High-Speed Ground Transportation Noise and Vibration Impact Assessment

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CHAPTER 3 - NOISE IMPACT CRITERIA

The criteria used in evaluating noise impacts from high-speed ground transportation are based on maintaining a noise environment considered acceptable for land uses where noise may have an effect. These criteria take into account the unusual noise characteristics of high-speed rail operations, including the effects of startle on humans, livestock, and wildlife to the extent that these effects are known.

The noise impact criteria for high-speed ground transportation facilities are presented in Section 3.1. These criteria are adapted from criteria developed by the Federal Transit Administration for rail noise sources operating on fixed guideways or at fixed facilities.[21] The criterion for the onset of **moderate impact** varies according to the existing noise level and the predicted project noise level, and it is determined by the minimum measurable change in community reaction. The corresponding criterion for **severe impact** also varies according to the existing noise level as well as the project noise level, but it is determined by the change in community reaction between an acceptable and an unacceptable noise environment. Guidelines for the application of the criteria are included in Section 3.2, and background material on the development of the criteria is included in Appendix A.

3.1 NOISE IMPACT CRITERIA FOR HIGH SPEED RAIL PROJECTS

The noise impact criteria for high-speed ground transportation projects are shown in graphs and tables in this section. The equations used to define these criteria are included in Appendix A. The criteria apply to high-speed train operations as well as to fixed facilities such as storage and maintenance yards, passenger stations and terminals, parking facilities, and substations.

3.1.1 Basis of Noise Impact Criteria

The noise impact criteria for human annoyance, presented in Figure 3-1 and Table 3-1, are based on comparison of the existing outdoor noise levels and the future outdoor noise levels from a proposed high-speed train project. They incorporate both absolute criteria, which consider activity interference caused by the high-speed train project alone, and relative criteria, which consider annoyance due to the change in the noise environment caused by the project. These criteria were developed to apply to a wide variety of

[21] U.S. Department of Transportation, Federal Transit Administration. "Transit Noise and Vibration Impact Assessment," Final Report, DOT-T-95-16, April 1995.

surface transportation modes, to recognize the heightened community annoyance caused by late-night or early-morning operations, and to respond to the varying sensitivities of communities to projects under different background noise conditions.

The noise criteria and descriptors for human annoyance depend on land use, as defined in Table 3-2. Further guidance on the definition of land use, the selection of the appropriate noise metric, and the application of these criteria are given in Section 3.2, with more detailed guidelines provided in Chapters 4 and 5.

Noise effects on livestock and wildlife also have been considered. There are no established criteria relating high-speed train noise and animal behavior. However, some characteristics of high-speed train noise are similar to low overflights of aircraft, and researchers generally agree that high noise levels from aircraft overflights can have a disturbing effect on both domestic livestock and wildlife. Some animals get used to noise exposure, while some do not. Documented effects range from simply taking notice and changing body position to taking flight in panic. Whether these responses represent a threat to survival of animals remains unclear, although panic flight may result in injuries to animals in rough terrain or in predation of unprotected eggs of birds. A limited amount of quantitative noise data relating actual levels to effects provides enough information to develop a screening procedure to identify areas where noise from high speed train operations could affect domestic and wild animals. The basis for the screening is shown in Table 3-3. A summary of recent literature related to noise effects on livestock and wildlife is included in Appendix A.

environment for "clusters" of sites based on measurements or estimates at representative locations in the community. In view of the sensitivity of the noise criteria to the existing noise exposure, careful characterization of the existing noise is important. Guidelines for selecting representative receiver locations and determining ambient noise are provided in Appendix B.

Application of criteria for livestock and wildlife provides information on the exposed area in which noise could have an effect, even if the consequences of those effects are not fully known. Researchers have observed both behavioral and physiological effects with the approximate single event sound levels listed in Table 3-3. The noise descriptors used by the researchers are not always well defined, but the best descriptor for a single event that incorporates both level and duration is the Sound Exposure Level (SEL). Procedures for calculating SEL for varying distances from high speed train passbys are described in Chapters 4 and 5. Criteria are not yet fully developed to the point where dose-response relationships can be fully described for different animal species. However, the assessment is based on the assumption that impact occurs when a noise event is sufficiently loud to generate an observable effect in domestic livestock or wildlife. The term “wildlife” is assumed to include all endangered species until species-specific information can be developed.

3.2.3 Mitigation Policy Considerations

FRA’s traditional approach to abatement of noise sources from high speed train systems is embodied in its Railroad Noise Emission Compliance Regulation.[22] Rather than specific environmental regulations, the compliance regulation is intended to enforce the “Noise Emission Standards for Transportation Equipment: Interstate Rail Carriers” promulgated by the U.S. Environmental Protection Agency.[23] These Standards limit the amount of noise emitted from power cars and rail cars under stationary and moving conditions. In addition, the National Environmental Policy Act (NEPA) establishes a broad mandate for federal agencies to incorporate environmental protection and enhancement measures into the programs and projects they help promote, approve and/or finance.[24] FRA strongly encourages noise abatement on high speed train projects, especially where severe noise impacts are identified according to methods of this manual.

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[22]U.S. Department of Transportation, Federal Railroad Administration,”Railroad Noise Emission Compliance Regulations,” Final Rule, 48 Federal Register 56756- 56761; December 23, 1983 (49 Code of Federal Regulations 210).

[23]U.S. Environmental Protection Agency, “Noise Emission Standards for Transportation Equipment: Interstate Rail Carriers,” 40 Code of Federal Regulations 201, July 1, 1984.

[24]United States Congress, National Environmental Policy Act of 1969; P.L. 91-190, January 1, 1970.

Without better definition of the application of results of noise from aircraft overflights to noise from high-speed rail passbys, it is appropriate to consider startle effects as "additional information" included in the impact assessment, rather than to include a penalty in the calculation of noise exposure itself. What remains to be determined is an onset rate that could be considered significant enough to cause startle on a regular basis. Lacking any other direction from research, the onset rate that would cause a 3 dB adjustment for the Air Force has been adopted for this manual. The resulting distance vs speed relationship is given in Figure 4-2.

A.5 EFFECTS ON LIVESTOCK AND WILDLIFE

A.5.1 Summary

A wide range of studies have been conducted concerning noise effects on animals. For humans, annoyance is considered to be the primary environmental noise effect; thresholds for annoyance in terms of sound exposure have been determined by surveys as described in Section A.3. However, for animals, the effects are not easily determined. Usually the studies require introduction of a specific noise event like an aircraft overflight and a subsequent observation of animal response. Observations of response to noise exposure have ranged from no reaction or mild responses such as slight changes in body position to extreme responses such as panic and attempts to escape. Long-term changes in behavior tend to be strongly influenced by factors other than short term noise exposure, such as weather, predation, disease and other disturbances to animal populations. Conclusions from research conducted to date provide only preliminary indications of the appropriate descriptor, rough estimates of threshold levels for observed animal disturbance, and habituation characteristics of only a few species. Long-term effects continue to be a matter of speculation. Moreover, most of the noise events used in prior studies are related to aircraft overflights. Consequently, any criteria adopted for effects on animals by high-speed rail noise must be considered interim until further specific research results are known. Following are discussions of descriptors and levels from the literature.[85,86,87,88,89]

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[85] K.M. Manci, D.N. Gladwin, R. Villella, and M.G. Cavendish. "Effects of aircraft noise and sonic booms on domestic animals and wildlife: a literature synthesis." U.S. Fish and Wildlife Service National Ecology Research Center, Ft. Collins, CO., Report NERC-88/29, 1988.

[86] P. Dufour, "Effects of Noise on Wildlife and Other Animals: Review of Research Since 1971." US Environmental Protection Agency, Report 550/9-80100, July 1980.

[87] A. M. McKechnie, D.N. Gladwin. "Aircraft Overflight Effects on Wildlife Resources." US National Park Service, NPOA Report No. 93-8, November 1993.

[88] F. Bradley, C. Book, and A.E. Bowles. "Effects of Low-Altitude Aircraft Overflights on Domestic Turkey Poults," Report No. HSD-TR-90-034, US Air Force Systems Command, Noise and Sonic Boom Impact Technology Program, June 1990.

[89] C.S.Y. Lee and G. Fleming. "General Health Effects of Transportation Noise." U.S. Department of Transportation, Federal Railroad Administration, DTS-34-RR297-LRZ, June 2002

A.5.2 Noise Descriptor

A noise descriptor for noise effects on wildlife has not been universally adopted, but recent research indicates the sound exposure level (SEL) is the most useful predictor of responses. Characteristic of the bulk of research to date has been lack of systematic documentation of the source noise event. Many studies report "sound levels" without specifying the frequency spectrum or duration. A notable exception is a study sponsored by U.S. Air Force that identifies SEL as the best descriptor for response of domestic turkey poults to low-altitude aircraft overflights (ref. 21). Another report questions whether an A-weighted sound level used in the SEL for aircraft overflights is appropriate for animals since their hearing differs from humans (ref. 20). However, since no weighting has been established for representing the hearing characteristics of wild animals, the A-weighted sound level continues to be used.

A.5.3 Thresholds for Disturbance

Most studies have focused on identifying a noise level associated with disturbance effects, even if the type of noise event varied considerably from study to study. In the well-documented study that recommended SEL as the preferred descriptor, a threshold of response for disturbance ("100 percent rate of crowding") of domestic turkeys was identified as SEL = 100 dB (ref. 21). Even if the descriptors are not the same, many studies report levels in the vicinity of 100 dB as associated with an observable effect, as shown in Table A-1. The information in this table is taken from an extensive survey on aircraft noise effects[90]. Until more definitive information on thresholds can be developed, an interim criterion of SEL = 100 dB will be used for disturbance by high-speed train operations.

A.5.4 Habituation

There is evidence that some animals demonstrate reduced response to noise after prior exposure, but that a few species never become accustomed to, or **habituate**, to high noise levels. Researchers found that for turkeys, previous exposure to sound levels below the 100 dB threshold was sufficient to eliminate panic responses to higher level sounds (ref. 21). On the other hand, some animals and birds, such as the grizzly bear, Dall sheep, and least tern, have not been observed to habituate (ref. 20). Since habituation is found to be species-dependent, a general criterion cannot be developed at this time.

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[90] K.M. Manci, D.N. Gladwin, R. Villella, and M.G. Cavendish. "Effects of aircraft noise and sonic booms on domestic animals and wildlife: a literature synthesis." U.S. Fish and Wildlife Service National Ecology Research Center, Ft. Collins, CO., Report NERC-88/29, 1988.

Table A-1 Summary of Noise Levels Associated with Effects on Animals and Birds (from ref. 20)

Animal Category	Species	Noise Level and Type (if known) Associated with Effect	Effect
Domestic Mammals	Dairy Cow	105 dB	Reduction in milk production
		97 dB	Changes in blood composition
		110 dB, 1 kHz	Changes in blood composition
	Swine	108-120 dB	Hormonal changes
		93 dB	Hormonal changes
		120-135 dB	Increased heart rate
	Sheep	100 dB “white noise”	Increased heart rate, respiration
		90 dB”white noise”	Decreased thyroid activity
		100 dB	Increase in number of lambs per ewe
Wild Mammals	Reindeer	Sonic booms	Startle
	Caribou	Aircraft	Startle, panic running
	Pronghorn antelope	77 dBA, helicopter	Running
Domestic Birds	Chicken	100 dB	Blood composition
		115 dB	Interrupt brooding
Wild Birds	Quail	80 dB	Accelerated hatching
	Canary	95-100 dB	Hearing loss
	Seabirds (general)	Sonic boom	Startle, flush from nest
	Tern	Sonic boom, frequent	Reduced reproduction
	California condor	Blasting, drilling, etc.	Flush from nest; abandon area
	Raptors	Sonic booms	Alarm