which is affected by vehicle speed.

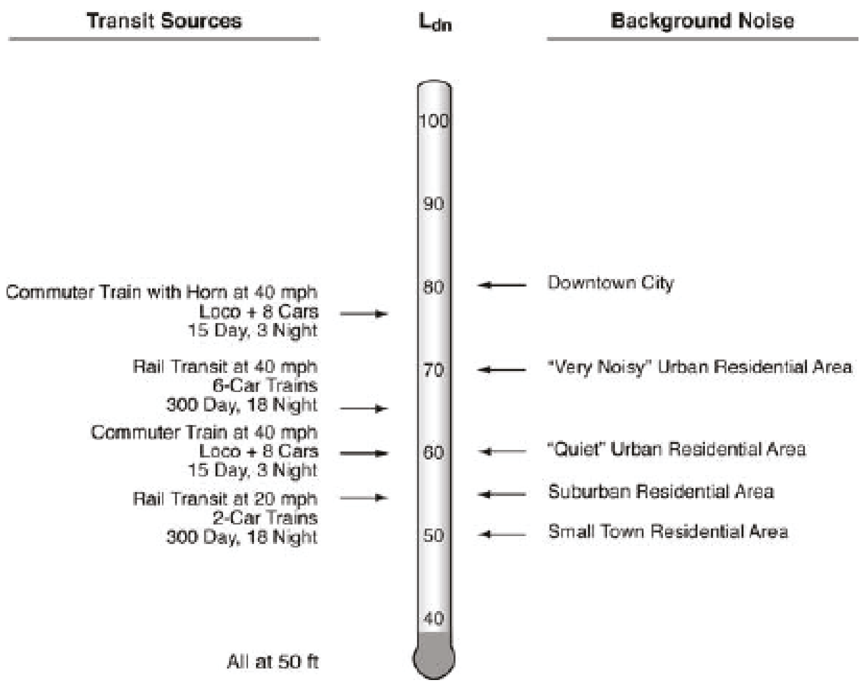


Figure B- 11 Typical L_{dn}'s

An example of sound level variation over 24 hours is visualized in the bottom frame of Figure B-10. The area under the curve represents the receiver's noise exposure over the 24 hours. Note that some vehicle passbys occur at night, when the background noise is typically lower and the 10 dB adjustment is applied.

Conceptually, the day-night level can be expressed as:

$$L_{dn} = 10log_{10}(\frac{Total\ Sound\ Energy_{Day}}{Time\ Period_{Day}\ (seconds)} + \frac{n_{adj,n} \times Total\ Sound\ Energy_{Night}}{Time\ Period_{Night}\ (seconds)})$$

[illegible]

$$L_{dn} = 10log_{10}\left(\frac{1}{T_d}\sum_{i=1}^{N} t_i \times 10^{(L_{d,i}/10)} + \frac{1}{T_n}\sum_{j=1}^{M} t_j \times 10^{((L_{n,j}+n_{adj,n})/10)}\right)$$ [illegible]

[illegible]

- L_{dn} [illegible]
- T_d [illegible]
- N [illegible]
- i = [illegible]
- t_i [illegible]
- $L_{d,i}$ [illegible]
- T_n [illegible]
- M [illegible]
- j [illegible]
- t_j [illegible]
- $L_{n,j}$ [illegible]
- $n_{adj,n}$ [illegible]

[illegible]

$$L_{dn} = 10log_{10}\left[\left(15 * Total\ Sound\ Energy_{Day}\right) + \left(9 * n_{adj,n} * \ Total\ Sound\ Energy_{Night}\right)\right] - 49.4$$

[illegible]

[illegible]

$$L_{dn} = 10log_{10}\left(\frac{\begin{matrix}Energy\ sum\ of\\ daytime, hourly\ Leqs\end{matrix} + \left(n_{adj,n} * \begin{matrix}Energy\ sum\ of\\ nighttime, hourly\ Leqs\end{matrix}\right)}{Time\ period\ (seconds)}\right)$$

[illegible]

$$L_{dn} = 10log_{10}\left(\frac{\begin{matrix}Energy\ sum\ of\\ daytime, hourly\ Leqs\end{matrix} + \left(n_{adj,n} * \begin{matrix}Energy\ sum\ of\\ nighttime, hourly\ Leqs\end{matrix}\right)}{\left(\frac{86400}{3600}\right)}\right)$$

[illegible]

$$L_{dn} = 10log_{10}\left(\begin{matrix}Energy\ sum\ of\\ daytime, hourly\ Leqs\end{matrix} + \left(n_{adj,n} * \begin{matrix}Energy\ sum\ of\\ nighttime, hourly\ Leqs\end{matrix}\right)\right) - 13.8$$ [illegible]

L_{dn} due to a series of transit-noise events can also be computed in terms of SEL. The equation below assumes that transit noise dominates the 24-hour noise environment, where nighttime SELs are increased by 10 dB before totaling:

$$L_{dn} = 10log_{10}(\frac{Energy\ sum\ of}{all\ daytime\ SELs} + (n_{adj,n} * \frac{Energy\ sum\ of}{all\ nighttime\ SELs})) - 49.4 \qquad \textbf{Eq. B-11}$$

L_{dn} is adopted as the measure of cumulative noise impact for residential land uses (those involving sleep), because it:

- Correlates well with the results of attitudinal surveys of residential noise impact
- Increases with the duration of transit events
- Accounts for the number of transit events over the full twenty-four hours
- Accounts for the increased sensitivity to noise at night, when most people are asleep
- Allows composite measurements to capture all sources of community noise combined
- Allow quantitative comparison of transit noise with other community noises
- Is the designated metric of choice of other Federal agencies (e.g., HUD, FAA, and EPA) and has wide international acceptance

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible] 's [illegible] " (7)
   [illegible]

2. [illegible] " (3)
   [illegible] d .

3. [illegible] (6)
   [illegible] ; [illegible] s
   [illegible] L [illegible] R [illegible]

4. [illegible] (7)
   [illegible] A

[illegible]

[illegible]

5 [illegible] 's [illegible]

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible] b [illegible]
- [illegible]

[illegible] 6 [illegible]

[illegible] a [illegible]

[illegible]

- [illegible]

- [illegible]
- [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]

Category 1 and 2

$$L_p = \begin{cases} 11.450 + 0.953L_E, & L_E < 42 \\ 71.662 - 1.164L_E + 0.018{L_E}^2 - 4.088 \times 10^{-5}{L_E}^3, & 42 \le L_E \le 71 \\ 65, & L_E > 71 \end{cases}$$

Category 3

$$L_p = \begin{cases} 16.450 + 0.953L_E, & L_E < 42 \\ 76.662 - 1.164L_E + 0.018{L_E}^2 - 4.088 \times 10^{-5}{L_E}^3, & 42 \le L_E \le 71 \\ 70, & L_E > 71 \end{cases}$$

Category 1 and 2

$$L_p = \begin{cases} 17.322 + 0.940L_E, & L_E < 44 \\ 96.725 - 1.992L_E + 3.02 \times 10^{-2}{L_E}^2 - 1.043 \times 10^{-4}{L_E}^3, & 44 \le L_E \le 77 \\ 75, & L_E > 77 \end{cases}$$

Category 3

$$L_p = \begin{cases} 22.322 + 0.940L_E, & L_E < 44 \\ 101.725 - 1.992L_E + 3.02 \times 10^{-2}{L_E}^2 - 1.043 \times 10^{-4}{L_E}^3, & 44 \le L_E \le 77 \\ 80, & L_E > 77 \end{cases}$$

L_E

L_p

[illegible]

[illegible]

[illegible]

- [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
- [illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

1. [illegible]

   [illegible]

   - [illegible]

- [illegible]

[illegible]

- [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
- [illegible]

2 [illegible]

- [illegible]
- [illegible]
- [illegible]

3 [illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

4 [illegible]

- [illegible]
- [illegible]

[illegible]

Primary Project Source

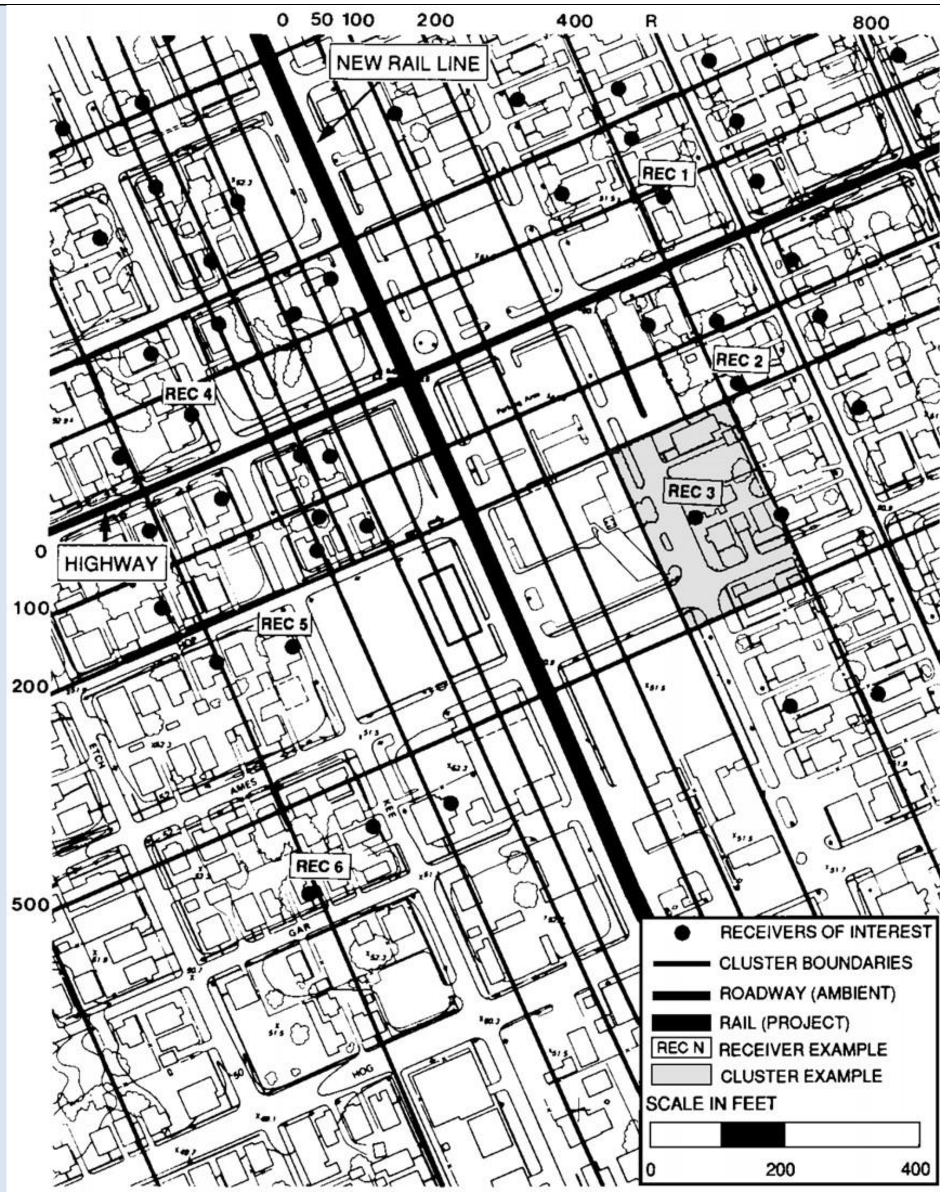
[illegible]

Rows of Buildings Parallel to the Transit Corridor

[illegible]

[illegible] d with “REC” [illegible]

[illegible]


0 50 100 200 400 R 800
NEW RAIL LINE
REC 1
REC 2
REC 3
REC 4
REC 5
REC 6
HIGHWAY
0
100
200
500
RECEIVERS OF INTEREST
CLUSTER BOUNDARIES
ROADWAY (AMBIENT)
RAIL (PROJECT)
REC N
RECEIVER EXAMPLE
CLUSTER EXAMPLE
SCALE IN FEET
0
200
400

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
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[illegible]

- [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
- [illegible]
- [illegible]
- [illegible]

$$L_{dn} \approx 10\log(3 \times 10^{\frac{L_{eq.peakhour}-2}{10}} + 12 \times 10^{\frac{L_{eq.midday}-2}{10}} + 9 \times 10^{\frac{L_{eq.latenight}+8}{10}}) - 13.8$$

$$L_{dn} \approx L_{eq} - 2$$ -2

$$L_{dn} \approx L_{eq} + 3$$ -3

$$L_{dn} \approx L_{eq} + 8$$ -4

- The ambient level of the comparable receiver was measured according to Option 1 or Option 2 above
- The ambient measurement at the comparable receiver was made in direct view of the major source of ambient noise, unshielded by noise barriers, terrain, rows of buildings, or dense tree zones

- Determine the following from a plan or aerial photograph:
  - The distance ($D_{CompRec}$) from the comparable receiver to the near edge of the ambient source
  - The distance (D_{Rec}) from this receiver of interest to the near edge of the ambient source
- Determine the number of rows of buildings (N) that intervene between the receiver of interest and the ambient source.
- Compute the ambient level at the receiver of interest (Rec) with the appropriate equation below

If roadway sources dominate:

$$L_{Rec} \approx L_{CompRec} - 15\log(\frac{D_{Rec}}{D_{CompRec}}) - 3N \qquad \textbf{Eq. E-5}$$

If other sources dominate:

$$L_{Rec} \approx L_{CompRec} - 25\log(\frac{D_{Rec}}{D_{CompRec}}) - 3N \qquad \textbf{Eq. E-6}$$

The resulting L_{Rec} will be moderately underestimated. This underestimation is intended to compensate for the reduced precision of the computed L_{dn}.

Option 6: Estimation of L_{dn} by table look-up (all land uses) – The least precise way to determine the ambient noise is to estimate the level using a table. A tabular look-up can be used to establish baseline conditions for a General Noise Assessment if a noise measurement cannot be made. This method should not be used for a Detailed Noise Analysis. The following instruction applies to this method of determining of ambient noise:

Estimate either the $L_{eq(1hr)}$ or the L_{dn} using Table 4-17 based on distance from major roadways, rail lines, or upon population densities. In general, these tabulated values are substantially underestimated.

The underestimation is intended to compensate for the reduced precision of the estimated ambients.

Examples – Examples of when each method of determining existing noise may be appropriate are provided below using the example from Appendix D. Existing noise at the receivers labeled "REC" in Figure D-1 could be estimated as follows:

- **Option 1: $L_{eq(1hr)}$ measurement** – Existing noise at REC 1 is due to the highway at the side of this church. $L_{eq(1hr)}$ can be measured during a typical church hour.
- **Option 2: L_{dn} measurement –** Existing noise at the residence REC 2 is due to a combination of the highway and local streets. L_{dn} can be measured for a full 24-hours.
- **Option 3: L_{dn} computation of L_{dn} from 3 partial $L_{eq(1hr)}$ measurements** – Existing noise at the residence REC 3 is due to the street in front of this residence. L_{dn} can be computed from three $L_{eq(1hr)}$ measurements.

source measurements for stationary sources capture the source's SEL over one source event,

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	$SEL_{ref} = SEL_{meas} + 10\log(\frac{S_{meas}}{50}) + 10log(\frac{D_{meas}}{50}) + C_{consist} + C_{emissions}$ [illegible] -1
$L_{[illegible]}$	[illegible]	$SEL_{ref} = L_{Amax} + 10\log(\frac{L_{meas}}{50}) + 10\log(\frac{D_{meas}}{50}) - 10\log(2\propto) + C_{consist}$ $+C_{emissions} + 3.3$ [illegible] -2
	[illegible]	$SEL_{ref} = L_{Amax} + 10\log(\frac{L_{meas}}{50}) + 10\log(\frac{D_{meas}}{50}) - 10\log\ [2\propto + \sin(2\propto)]$ $+C_{consist} + C_{emissions} + 3.3$ [illegible] -3
	[illegible]	$SEL_{ref} = L_{Amax} + 20\log(\frac{D_{meas}}{50}) + C_{emissions} + 3.3$ [illegible] -4

$S_{[illegible]}$ [illegible]

$D_{[illegible]}$ [illegible]

$C_{[illegible]}$ [illegible]

$-10\log(N_{Cars})$ [illegible]

$C_{[illegible]}$ [illegible] for T ≥ 6

$-30\log(\frac{S_{meas}}{50})$ [illegible]

$-25\log(\frac{S_{meas}}{50})$ [illegible]

$-38.1\log(\frac{S_{meas}}{50})$ [illegible]

$E_{[illegible]}$ [illegible]

$L_{[illegible]}$ [illegible] *or* [illegible]

$\propto$ [illegible] $\frac{L_{meas}}{2D_{meas}}$), [illegible]

N_{Cars}

T

S

D

-1.

$$SEL_{ref} = SEL_{meas} + 10\log(\frac{S_{meas}}{50}) + 10log(\frac{D_{meas}}{50}) + C_{consist} + C_{emissions}$$

$$= 90 + 10\log\left(\frac{55}{50}\right) + 10\log\left(\frac{65}{50}\right) - 10\log(2) + (-2(6-5))$$

L

L

N_{Cars}

S

D

L

∝

-3.

$$SEL_{ref} = L_{Amax} + 10\log(\frac{L_{meas}}{50}) + 10\log(\frac{D_{meas}}{50}) - 10\log\,[2 \propto + \sin(2 \propto)] + C_{consist} + C_{emissions} + 3.3$$

$$= 90 + 10\log(\frac{280}{50}) + 10\log(\frac{65}{50}) - 10\log\,\left[2(1.14) + \sin\left(2(1.14)\right)\right] - 10\log(4) - 30\log(\frac{70}{50}) + 3.3$$

L_{max}

D_{meas}

$S_{\dots}$

-4

$$
\begin{aligned}
SEL_{ref} &= L_{max} + 20\log(\frac{D_{meas}}{50}) + C_{emissions} + 3.3 \\
&= 78 + 20\log(\frac{80}{50}) - 25\log(\frac{40}{50}) + 3.3
\end{aligned}
$$

$$\frac{Distance\ to\ the\ farthest\ source\ component}{Distance\ to\ the\ closest\ source\ component}$$

$$\frac{Lateral\ length\ of\ the\ source\ area}{Distance\ to\ the\ closest\ source\ component}$$

		$SEL_{ref} = SEL_{meas} - 10\log(\frac{E_{meas}}{3600}) + 20\log(\frac{D_{meas}}{50})$ - 5

-5.

$$SEL_{ref} = SEL_{meas} - 10\log(\frac{E_{meas}}{3600}) + 20\log(\frac{D_{meas}}{50})$$

$$= 70 - 10\log(\frac{10}{3600}) + 20\log(\frac{65}{50})$$

- L
- L

	$$L_{max.Loco} = SEL_{locos} + 10log\left(\frac{S}{50}\right) - 10log\left(\frac{L}{50}\right) + 10\log(2 \propto) - 3.3$$ -6
	$$L_{max.Rcars} = SEL_{Rcars} + 10log\left(\frac{S}{50}\right) - 10log\left(\frac{L}{50}\right) + 10\log(2 \propto + \sin(2 \propto)) - 3.3$$ -7
	$$L_{max.total} = max(L_{max.Loco}\ or\ L_{max.RCars})$$ -8
L ft	
S ,	
$\propto$ $\left(\frac{L}{2D}\right)$,	
D , ft	

[illegible]

[illegible]

[illegible]

N_{Loco} [illegible]

N_{Cars} [illegible]

S [illegible]

D [illegible]

$\propto_{locos}$ [illegible]

$\propto_{cars}$ [illegible]

[illegible]

L_b [illegible]

L [illegible]

[illegible] -6:

$$L_{max.Loco} = SEL_{loco} + 10log\left(\frac{S}{50}\right) - 10log\left(\frac{L}{50}\right) + 10\log(2 \propto) - 3.3$$

$$= 92 + 10log\left(\frac{43}{50}\right) - 10log\left(\frac{70}{50}\right) + 10\log(2 \times 0.27) - 3.3$$

= [illegible]

[illegible] -7:

$$L_{max.Rcars} = SEL_{Rcars} + 10log\left(\frac{S}{50}\right) - 10log\left(\frac{L}{50}\right) + 10\log(2 \propto + \sin(2 \propto)) - 3.3$$

$$= 82 + 10log\left(\frac{43}{50}\right) - 10log\left(\frac{420}{50}\right) + 10\log((2 \times 1.03) + \sin(2 \times 1.03)) - 3.3$$

= [illegible]

[illegible] -8.

$$L_{max.total} = max(L_{max.Loco}\; or\; L_{max.Rcars})$$

[illegible]

[illegible]

[illegible]

[illegible] — [illegible]

1. [illegible]
2. [illegible]

[illegible] — [illegible]

- [illegible]
- [illegible]
- [illegible], [illegible]
- [illegible]
- [illegible], [illegible]
- [illegible]

[illegible] — [illegible]

- [illegible]

- [illegible]

- [illegible]

- [illegible]

- [illegible]

ENDNOTES

[1] Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, Council on Environmental Quality, 40 CFR parts 1500-1508, 1978.

[2] National Environmental Policy Act of 1969, United States Congress, 42 U.S.C §4331, 1969.

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[5] U.S. Environmental Protection Agency, "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," Report No. 550/9-74-004, Washington DC, March 1974.

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[15] National Historic Preservation Act, Section 106; P.L. 89-665, 15 October 1966.

[16] The Department of Transportation Act of 1966, Section 4(f); P.L. 89-670, 15 October 1966.

[17] U.S. Department of Transportation, Federal Transit Administration and Federal Highway Administration, "Protection of Historic Properties." Final Rule, 65 *Federal Register* 77725, July 2013 (36 CFR 800).

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[19] U.S. Department of Housing and Urban Development, "Environmental Criteria and Standards", Vol. 12, July 1979; amended by 49 *Federal Register* 880, 6 January 1984 (24CFR part 51).

[20] U.S. Department of Transportation, Federal Aviation Administration, "Federal Aviation Regulations Part 150: Airport Noise Compatibility Planning," January 1981.

[21] U.S. Department of Transportation, Federal Railroad Administration, "Use of Locomotive Horns at Public Highway-Rail Grade Crossings." Final Rule, 70 *Federal Register* 21844, October 2013 (49 CFR 222).

[22] U.S. Department of Transportation, Federal Highway Administration, "FHWA Traffic Noise Model User's Guide," Report No. FHWA-PD-96-009, Washington, DC, January 1998. Also, "FHWA Traffic Noise Model User's Guide (Version 2.5 Addendum)," April 2004.

[23] J.C. Ross, C.E. Hanson, R.V. Hartz, "Houston Southeast Corridor Environmental Impact Statement BRT Noise and Vibration Assessment," technical memorandum prepared by Harris Miller Miller & Hanson for Metropolitan Transit Authority of Harris County Houston, Texas, September 20, 2005.

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INTERNATIONAL STANDARD

ISO 9613-2

First edition
1996-12-15

Acoustics — Attenuation of sound during propagation outdoors —

Part 2:
General method of calculation

Acoustique — Atténuation du son lors de sa propagation à l'air libre —

Partie 2: Méthode générale de calcul

Reference number
ISO 9613-2:1996(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9613-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

ISO 9613 consists of the following parts, under the general title *Acoustics — Attenuation of sound during propagation outdoors:*

— *Part 1: Calculation of the absorption of sound by the atmosphere*

— *Part 2: General method of calculation*

Part 1 is a detailed treatment restricted to the attenuation by atmospheric absorption processes. Part 2 is a more approximate and empirical treatment of a wider subject — the attenuation by all physical mechanisms.

Annexes A and B of this part of ISO 9613 are for information only.

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Introduction

The ISO 1996 series of standards specifies methods for the description of noise outdoors in community environments. Other standards, on the other hand, specify methods for determining the sound power levels emitted by various noise sources, such as machinery and specified equipment (ISO 3740 series), or industrial plants (ISO 8297). This part of ISO 9613 is intended to bridge the gap between these two types of standard, to enable noise levels in the community to be predicted from sources of known sound emission. The method described in this part of ISO 9613 is general in the sense that it may be applied to a wide variety of noise sources, and covers most of the major mechanisms of attenuation. There are, however, constraints on its use, which arise principally from the description of environmental noise in the ISO 1996 series of standards.

Acoustics — Attenuation of sound during propagation outdoors —

Part 2:
General method of calculation

1 Scope

This part of ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (as described in parts 1 to 3 of ISO 1996) under meteorological conditions favourable to propagation from sources of known sound emission.

These conditions are for downwind propagation, as specified in 5.4.3.3 of ISO 1996-2:1987 or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night. Inversion conditions over water surfaces are not covered and may result in higher sound pressure levels than predicted from this part of ISO 9613.

The method also predicts a long-term average A-weighted sound pressure level as specified in ISO 1996-1 and ISO 1996-2. The long-term average A-weighted sound pressure level encompasses levels for a wide variety of meteorological conditions.

The method specified in this part of ISO 9613 consists specifically of octave-band algorithms (with nominal midband frequencies from 63 Hz to 8 kHz) for calculating the attenuation of sound which originates from a point sound source, or an assembly of point sources. The source (or sources) may be moving or stationary. Specific terms are provided in the algorithms for the following physical effects:

— geometrical divergence;
— atmospheric absorption;
— ground effect;
— reflection from surfaces;
— screening by obstacles.

Additional information concerning propagation through housing, foliage and industrial sites is given in annex A.

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground-based noise sources. It does not apply to sound from aircraft in flight, or to blast waves from mining, military or similar operations.

To apply the method of this part of ISO 9613, several parameters need to be known with respect to the geometry of the source and of the environment, the ground surface characteristics, and the source strength in terms of octave-band sound power levels for directions relevant to the propagation.

NOTE 1 If only A-weighted sound power levels of the sources are known, the attenuation terms for 500 Hz may be used to estimate the resulting attenuation.

The accuracy of the method and the limitations to its use in practice are described in clause 9.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9613. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9613 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1996-1:1982, *Acoustics — Description and measurement of environmental noise — Part 1: Basic quantities and procedures.*

ISO 1996-2:1987, *Acoustics — Description and measurement of environmental noise — Part 2: Acquisition of data pertinent to land use.*

ISO 1996-3:1987, *Acoustics — Description and measurement of environmental noise — Part 3: Application to noise limits.*

ISO 9613-1:1993, *Acoustics — Attenuation of sound during propagation outdoors — Part 1: Calculation of the absorption of sound by the atmosphere.*

IEC 651:1979, *Sound level meters,* and Amendment 1:1993.

3 Definitions

For the purposes of this part of ISO 9613, the definitions given in ISO 1996-1 and the following definitions apply. (See table 1 for symbols and units.)

3.1 equivalent continuous A-weighted sound pressure level, L_{AT}: Sound pressure level, in decibels, defined by equation (1):

$$L_{AT} = 10 \lg \left\{ \left[(1/T) \int_0^T p_A^2(t)\,dt \right] \Big/ p_0^2 \right\} \text{ dB} \qquad \dots (1)$$

where

$p_A(t)$ is the instantaneous A-weighted sound pressure, in pascals;

p_0 is the reference sound pressure ($= 20 \times 10^{-6}$ Pa);

T is a specified time interval, in seconds.

The A-frequency weighting is that specified for sound level meters in IEC 651.

NOTE 2 The time interval T should be long enough to average the effects of varying meteorological parameters. Two different situations are considered in this part of ISO 9613, namely short-term downwind and long-term overall averages.

Table 1 — Symbols and units

Symbol	Definition	Unit
A	octave-band attenuation	dB
C_{met}	meteorological correction	dB
d	distance from point source to receiver (see figure 3)	m
d_p	distance from point source to receiver projected onto the ground plane (see figure 1)	m
$d_{s,o}$	distance between source and point of reflection on the reflecting obstacle (see figure 8)	m
$d_{o,r}$	distance between point of reflection on the reflecting obstacle and receiver (see figure 8)	m
d_{ss}	distance from source to (first) diffraction edge (see figures 6 and 7)	m
d_{sr}	distance from (second) diffraction edge to receiver (see figures 6 and 7)	m
D_I	directivity index of the point sound source	—
D_z	screening attenuation	—
e	distance between the first and second diffraction edge (see figure 7)	m
G	ground factor	—
h	mean height of source and receiver	m
h_s	height of point source above ground (see figure 1)	m
h_r	height of receiver above ground (see figure 1)	m
h_m	mean height of the propagation path above the ground (see figure 3)	m
H_{max}	largest dimension of the sources	m
l_{min}	minimum dimension (length or height) of the reflecting plane (see figure 8)	m
L	sound pressure level	dB
α	atmospheric attenuation coefficient	dB/km
β	angle of incidence	rad
ρ	sound reflection coefficient	—

3.2 equivalent continuous downwind octave-band sound pressure level, L_{fT}(DW): Sound pressure level, in decibels, defined by equation (2):

$$L_{fT}(\mathrm{DW}) = 10 \lg \left\{ \left[(1/T) \int_0^T p_f^{\,2}(t)\,\mathrm{d}t \right] \Big/ p_0^{\,2} \right\} \ \mathrm{dB} \qquad \ldots (2)$$

where $p_f(t)$ is the instantaneous octave-band sound pressure downwind, in pascals, and the subscript f represents a nominal midband frequency of an octave-band filter.

NOTE 3 The electrical characteristics of the octave-band filters should comply at least with the class 2 requirements of IEC 1260.

3.3 insertion loss (of a barrier): Difference, in decibels, between the sound pressure levels at a receiver in a specified position under two conditions:

a) with the barrier removed, and

b) with the barrier present (inserted),

and no other significant changes that affect the propagation of sound.

4 Source description

The equations to be used are for the attenuation of sound from point sources. Extended noise sources, therefore, such as road and rail traffic or an industrial site (which may include several installations or plants, together with traffic moving on the site) shall be represented by a set of sections (cells), each having a certain sound power and directivity. Attenuation calculated for sound from a representative point within a section is used to represent the attenuation of sound from the entire section. A line source may be divided into line sections, an area source into area sections, each represented by a point source at its centre.

However, a group of point sources may be described by an equivalent point sound source situated in the middle of the group, in particular if

a) the sources have approximately the same strength and height above the local ground plane,

b) the same propagation conditions exist from the sources to the point of reception, and

c) the distance d from the single equivalent point source to the receiver exceeds twice the largest dimension H_{max} of the sources ($d > 2H_{max}$).

If the distance d is smaller ($d \leqslant 2H_{max}$), or if the propagation conditions for the component point sources are different (e.g. due to screening), the total sound source shall be divided into its component point sources.

NOTE 4 In addition to the real sources described above, image sources will be introduced to describe the reflection of sound from walls and ceilings (but not by the ground), as described in 7.5.

5 Meteorological conditions

Downwind propagation conditions for the method specified in this part of ISO 9613 are as specified in 5.4.3.3 of ISO 1996-2:1987, namely

— wind direction within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and

— wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.

The equations for calculating the average downwind sound pressure level L_{AT}(DW) in this part of ISO 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.

These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights.

6 Basic equations

The equivalent continuous downwind octave-band sound pressure level at a receiver location, L_{fT}(DW), shall be calculated for each point source, and its image sources, and for the eight octave bands with nominal midband frequencies from 63 Hz to 8 kHz, from equation (3):

$$L_{fT}(\mathrm{DW}) = L_W + D_c - A \qquad \ldots (3)$$

where

L_W is the octave-band sound power level, in decibels, produced by the point sound source relative to a reference sound power of one picowatt (1 pW);

D_c is the directivity correction, in decibels, that describes the extent by which the equivalent continuous sound pressure level from the point sound source deviates in a specified direction from the level of an omnidirectional point sound source producing sound power level L_W; D_c equals the directivity index D_I of the point sound source plus an index D_Ω that accounts for sound propagation into solid angles less than 4π steradians; for an omnidirectional point sound source radiating into free space, $D_c = 0$ dB;

A is the octave-band attenuation, in decibels, that occurs during propagation from the point sound source to the receiver.

NOTES

5 The letter symbol A (in italic type) signifies attenuation in this part of ISO 9613 except in subscripts, where it designates the A-frequency weighting (in roman type).

6 Sound power levels in equation (3) may be determined from measurements, for example as described in the ISO 3740 series (for machinery) or in ISO 8297 (for industrial plants).

The attenuation term A in equation (3) is given by equation (4):

$$A = A_{\text{div}} + A_{\text{atm}} + A_{\text{gr}} + A_{\text{bar}} + A_{\text{misc}} \quad \ldots (4)$$

where

A_{div} is the attenuation due to geometrical divergence (see 7.1);

A_{atm} is the attenuation due to atmospheric absorption (see 7.2);

A_{gr} is the attenuation due to the ground effect (see 7.3);

A_{bar} is the attenuation due to a barrier (see 7.4);

A_{misc} is the attenuation due to miscellaneous other effects (see annex A).

General methods for calculating the first four terms in equation (4) are specified in this part of ISO 9613. Information on three contributions to the last term, A_{misc} (the attenuation due to propagation through foliage, industrial sites and areas of houses), is given in annex A.

The equivalent continuous A-weighted downwind sound pressure level shall be obtained by summing the contributing time-mean-square sound pressures calculated according to equations (3) and (4) for each point sound source, for each of their image sources, and for each octave band, as specified by equation (5):

$$L_{\text{AT}}(\text{DW}) = 10 \lg \left\{ \sum_{i=1}^{n} \left[\sum_{j=1}^{8} 10^{0,1\left[L_{fT}(ij) + A_f(j)\right]} \right] \right\} \text{ dB} \quad \ldots (5)$$

where

n is the number of contributions i (sources and paths);

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

A_f denotes the standard A-weighting (see IEC 651).

The long-term average A-weighted sound pressure level $L_{\text{AT}}(\text{LT})$ shall be calculated according to

$$L_{\text{AT}}(\text{LT}) = L_{\text{AT}}(\text{DW}) - C_{\text{met}} \quad \ldots (6)$$

where C_{met} is the meteorological correction described in clause 8.

The calculation and significance of the various terms in equations (1) to (6) are explained in the following clauses. For a more detailed treatment of the attenuation terms, see the literature references given in annex B.

7 Calculation of the attenuation terms

7.1 Geometrical divergence (A_{div})

The geometrical divergence accounts for spherical spreading in the free field from a point sound source, making the attenuation, in decibels, equal to

$$A_{\text{div}} = \left[20 \lg(d/d_0) + 11\right] \text{ dB} \quad \ldots (7)$$

where

d is the distance from the source to receiver, in metres;

d_0 is the reference distance (= 1 m).

NOTE 7 The constant in equation (7) relates the sound power level to the sound pressure level at a reference distance d_0 which is 1 m from an omnidirectional point sound source.

7.2 Atmospheric absorption (A_{atm})

The attenuation due to atmospheric absorption A_{atm}, in decibels, during propagation through a distance d, in metres, is given by equation (8):

$$A_{atm} = \alpha d/1\,000 \qquad \ldots (8)$$

where α is the atmospheric attenuation coefficient, in decibels per kilometre, for each octave band at the midband frequency (see table 2).

For values of a at atmospheric conditions not covered in table 2, see ISO 9613-1.

NOTES

8 The atmospheric attenuation coefficient depends strongly on the frequency of the sound, the ambient temperature and relative humidity of the air, but only weakly on the ambient pressure.

9 For calculation of environmental noise levels, the atmospheric attenuation coefficient should be based on average values determined by the range of ambient weather which is relevant to the locality.

7.3 Ground effect (A_{gr})

7.3.1 General method of calculation

Ground attenuation, A_{gr}, is mainly the result of sound reflected by the ground surface interfering with the sound propagating directly from source to receiver. The downward-curving propagation path (downwind) ensures that this attenuation is determined primarily by the ground surfaces near the source and near the receiver. This method of calculating the ground effect is applicable only to ground which is approximately flat, either horizontally or with a constant slope. Three distinct regions for ground attenuation are specified (see figure 1):

a) the source region, stretching over a distance from the source towards the receiver of $30h_s$, with a maximum distance of d_p (h_s is the source height, and d_p the distance from source to receiver, as projected on the ground plane);

b) the receiver region, stretching over a distance from the receiver back towards the source of $30h_r$, with a maximum distance of d_p (h_r is the receiver height);

c) a middle region, stretching over the distance between the source and receiver regions. If $d_p < (30h_s + 30h_r)$, the source and receiver regions will overlap, and there is no middle region.

According to this scheme, the ground attenuation does not increase with the size of the middle region, but is mostly dependent on the properties of source and receiver regions.

The acoustical properties of each ground region are taken into account through a ground factor G. Three categories of reflecting surface are specified as follows.

Table 2 — Atmospheric attenuation coefficient α for octave bands of noise

Temperature	Relative humidity	Atmospheric attenuation coefficient α, dB/km							
		Nominal midband frequency, Hz							
°C	%	63	125	250	500	1 000	2 000	4 000	8 000
10	70	0,1	0,4	1,0	1,9	3,7	9,7	32,8	117
20	70	0,1	0,3	1,1	2,8	5,0	9,0	22,9	76,6
30	70	0,1	0,3	1,0	3,1	7,4	12,7	23,1	59,3
15	20	0,3	0,6	1,2	2,7	8,2	28,2	88,8	202
15	50	0,1	0,5	1,2	2,2	4,2	10,8	36,2	129
15	80	0,1	0,3	1,1	2,4	4,1	8,3	23,7	82,8

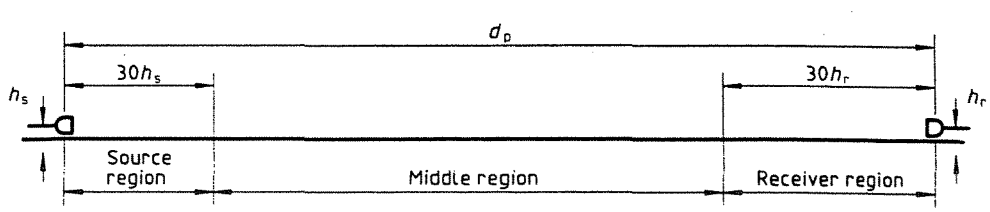


Figure 1 — Three distinct regions for determination of ground attenuation

a) **Hard ground,** which includes paving, water, ice, concrete and all other ground surfaces having a low porosity. Tamped ground, for example, as often occurs around industrial sites, can be considered hard. For hard ground $G = 0$.

NOTE 10 It should be recalled that inversion conditions over water are not covered by this part of ISO 9613.

b) **Porous ground,** which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground $G = 1$.

c) **Mixed ground:** if the surface consists of both hard and porous ground, then G takes on values ranging from 0 to 1, the value being the fraction of the region that is porous.

To calculate the ground attenuation for a specific octave band, first calculate the component attenuations A_s for the source region specified by the ground factor G_s (for that region), A_r for the receiver region specified by the ground factor G_r, and A_m for the middle region specified by the ground factor G_m, using the expressions in table 3. (Alternatively, the functions a', b', c' and d' in table 3 may be obtained directly from the curves in figure 2.) The total ground attenuation for that octave band shall be obtained from equation (9):

$$A_{gr} = A_s + A_r + A_m \qquad \ldots (9)$$

NOTE 11 In regions with buildings, the influence of the ground on sound propagation may be changed (see A.3).

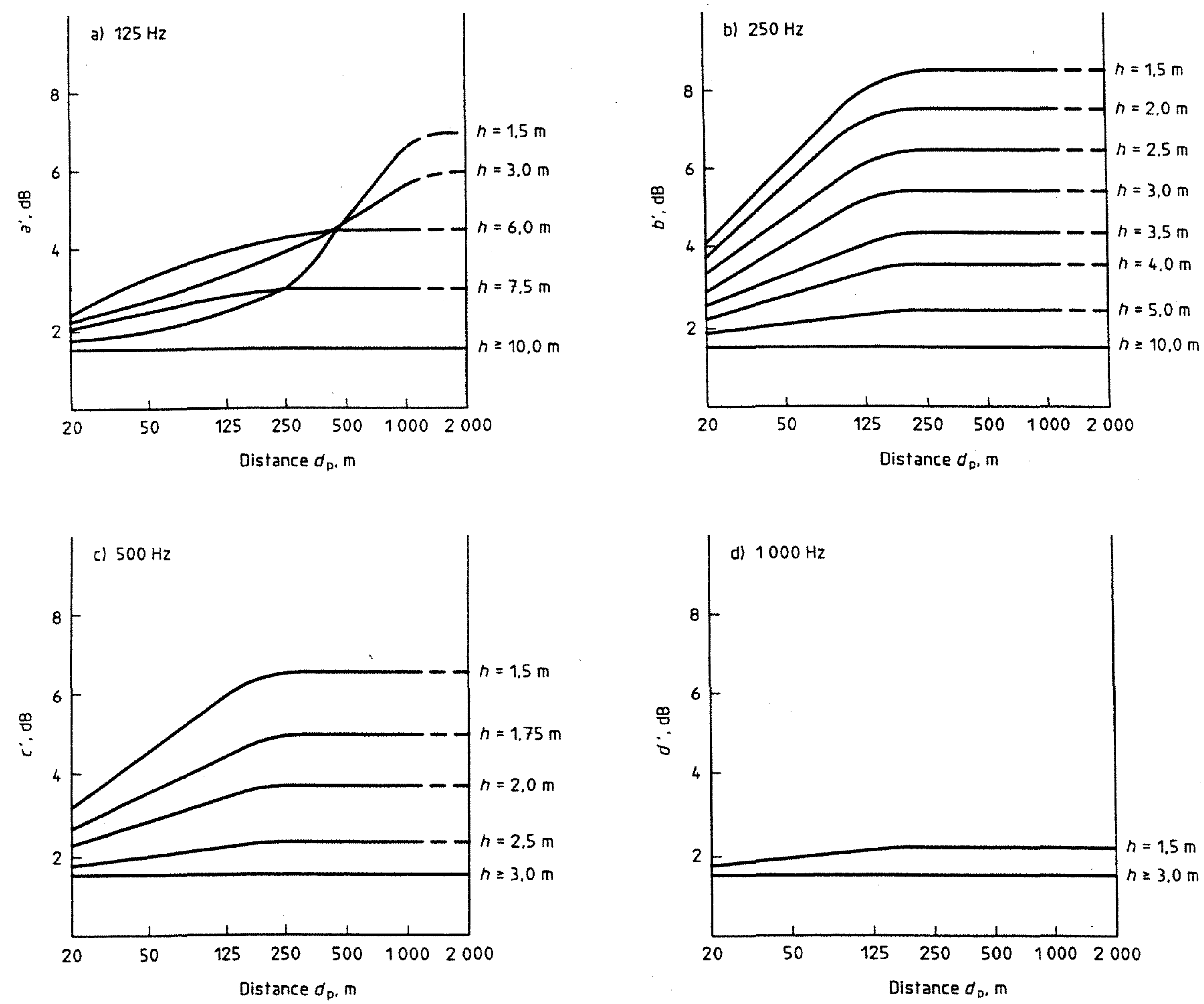


Figure 2 — Functions a', b', c' and d' representing the influence of the source-to-receiver distance d_p and the source or receiver height h, respectively, on the ground attenuation A_{gr} (computed from equations in table 3)

Table 3 — Expressions to be used for calculating ground attenuation contributions A_s, A_r and A_m in octave bands

Nominal midband frequency Hz	A_s or A_r 1) dB	A_m dB
63	$-1,5$	$-3q$ 2)
125	$-1,5 + G \times a'(h)$	$-3q(1 - G_m)$
250	$-1,5 + G \times b'(h)$	
500	$-1,5 + G \times c'(h)$	
1 000	$-1,5 + G \times d(h)$	
2 000	$-1,5(1 - G)$	
4 000	$-1,5(1 - G)$	
8 000	$-1,5(1 - G)$	

NOTES

$$a'(h) = 1,5 + 3,0 \times e^{-0,12(h-5)^2}\left(1 - e^{-d_p/50}\right) + 5,7 \times e^{-0,09h^2}\left(1 - e^{-2,8 \times 10^{-6} \times d_p^2}\right)$$

$$b'(h) = 1,5 + 8,6 \times e^{-0,09h^2}\left(1 - e^{-d_p/50}\right)$$

$$c'(h) = 1,5 + 14,0 \times e^{-0,46h^2}\left(1 - e^{-d_p/50}\right)$$

$$d'(h) = 1,5 + 5,0 \times e^{-0,9h^2}\left(1 - e^{-d_p/50}\right)$$

1) For calculating A_s, take $G = G_s$ and $h = h_s$. For calculating A_r, take $G = G_r$ and $h = h_r$. See 7.3.1 for values of G for various ground surfaces.

2) $q = 0$ when $d_p \leqslant 30(h_s + h_r)$

$$q = 1 - \frac{30(h_s + h_r)}{d_p} \quad \text{when } d_p > 30(h_s + h_r)$$

where d_p is the source-to-receiver distance, in metres, projected onto the ground planes.

7.3.2 Alternative method of calculation for A-weighted sound pressure levels

Under the following specific conditions

— only the A-weighted sound pressure level at the receiver position is of interest,

— the sound propagation occurs over porous ground or mixed ground most of which is porous (see 7.3.1),

— the sound is not a pure tone,

and for ground surfaces of any shape, the ground attenuation may be calculated from equation (10):

$$A_{gr} = 4,8 - (2h_m/d)\left[17 + (300/d)\right] \geqslant 0 \text{ dB} \quad \ldots (10)$$

where

h_m is the mean height of the propagation path above the ground, in metres;

d is the distance from the source to receiver, in metres.

The mean height h_m may be evaluated by the method shown in figure 3. Negative values for A_{gr} from equation (10) shall be replaced by zeros.

NOTE 12 For short distances d, equation (10) predicts no attenuation and equation (9) may be more accurate.

When the ground attenuation is calculated using equation (10), the directivity correction D_c in equation (3) shall include a term D_Ω, in decibels, to account for the apparent increase in sound power level of the source due to reflections from the ground near the source.

$$D_\Omega = 10 \lg \left\{1 + \left[d_p^2 + (h_s - h_r)^2\right] \Big/ \left[d_p^2 + (h_s + h_r)^2\right]\right\} \text{ dB} \quad \ldots (11)$$

where

h_s is the height of the source above the ground, in metres;

h_r is the height of the receiver above the ground, in metres;

d_p is the source-to-receiver distance projected onto the ground plane, in metres.

7.4 Screening (A_{bar})

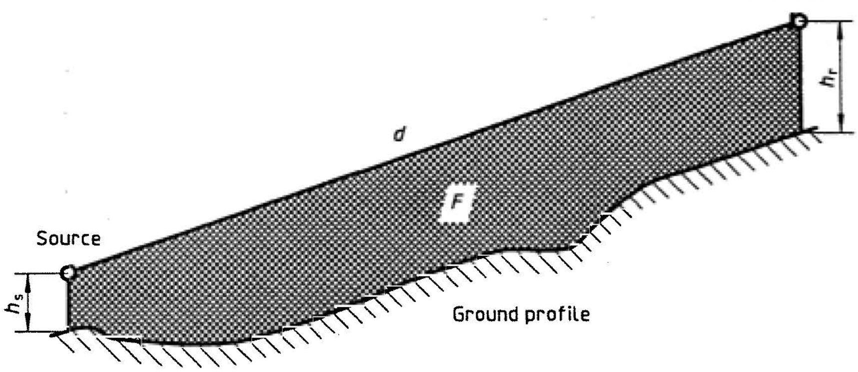
An object shall be taken into account as a screening obstacle (often called a barrier) if it meets the following requirements:

— the surface density is at least 10 kg/m^2;

— the object has a closed surface without large cracks or gaps (consequently process installations in chemical plants, for example, are ignored);

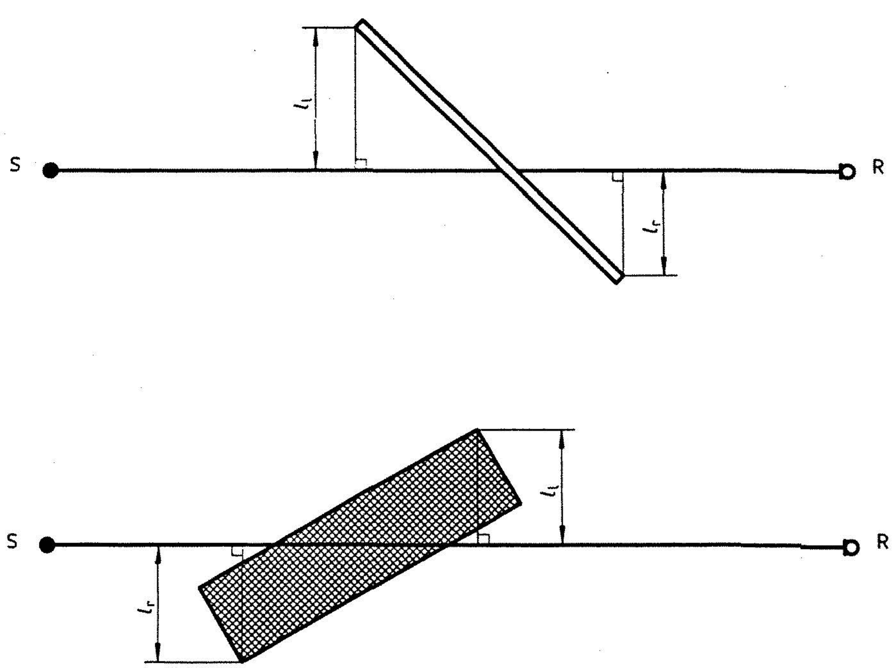
— the horizontal dimension of the object normal to the source-receiver line is larger than the acoustic wavelength λ at the nominal midband frequency for the octave band of interest; in other words $l_l + l_r > \lambda$ (see figure 4).

Each object that fulfils these requirements shall be represented by a barrier with vertical edges. The top edge of the barrier is a straight line that may be sloping.



$h_m = F/d$, where F is the area

Figure 3 — Method for evaluating the mean height h_m



NOTE — An object is only considered to be a screening obstacle when its horizontal dimension perpendicular to the source-receiver line SR is larger than the wavelength: $(l_l + l_r) > \lambda$

Figure 4 — Plan view of two obstacles between the source (S) and the receiver (R)

For the purposes of this part of ISO 9613, the attenuation by a barrier, A_{bar}, shall be given by the insertion loss. Diffraction over the top edge and around a vertical edge of a barrier may both be important. (See figure 5.) For downwind sound propagation, the effect of diffraction (in decibels) over the top edge shall be calculated by

$$A_{bar} = D_z - A_{gr} > 0 \quad \text{... (12)}$$

and for diffraction around a vertical edge by

$$A_{bar} = D_z > 0 \quad \text{... (13)}$$

where

D_z is the barrier attenuation for each octave band [see equation (14)];

A_{gr} is the ground attenuation **in the absence of the barrier** (i.e. with the screening obstacle removed) (see 7.3).

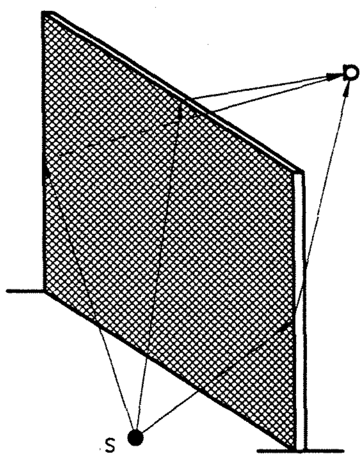


Figure 5 — Different sound propagation paths at a barrier

NOTES

13 When A_{bar} as defined by equation (12) is substituted in equation (4) to find the total attenuation A, the two A_{gr} terms in equation (4) will cancel. The barrier attenuation D_z in equation (12) then includes the effect of the ground in the presence of the barrier.

14 For large distances and high barriers, the insertion loss calculated by equation (12) is not sufficiently confirmed by measurements.

15 In calculation of the insertion loss for multisource industrial plants by high buildings (more than 10 m above the ground), and also for high-noise sources within the plant, equation (13) should be used in both cases for determining the long-term average sound pressure level [using equation (6)].

16 For sound from a depressed highway, there may be attenuation in addition to that indicated by equation (12) along a ground surface outside the depression, due to that ground surface.

To calculate the barrier attenuation D_z, assume that only one significant sound-propagation path exists from the sound source to the receiver. If this assumption is not valid, separate calculations are required for other propagation paths (as illustrated in figure 5) and the contributions from the various paths to the squared sound pressure at the receiver are summed.

The barrier attenuation D_z, in decibels, shall be calculated for this path by equation (14):

$$D_z = 10 \lg \left[3 + (C_2/\lambda) C_3 z K_{met}\right] \text{ dB} \quad \text{... (14)}$$

where

C_2 is equal to 20, and includes the effect of ground reflections; if in special cases ground reflections are taken into account separately by image sources, $C_2 = 40$;

C_3 is equal to 1 for single diffraction (see figure 6);

$$C_3 = \left[1 + (5\lambda/e)^2\right] \Big/ \left[(1/3) + (5\lambda/e)^2\right] \quad \text{... (15)}$$

for double diffraction (see figure 7);

λ is the wavelength of sound at the nominal midband frequency of the octave band, in metres;

z is the difference between the pathlengths of diffracted and direct sound, as calculated by equations (16) and (17), in metres;

K_{met} is the correction factor for meteorological effects, given by equation (18);

e is the distance between the two diffraction edges in the case of double diffraction (see figure 7).

For single diffraction, as shown in figure 6, the pathlength difference z shall be calculated by means of equation (16):

$$z = \left[(d_{ss} + d_{sr})^2 + a^2\right]^{1/2} - d \quad \text{... (16)}$$

where

d_{ss} is the distance from the source to the (first) diffraction edge, in metres;

d_{sr} is the distance from the (second) diffraction edge to the receiver, in metres;

a is the component distance parallel to the barrier edge between source and receiver, in metres.

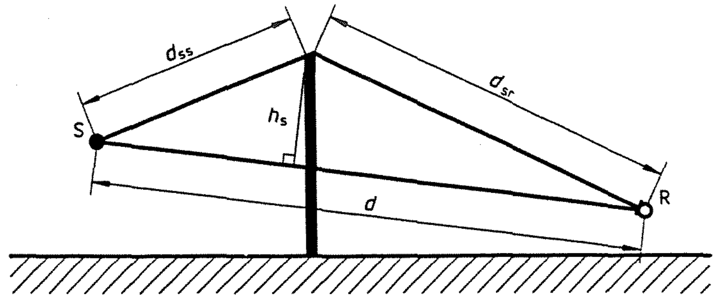


Figure 6 — Geometrical quantities for determining the pathlength difference for single diffraction

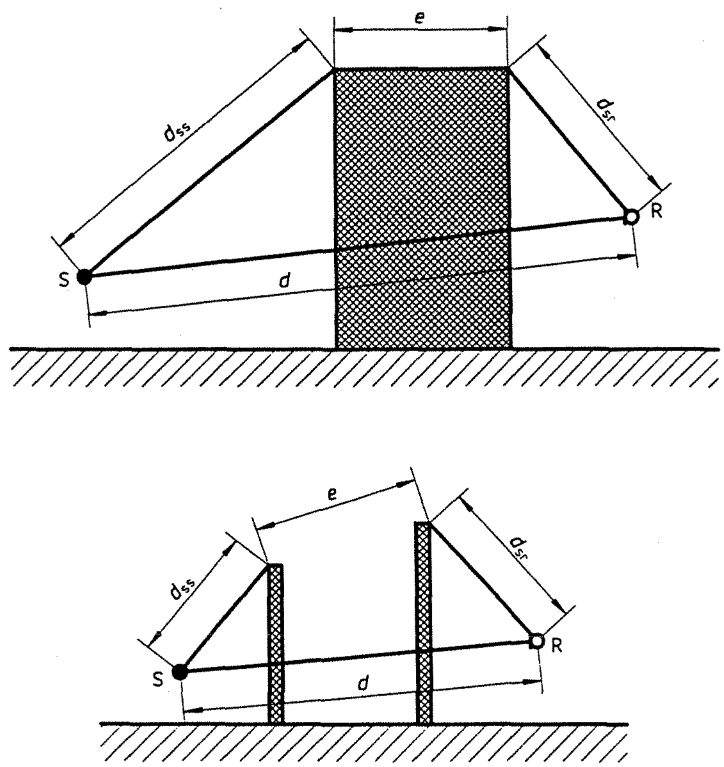


Figure 7 — Geometrical quantities for determining the pathlength difference for double diffraction

If the line of sight between the source S and receiver R passes above the top edge of the barrier, z is given a negative sign.

For double diffraction, as shown in figure 7, the pathlength difference z shall be calculated by

$$z = \left[\left(d_{ss} + d_{sr} + e \right)^2 + a^2 \right]^{1/2} - d \qquad \ldots (17)$$

The correction factor K_{met} for meteorological conditions in equation (14) shall be calculated using equation (18):

$$K_{met} = \exp\left[-(1/2000)\sqrt{d_{ss} d_{sr} d/(2z)} \right] \quad \text{for } z > 0 \qquad \ldots (18)$$

$$K_{met} = 1 \quad \text{for } z \leq 0$$

For lateral diffraction around obstacles, it shall be assumed that $K_{met} = 1$ (see figure 5).

NOTES

17 For source-to-receiver distances less than 100 m, the calculation using equation (14) shows that K_{met} may be assumed equal to 1, to an accuracy of 1 dB.

18 Equation (15) provides a continuous transition from the case of single diffraction ($e = 0$) where $C_3 = 1$, to that of a well-separated double diffraction ($e \gg \lambda$) where $C_3 = 3$.

19 A barrier may be less effective than calculated by equations (12) to (18) as a result of reflections from other acoustically hard surfaces near the sound path from the source to the receiver or by multiple reflections between an acoustically hard barrier and the source.

The barrier attenuation D_z, in any octave band, should not be taken to be greater than 20 dB in the case of single diffraction (i.e. thin barriers) and 25 dB in the case of double diffraction (i.e. thick barriers).

The barrier attenuation for two barriers is calculated using equation (14) for double diffraction, as indicated in the lower part of figure 7. The barrier attenuation for more than two barriers may also be calculated approximately using equation (14), by choosing the two most effective barriers, neglecting the effects of the others.

7.5 Reflections

Reflections are considered here in terms of image sources. These reflections are from outdoor ceilings and more or less vertical surfaces, such as the façades of buildings, which can increase the sound pressure levels at the receiver. The effect of reflections from the ground are not included because they enter into the calculation of A_{gr}.

The reflections from an obstacle shall be calculated for all octave bands for which all the following requirements are met:

— a specular reflection can be constructed, as shown in figure 8;

— the magnitude of the sound reflection coefficient for the surface of the obstacle is greater than 0,2;

— the surface is large enough for the nominal midband wavelength λ (in metres) for the octave band under consideration to obey the relationship

$$1/\lambda > \left[2/(l_{min} \cos \beta)^2\right]\left[d_{s,o}d_{o,r}/(d_{s,o} + d_{o,r})\right] \qquad \ldots (19)$$

where

- λ is the wavelength of sound (in metres) at the nominal midband frequency f (in hertz) of the octave band $\left(\lambda = \dfrac{340 \text{ m/s}}{f}\right)$;
- $d_{s,o}$ is the distance between the source and the point of reflection on the obstacle;
- $d_{o,r}$ is the distance between the point of reflection on the obstacle and the receiver;
- β is the angle of incidence, in radians (see figure 8);
- l_{min} is the minimum dimension (length or height) of the reflecting surface (see figure 8).

If any of these conditions is not met for a given octave band, then reflections shall be neglected.

The real source and source image are handled separately. The sound power level of the source image $L_{W,im}$ shall be calculated from

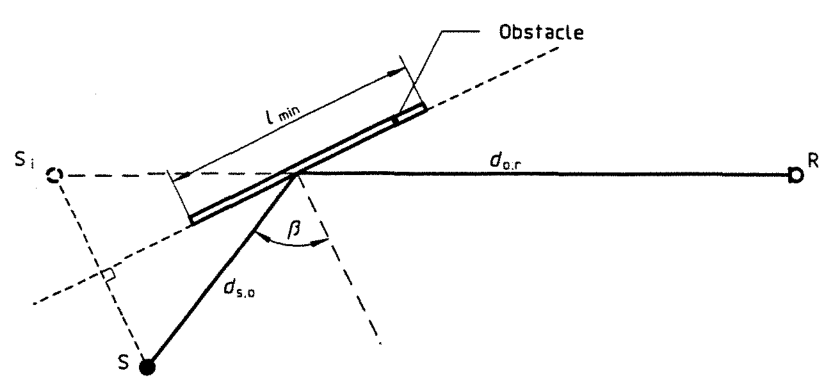
$$L_{W,im} = L_W + 10 \lg(\rho)\,\text{dB} + D_{Ir} \qquad \ldots (20)$$

where

- ρ is the sound reflection coefficient at angle β on the surface of the obstacle ($\geqslant 0{,}2$) (see figure 8);
- D_{Ir} is the directivity index of the source in the direction of the receiver image.

If specific data for the sound reflection coefficient are not available, the value may be estimated using table 4.

For the sound source image, the attenuation terms of equation (4), as well as ρ and D_{Ir} in equation (20), shall be determined according to the propagation path of the reflected sound.



NOTE — A path $d_{s,o} + d_{o,r}$ connecting the source S and receiver R by reflection from the obstacle exists in which β, the angle of incidence, is equal to the angle of reflection. The reflected sound appears to come from the source image S_i.

Figure 8 — Specular reflection from an obstacle

Table 4 — Estimates of the sound reflection coefficient ρ

Object	ρ
Flat hard walls	1
Walls of building with windows and small additions or bay	0,8
Factory walls with 50 % of the surface consisting of openings, installations or pipes	0,4
Cylinders with hard surfaces (tanks, silos)	$\dfrac{D \sin(\phi/2)}{2d_{sc}}$ *) where D is the diameter of the cylinder; d_{sc} is the distance from the source to the centre C of the cylinder; ϕ is the supplement of the angle between lines SC and CR.
Open installations (pipes, towers, etc.)	0
*) This expression applies only if the distance d_{sc} from the source S to cylinder C is much smaller than the distance d_{cr} from the cylinder to receiver; see figure 9.	

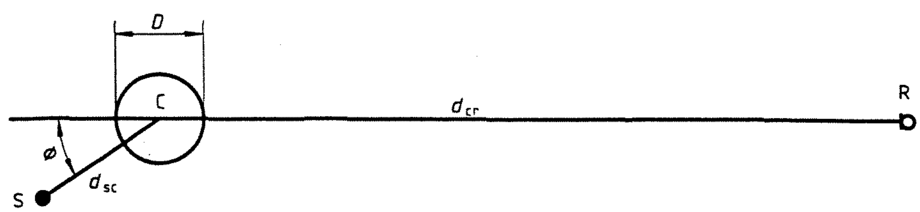


Figure 9 — Estimation of sound reflection coefficient for a cylinder

8 Meteorological correction (C_{met})

Use of equation (3) leads directly to an equivalent continuous A-weighted sound pressure level L_{AT} at the receiver for meteorological conditions which are favourable for propagation from the sound source to that receiver, as described in clause 5. This may be the appropriate condition for meeting a specific community noise limit, i.e. a level which is seldom exceeded (see ISO 1996-3). Often, however, a long-term average A-weighted sound pressure level L_{AT}(LT) is required, where the time interval T is several months or a year. Such a period will normally include a variety of meteorological conditions, both favourable and unfavourable to propagation. A value for L_{AT}(LT) may be obtained in this situation from that calculated for L_{AT}(DW) via equation (3), by using the meteorological correction C_{met} in equation (6).

A value (in decibels) for C_{met} in equation (6) may be calculated using equations (21) and (22) for the case of a point sound source with an output which is effectively constant with time:

$$C_{met} = 0 \qquad \dots (21)$$

$$\text{if } d_p \leqslant 10(h_s + h_r)$$

$$C_{met} = C_0 \left[1 - 10(h_s + h_r)/d_p\right] \qquad \dots (22)$$

$$\text{if } d_p > 10(h_s + h_r)$$

where

h_s is the source height, in metres;

h_r is the receiver height, in metres;

d_p is the distance between the source and receiver projected to the horizontal ground plane, in metres;

C_0 is a factor, in decibels, which depends on local meteorological statistics for wind speed and direction, and temperature gradients.

The effects of meteorological conditions on sound propagation are small for short distances d_p, and for longer distances at greater source and receiver heights. Equations (21) and (22) account approxi-

Values in metres

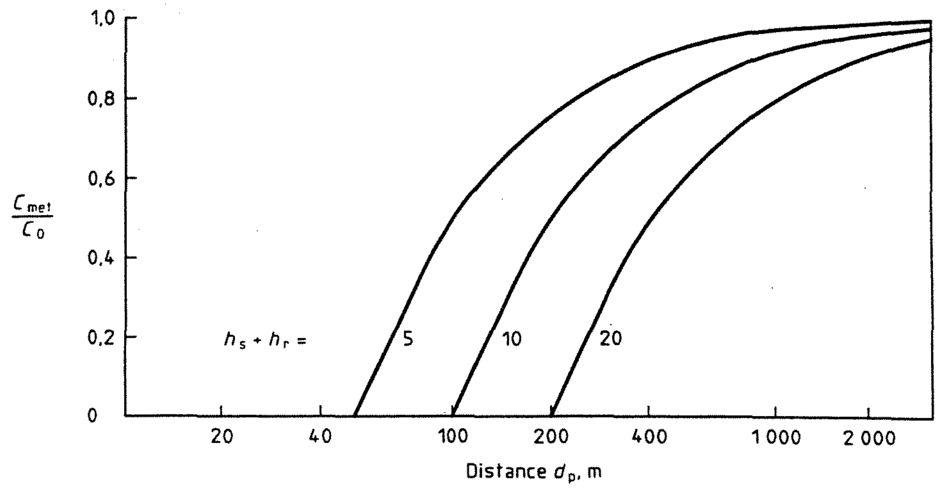


Figure 10 — Meteorological correction C_{met}

NOTES

20 A value for C_0 in equations (21) and (22) may be estimated from an elementary analysis of the local meteorological statistics. For example, if the meteorological conditions favourable to propagation described in clause 5 are found to occur for 50 % of the time period of interest, and the attenuation during the other 50 % is higher by 10 dB or more, then the sound energy which arrives for meteorological conditions unfavourable to propagation may be neglected, and C_0 will be approximately + 3 dB.

21 The meteorological conditions for evaluating C_0 may be established by the local authorities.

22 Experience indicates that values of C_0 in practice are limited to the range from zero to approximately + 5 dB, and values in excess of 2 dB are exceptional. Thus only very elementary statistics of the local meteorology are needed for a ± 1 dB accuracy in C_0.

For a source that is composed of several component point sources, h_s in equations (21) and (22) represents the predominant source height, and d_p the distance from the centre of that source to the receiver.

9 Accuracy and limitations of the method

The attenuation of sound propagating outdoors between a fixed source and receiver fluctuates due to variations in the meteorological conditions along the propagation path. Restricting attention to moderate downwind conditions of propagation, as specified in clause 5, limits the effect of variable meteorological conditions on attenuation to reasonable values.

There is information to support the method of calculation given in clauses 4 to 8 (see annex B) for broadband noise sources. The agreement between calculated and measured values of the average A-weighted sound pressure level for downwind propagation, L_{AT}(DW), supports the estimated accuracy of calculation shown in table 5. These estimates of accuracy are restricted to the range of conditions specified for the validity of the equations in clauses 3 to 8 and are independent of uncertainties in sound power determination.

NOTE 24 The estimates of accuracy in table 5 are for downwind conditions averaged over independent situations (as specified in clause 5). They should not necessarily be expected to agree with the variation in measurements made at a given site on a given day. The latter can be expected to be considerably larger than the values in table 5.

The estimated errors in calculating the average downwind octave-band sound pressure levels, as well as pure-tone sound pressure levels, under the same conditions, may be somewhat larger than the estimated errors given for A-weighted sound pressure levels of broad-band sources in table 5.

In table 5, an estimate of accuracy is not provided in this part of ISO 9613 for distances d greater than the 1 000 m upper limit.

Throughout this part of ISO 9613 the meteorological conditions under consideration are limited to only two cases:

a) moderate downwind conditions of propagation, or their equivalent, as defined in clause 5;

b) a variety of meteorological conditions as they exist over months or years.

The use of equations (1) to (5) and (7) to (20) (and therefore also table 5) is limited to case a): meteorological conditions only. Case b) is relevant only to the use of equations (6), (21) and (22). There are also a substantial number of limitations (non-meteorological) in the use of individual equations. Equation (9) is, for example, limited to approximately flat terrain. These specific limitations are described in the text accompanying the relevant equation.

Table 5 — Estimated accuracy for broadband noise of L_{AT}(DW) calculated using equations (1) to (10)

Height, h *)	Distance, d *)	
	$0 < d < 100$ m	$100\text{ m} < d < 1\,000$ m
$0 < h < 5$ m	± 3 dB	± 3 dB
$5\text{ m} < h < 30$ m	± 1 dB	± 3 dB

*) h is the mean height of the source and receiver.
d is the distance between the source and receiver.

NOTE — These estimates have been made from situations where there are no effects due to reflection or attenuation due to screening.

Annex A
(informative)

Additional types of attenuation (A_{misc})

The term A_{misc} in equation (4) covers contributions to the attenuation from miscellaneous effects not accessible by the general methods of calculating the attenuation specified in clause 7. These contributions include

— A_{fol}, the attenuation of sound during propagation through foliage,

— A_{site}, the attenuation during propagation through an industrial site, and

— A_{hous}, the attenuation during propagation through a built-up region of houses,

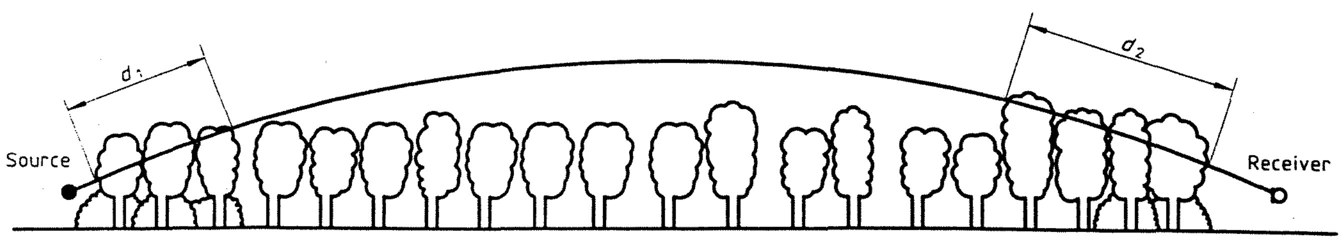
which are all considered in this annex.

For calculating these additional contributions to the attenuation, the curved downwind propagation path may be approximated by an arc of a circle of radius 5 km, as shown in figure A.1.

A.1 Foliage (A_{fol})

The foliage of trees and shrubs provides a small amount of attenuation, but only if it is sufficiently dense to completely block the view along the propagation path, i.e. when it is impossible to see a short distance through the foliage. The attenuation may be by vegetation close to the source, or close to the receiver, or by both situations, as illustrated in figure A.1. Alternatively, the path for the distances d_1 and d_2 may be taken as falling along lines at propagation angles of 15° to the ground.

The first line in table A.1 gives the attenuation to be expected from dense foliage if the total path length through the foliage is between 10 m and 20 m, and the second line if it is between 20 m and 200 m. For path lengths greater than 200 m through dense foliage, the attenuation for 200 m should be used.



NOTE — $d_f = d_1 + d_2$

For calculating d_1 and d_2, the curved path radius may be assumed to be 5 km.

Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance d_f through the foliage

Table A.1 — Attenuation of an octave band of noise due to propagation a distance d_f through dense foliage

Propagation distance d_f m	**Nominal midband frequency** Hz 63	125	250	500	1 000	2 000	4 000	8 000
	Attenuation, dB:							
$10 \leq d_f \leq 20$	0	0	1	1	1	1	2	3
	Attenuation, dB/m:							
$20 \leq d_f \leq 200$	0,02	0,03	0,04	0,05	0,06	0,08	0,09	0,12

A.2 Industrial sites (A_{site})

At industrial sites, an attenuation can occur due to scattering from installations (and other objects), which may be described as A_{site}, unless accounted for under A_{bar}, or the sound source radiation specification. The term installations includes miscellaneous pipes, valves, boxes, structural elements, etc.

As the value of A_{site} depends strongly on the type of site, it is recommended that it is determined by measurements. However, for an estimate of this attenuation, the values in table A.2 may be used. The attenuation increases linearly with the length of the curved path d_s through the installations (see figure A.2), with a maximum of 10 dB.

A.3 Housing (A_{hous})

A.3.1 When either the source or receiver, or both are situated in a built-up region of houses, an attenuation will occur due to screening by the houses. However, this effect may largely be compensated by propagation between houses and by reflections from other houses in the vicinity. This combined effect of screening and reflections that constitutes A_{hous} can be calculated for a specific situation, at least in principle, by applying the procedures for both A_{bar} and reflections described in 7.4 and 7.5. Because the value of A_{hous} is very situation-dependent, such a calculation may be justified in practice. A more useful alternative, particularly for the case of multiple reflections where the accuracy of calculation suffers, may be to measure the effect, either in the field or by modelling.

A.3.2 An approximate value for the A-weighted attenuation A_{hous}, which should not exceed 10 dB, may also be estimated as follows. There are two separate contributions

$$A_{hous} = A_{hous,1} + A_{hous,2} \qquad \text{... (A.1)}$$

A.3.3 An average value for $A_{hous,1}$ (in decibels) may be calculated using the equation

$$A_{hous,1} = 0{,}1 B d_b \quad \text{dB} \qquad \text{... (A.2)}$$

where

B is the density of the buildings along that path, given by the total plan area of the houses divided by the total ground area (including that covered by the houses);

d_b is the length of the sound path, in metres, through the built-up region of houses, determined by a procedure analogous to that shown in figure A.1.

The path length d_b may include a portion d_1 near the source and a portion d_2 near the receiver, as indicated in figure A.1.

The value of A_{hous} shall be set equal to zero in the case of a small source with a direct, unobstructed line of sight to the receiver down a corridor gap between housing structures.

NOTE 25 The A-weighted sound pressure level at specific individual positions in a region of houses may differ by up to 10 dB from the average value predicted using equations (A.1) and (A.2).

Table A.2 — Attenuation coefficient of an octave band of noise during propagation through installations at industrial plants

Nominal midband frequency, Hz	63	125	250	500	1 000	2 000	4 000	8 000
A_{site}, dB/m	0	0,015	0,025	0,025	0,02	0,02	0,015	0,015

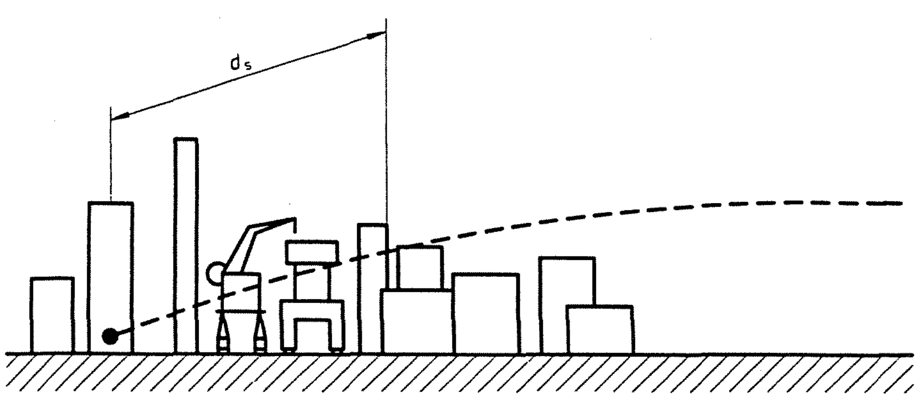


Figure A.2 — The attenuation A_{site} increases linearly with the propagation distance d_s through the installations at industrial plants

A.3.4 If there are well-defined rows of buildings near a road, a railway, or a similar corridor, an additional term $A_{hous,2}$ may be included (provided this term is less than the insertion loss of a barrier at the same position with the mean height of the buildings):

$$A_{hous,2} = -10\ \lg[1 - (p/100)]\ \text{dB} \qquad \ldots (A.3)$$

where p (the percentage of the length of the façades relative to the total length of the road or railway in the vicinity) is $\leqslant 90$ %.

A.3.5 In a built-up region of houses, the value of $A_{hous,1}$ [as calculated by equation (A.2)] interacts as follows with the value for A_{gr}, the attenuation due to the ground [as calculated by equation (9) or equation (10)].

Let $A_{gr,b}$ be the ground attenuation in the built-up region, and $A_{gr,0}$ be the ground attenuation if the houses were removed [i.e. as calculated by equation (9) or equation (10)]. For propagation through the built-up region in general, $A_{gr,b}$ is assumed to be zero in equation (4). If, however, the value of $A_{gr,0}$ is greater than that of A_{hous}, then the influence of A_{hous} is ignored and only the value of $A_{gr,0}$ is included in equation (4).

The interaction above is essentially to allow for a range of housing density B. For low-density housing, the value of A_{gr} is dominant, while for high-density housing A_{hous} dominates.

Annex B
(informative)

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INSULATION FACTS #58

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North American Insulation Manufacturers Association

The Facts About the Acoustical Performance of Metal Building Insulation

Metal Building insulation greatly reduces the level of both exterior and interior noise by preventing transmission of exterior sounds to the interior of the building and absorbing reverberating sounds within the building. This fact sheet discusses the fundamentals of acoustical performance and shows how to improve sound control in typical wall and roof assemblies through the use of fiber glass insulation.

Metal building insulation has been used for many years to thermally insulate the walls and roofs of metal buildings. An additional benefit is that it provides a better acoustical environment both inside and outside the building. Metal building insulation can absorb interior noise to provide a quieter work environment. It can also decrease the amount of noise transmitted into or out of a building.

Because of the porous nature of metal building insulation, it is an excellent absorber of sound. It can reduce noise levels in a building up to 5-6 dB. This same sound absorbing property is used to reduce the amount of sound that is transmitted through a wall or roof. Thus, it can reduce equipment noise transmitted to neighbors. It can also reduce outside noise so that building occupants are not disturbed by exterior noise sources such as traffic.

Sound Absorption Coefficient

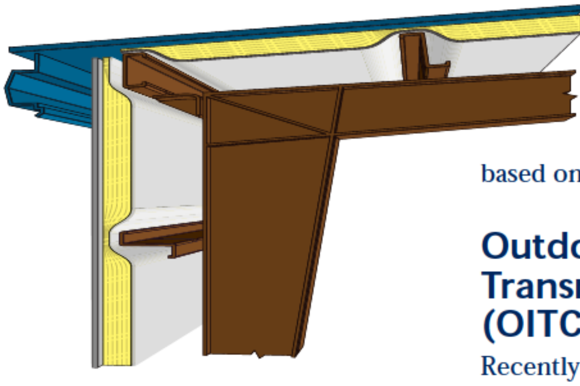
The sound absorption properties of a material are expressed in terms of a sound absorption coefficient. This coefficient typically ranges from 0.05 to 1.20. The higher the coefficient the better the material absorbs sound.

Sound absorption coefficients are measured at several frequencies since it varies with frequency. A material with an absorption coefficient of 0.66 at a particular frequency, means that 66% of the sound that strikes that material is absorbed or conversely 34% of the sound is reflected back into the room.

Metal building insulation is an excellent sound absorber with coefficients ranging from 0.20 to 1.20.

Noise Reduction Coefficient (NRC)

A single number rating has been established to express the ability of a material to absorb sound at multiple frequencies. This single number rating is called the noise reduction coefficient (NRC). Again, the higher the NRC value, the better a material absorbs sound. NRC values for faced metal building insulation range from about 0.75 to 0.90.



Sound Transmission Loss

The ability of a wall or roof to reduce the amount of sound transmitted through it is called sound transmission loss. Sound transmission loss is expressed in decibels (dB) and it also varies with frequency. Most materials and constructions reduce the transmission of high frequency sounds more than low frequency sounds.

When building a wall or roof it is imperative that there are no air (sound) leaks in the construction. Sound leaks can drastically reduce the effectiveness of a wall to reduce the transmission of sound from one space to another. The construction should be as tight as possible. Where gaps exist, they should be filled with a flexible sealant such as a non-curing Butyl, siliconized acrylic latex or an acrylic latex.

Sound Transmission Class (STC)

A single number rating system used to express the sound transmission loss properties of a wall or roof is the sound transmission class (STC). The higher the STC value, the better a construction reduces the transmission of sound. In a typical metal building construction the values for STC range from a low of about 20 to a high of 55. The STC rating has been in existence for many years and is based on speech sounds.

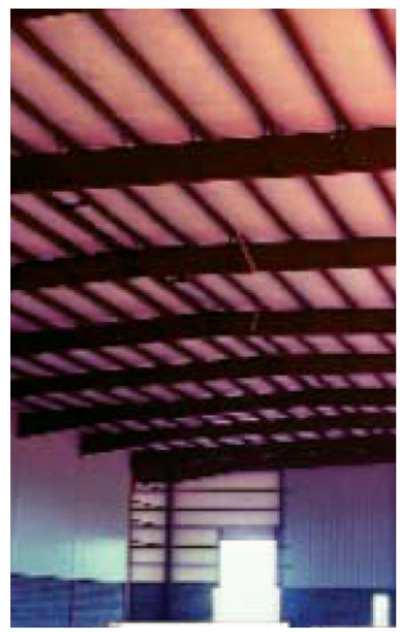
Outdoor-Indoor Transmission Class (OITC)

Recently a new single number rating has been introduced. It is called the outdoor-indoor transmission class (OITC). It is used to specify the sound transmission loss properties of exterior building elements such as walls and windows. The OITC uses outside noise sources such as traffic, aircraft and trains to calculate a single number rating. The OITC is the preferred rating for exterior walls and roofs of metal buildings.

Conclusion

Noise is becoming an indoor environmental pollution issue as it can effect the health and performance of the building occupants. Construction techniques to reduce sound are becoming increasingly important and many builders and architects are looking for cost-effective ways to further reduce sound transmission in metal buildings.

Adding faced metal building insulation alone to the metal building construction can reduce noise levels in a metal building by 5-6 dB. However, construction techniques do impact the way sound travels. To maximize a metal building's acoustical performance, the wall and/or roof panels should include at least one layer of faced metal building insulation, and one layer of unfaced metal building insulation. Additionally, the construction should be tight, with attention to detail such as filling gaps with flexible sealants to assure that sound does not transit via air leaks from one space to another.



Vapor Retarder Facing	Noise Reduction Coefficients (NRC)
PSK Light Duty	.85
PSK Standard Duty	.85
PSK Heavy Duty	.75
FSK Heavy Duty	.80
PSF	.90
Vinyl	.85

NRC rating is for facing laminated to R10 and R19 fiber glass.
Tested in accordance with ASTM C423 on an "A" mounting.

STC and OITC Ratings for Typical Metal Building Constructions

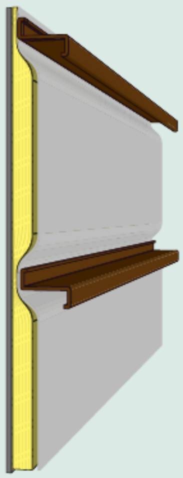
Walls

STC 21 / OITC 17

No Insulation

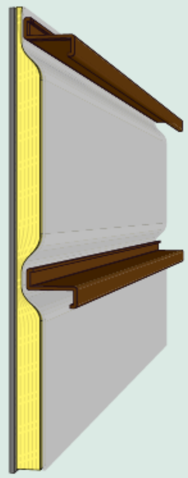
STC 28 / OITC 20

R-10 Faced 202-96 Insulation
Over the Girts



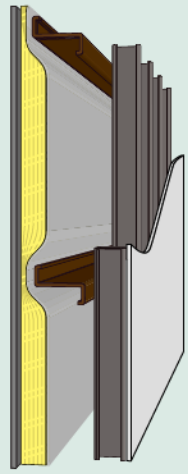
STC 29 / OITC 20

R-13 Faced 202-96 Insulation
Over the Girts



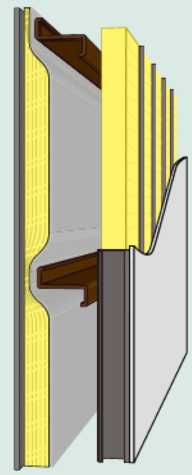
STC 50 / OITC 35

R-13 Faced 202-96 Insulation
Over the Girts
3 5/8" Steel Studs on
24" Centers with
1/2" Gyp. Board on Interior



STC 54 / OITC 39

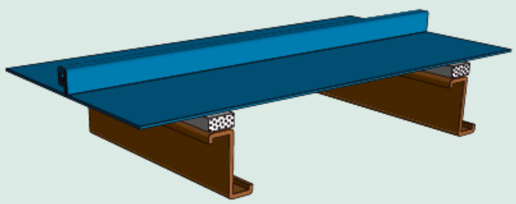
R-13 Faced 202-96 Insulation
Over the Girts
3 5/8" Steel Studs on
24" Centers with
R-11 Batts and
1/2" Gyp. Board on Interior



Roofs

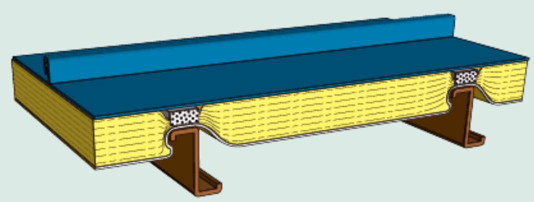
STC 24 / OITC 18

No Insulation



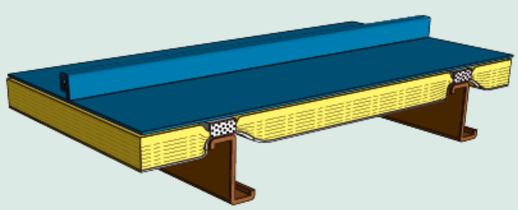
STC 32 / OITC 22

R-19 Faced Insulation Over the Purlins



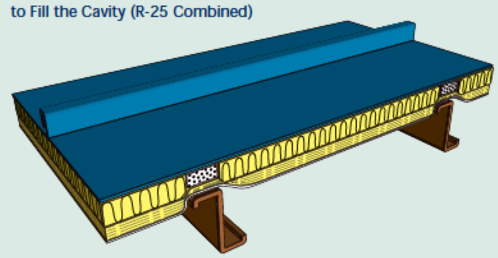
STC 29 / OITC 20

R-10 Faced 202-96 Insulation
Over the Purlins



STC 36 / OITC 24

202-96 Insulation Over and Between the Purlins
to Fill the Cavity (R-25 Combined)



Assemblies tested in accordance with ASTM E 90.
STC rating determined in accordance with ASTM E 413.
OITC ratings determined in accordance with ASTM E 1332.
Roof Construction is 24 ga. standing seam roof with 8" Z purlins on 5' centers.
Wall Construction is 26 ga. wall panels screwed to 8" Z purlins on 7' centers.

Metal Building Acoustical Performance

Sound Transmission Loss

	Construction Type	Transmission Loss -dB at Octave Band Frequencies 125	250	500	1000	2000	4000	STC Rating	OITC Rating
Roofs	No Insulation	12	13	19	24	30	32	24	18
Roofs	R-10 Faced 202-96 (Rev. 2000) insulation over the purlins	12	16	26	37	45	49	29	20
Roofs	R-19 Faced 202-96 (Rev. 2000) insulation over the purlins	13	20	30	41	49	51	32	22
Roofs	202-96 (Rev. 2000) insulation over the purlin and between the purlin to fill the cavity (R25 combined)	14	24	34	44	53	56	36	24
Walls	No Insulation	12	14	19	19	20	27	21	17
Walls	R10 faced 202-96 (Rev. 2000) insulation over the girts	13	16	25	32	37	46	28	20
Walls	R13 faced 202-96 (Rev. 2000) insulation over the girts	13	17	26	33	36	47	29	20
Walls	R13 faced 202-96 (Rev. 2000) insulation over the girts, 3 5/8" steel studs on 24" centers with 1/2" gyp. board on interior	26	40	51	60	64	65	50	35
Walls	R13 faced 202-96 (Rev. 2000) insulation over the girts, 3 5/8" steel studs on 24" centers with R-11 Batts and 1/2" gyp. board on interior	31	43	55	68	73	75	54	39

Sound Transmission Class (STC) in accordance with ASTM E 90.

Roof construction is 24 ga standing seam roof with 8" Z purlins on 5' centers.

Wall construction is 26 ga wall panels screwed to 8" Z girts placed on 7' centers.

Interior metal furring wall studs were 3 5/8" by 25 ga on 24" centers.

Sound Absorption

R19 Insulation Laminated with Vapor Retarder Facing	Absorption Coefficients @ Octave Band Frequencies 125	250	500	1000	2000	4000	NRC
PSK Light Duty Facing	1.06	1.2	0.93	0.8	0.51	0.3	0.85
PSK Standard Duty Facing	1.04	1.23	0.91	0.78	0.49	0.28	0.85
PSK Heavy Duty Facing	1.07	1.17	0.83	0.63	0.35	0.2	0.75
FSK Heavy Duty Facing	1.06	1.17	0.89	0.72	0.43	0.24	0.80
PSK Facing	1.06	1.22	0.93	0.83	0.57	0.34	0.90
Vinyl Facing	0.95	1.2	0.94	0.73	0.52	0.37	0.85
Unfaced	0.89	1.22	1.02	0.98	1.01	1.00	1.05

Sound Absorption Coefficient in accordance with ASTM C 423 using an "A"mounting.

About NAIMA

NAIMA is the association for North American manufacturers of fiber glass, rock wool, and slag wool insulation products. Its role is to promote energy efficiency and environmental preservation through the use of fiber glass, rock wool, and slag wool insulation, and to encourage the safe production and use of these materials.

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