U.S. Department of Transportation

Federal Railroad Administration

Handbook for Railroad Noise Measurement and Analysis

October 2009

Prepared for

U.S. Department of Transportation
Federal Railroad Administration
Office of Safety
1200 New Jersey Avenue, SE
Washington, D.C. 20590

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REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE October 2009	3. REPORT TYPE AND DATES COVERED September 2001 thru Oct. 2009

4. TITLE AND SUBTITLE
Handbook for Railroad Noise Measurement and Analysis

5. FUNDING NUMBERS
RR93B1 FG399

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
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Kendall Square
Cambridge, MA 02142-1093

8. PERFORMING ORGANIZATION REPORT NUMBER
DOT-VNTSC-FRA-10-01

9. SPONSORING/MONITORING AGENCY NAMES AND ADDRESS
U.S. Department of Transportation
Federal Railroad Administration
Office of Safety
Washington, DC 20590

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
DOT/FRA/RRS-09/10-IH

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This handbook is an update, restructuring and expansion of the 1982 document "Handbook for the Measurement, Analysis, and Abatement of Railroad Noise" originally developed by Wyle Laboratories.

The handbook is intended as guidance for those conducting sound level measurements for railroad regulatory compliance under 40CFR Part 201 and 49CFR Parts 210, 222, 227, 228, and 229. Specifically, it addresses 1) noise generated by locomotives and rail-cars during line haul operations, 2) noise generated by yard operations from stationary locomotives, locomotive switching, car-coupling impacts, retarders, and load cell test stands, 3) locomotive horn sound levels, 4) noise levels inside locomotive cabs, 5) noise levels inside employee sleeping quarters, and 6) train employee occupational noise exposure. It contains a history of these regulations, a general procedure for conducting a noise measurement or noise exposure monitoring program and regulation-specific measurement and data analysis procedures and guidance for each type of compliance, including planning recommendations and measurement equipment. It also contains example forms and log sheets to help facilitate the documentation of each measurement. These general procedures can be easily adapted to effectively measure most types of railroad-generated noise.

14. SUBJECT TERMS
Railroad Noise, noise measurement, noise exposure monitoring, noise analysis, locomotive, rail car, switcher locomotive, car-coupling, retarder, load cell test stand, horn, employee noise exposure, sleeping quarters, locomotive cab, sound level meter, dosimeter, FRA policy, regulatory compliance.

15. NUMBER OF PAGES
277

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

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 (c)	=	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)

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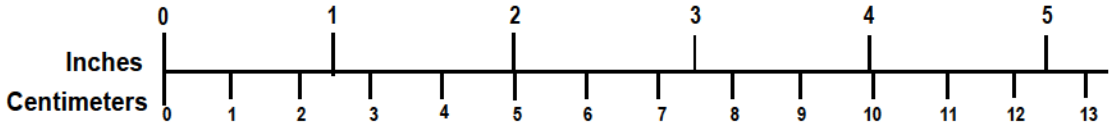
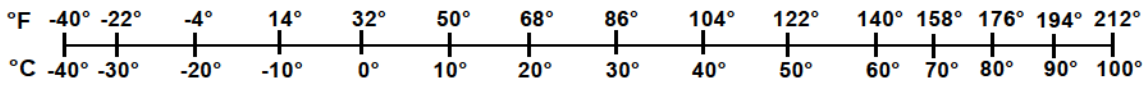
QUICK INCH - CENTIMETER LENGTH CONVERSION



QUICK FAHRENHEIT - CELSIUS TEMPERATURE CONVERSIO



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

Updated 6/17/98

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1 Introduction

This Handbook is an update of the 1982 document "Handbook for the Measurement, Analysis, and Abatement of Railroad Noise"[1]. Since the time of the 1982 publication, significant changes have occurred in the Federal Railroad Administration's (FRA) noise regulations, the applicable national and international noise standards, accepted noise measurement procedures, and noise measurement instrumentation. These changes have necessitated the development of this updated Handbook.

This Handbook does not cover the measurement or assessment of transit rail or high-speed rail noise. Assessment of noise from transit rail, including light rail, is documented in the 2006 Federal Transit Administration (FTA) report "Transit Noise and Vibration Impact Assessment[2]." Assessment of noise from high-speed rail (i.e., rail vehicles capable of maximum speeds of 125 mph (201 km/h) and higher) is documented in the 1998 FRA report "High-Speed Ground Transportation Noise and Vibration Impact Assessment[3]."

1.1 Development of the Handbook

This Handbook was developed by the U.S. Department of Transportation, Research and Innovative Technology Administration, John A. Volpe National Transportation Systems Center, Environmental Measurement and Modeling Division, Acoustics Facility in support of the Federal Railroad Administration, Office of Safety. As a part of this effort, an industry peer review of the Handbook was conducted with Timothy Casey of HDR, Inc., John Earshen of Angevine Acoustical Consultants, Inc., and Dr. Eric Stusnick. Their feedback was incorporated into this document.

1.2 Organization

This Handbook is organized into eight chapters. The first chapter consists of a brief introduction and overview of the Handbook, including its intended use. This chapter also provides an overview and brief history of the current railroad noise regulations.

Since the focus of this Handbook is guidance for FRA regulatory noise compliance measurements, the majority of the document focuses on measurement procedures. Chapter 2 presents a general procedure for conducting a noise measurement or noise exposure monitoring program, including planning recommendations and measurement equipment. This chapter also contains example forms and log sheets to help facilitate the documentation of each measurement. The general procedure can be easily adapted to effectively measure most types of railroad-generated noise, even those not specifically addressed in this Handbook.

Chapters 3, 4, 5, and 6 present regulation-specific measurement and data analysis procedures and guidance for each type of noise or sound level compliance covered under federal regulations. Chapter 3 is for noise generated by locomotives and rail-cars during line haul operations, Chapter 4 is for noise generated by yard operations from stationary locomotives, locomotive switching, car-coupling impacts, retarders, and load cell test stands, Chapter 5 is for other measurement types including locomotive horn sound levels, noise levels inside locomotive cabs, and noise levels inside employee sleeping quarters, and Chapter 6 is for personal monitoring of occupational noise exposure.

These chapters, in conjunction with Chapter 2, can be used to conduct a railroad noise compliance measurement in a scientific and legally defensible manner.

This Handbook includes supplementary information that may be useful to those with minimal experience in the field of acoustics and noise control. Chapter 7 provides a concise background in acoustics as it applies to the field of railroad noise. This includes an introduction to the concepts of sound waves and sound pressure, as well as the calculation of sound pressure level and the associated logarithmic mathematics required to add and average sound levels. It also describes the science behind the spectral representation of sound. Chapter 8 provides information on some additional topics which may be useful when conducting more detailed railroad noise measurements, such as may be necessary to conduct assessments of environmental impact. Included is information on additional measurement equipment, such as spectrum analyzers and recording devices, including measurement issues, such as the electronic noise floor and electromagnetic interference. The health effects caused by exposure to noise are discussed to provide additional motivation for encouraging good noise control practices. Finally, this chapter discusses numerous noise control options, organizing them according to source, path and receiver controls. This is meant to present an overview of possible noise control options as an initial design step; it does not go into the development and implementation of these options in great detail. Once the possible railroad noise control options have been considered and narrowed down, then the development and implementation of those noise abatement measures should be assigned to an experienced, noise abatement professional.

In addition to these eight chapters, this Handbook also contains five supporting appendices. Appendix A contains a glossary of the terminology used in the Handbook, including the acoustic metrics employed herein. Appendix B contains a collection of the checklists, example forms and log sheets to help facilitate the documentation of each noise measurement or monitoring study. Appendix C includes example calculations for each noise metric presented in Chapter 3, as well as example calculations for some of the data processing and analysis material. Appendix D contains copies of all the FRA and Environmental Protection Agency (EPA) regulations addressed in this Handbook. Finally, Appendix E contains a list of references used throughout this Handbook.

1.3 History and Brief Summary of Railroad Noise Regulations

The Noise Control Act of 1972 identified noise as a growing danger and declared the policy of the United States to be "to promote an environment for all Americans free from noise that jeopardizes their health and welfare."[4] Included in the Act was the authorization to establish federal noise emission standards for products distributed in commerce, and the mandate for the U. S. Environmental Protection Agency (EPA) to coordinate federal activities in noise control. Section 17 of the Act specifically required the EPA to promulgate regulations setting limits on "noise emission resulting from operation of the equipment and facilities of surface carriers engaged in interstate commerce by railroad." It further required that such regulations include noise emission standards which "reflect the degree of noise reduction achievable through the application of the best available technology, taking into account the cost of compliance."

In accordance with Section 17 of the Act, the EPA issued final railroad noise emission standards on December 31, 1975. These standards applied to all railroad cars and locomotives, except steam locomotives. On August 23, 1977, the Federal Railroad Administration (FRA) published Railroad Noise Emission Compliance regulations setting forth procedures for enforcing the EPA standards.

In June of 1977, the Association of American Railroads, along with several railroad companies, challenged the EPA regulation in the U. S. Court of Appeals on the basis that it did not include standards for all railroad equipment and facilities as required by the Noise Control Act. The concern of the railroad industry was that, lacking federal preemption of all railroad noise source regulations, a variety of differing and inconsistent standards in every jurisdiction along the railroad's routes may be developed. In addition, local communities would not necessarily be bound by the protective "best available technology, taking into account the cost of compliance" requirement of the Noise Control Act.

The judgment of the court was in favor of the railroad industry. As a result, EPA published noise regulations for additional railroad equipment and facilities in April 1979. These regulations established standards for overall railroad facility and equipment noise, as well as specific standards for retarders, refrigerator cars, and car coupling operations.

After an extended public comment period, EPA published final rules on January 4, 1980, establishing standards for noise from four specific sources, namely, locomotive load cell test stands, switcher locomotives, retarders, and car couplings. A property line standard, limiting the total noise emitted from rail yard facilities including sources which are not covered by existing standards, was to be issued by EPA after further assessment of the extensive comments received. However, EPA did not proceed with the scheduled promulgation. Instead, on November 12, 1981, the parties to the AAR litigation filed with the court a "Status Report," stating that the agency had "concluded that no further standards are necessary to regulate rail facilities and equipment". Concluding that "the proposed standards are unnecessary," EPA withdrew both the proposed property line and refrigerator car standards.

Concurrent with the development of railroad noise standards by EPA, the FRA was developing rules of permissible maximum noise levels within locomotive cabs and railroad employee sleeping quarters and safety standards setting minimum and maximum sound levels from audible warning devices (horns) on locomotives.

Up until 1983, the Environmental Protection Agency (EPA) coordinated all federal noise control activities through its Office of Noise Abatement and Control. However, Congress phased out the office's funding in FY1983 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments. Although EPA no longer plays a prominent role in regulating noise, its past standards and regulations remain in effect, and other federal agencies, including the FRA, continue to set and enforce noise standards for sources within their regulatory jurisdiction.

As an enforcement entity, the FRA has continued to use the EPA standards as the basis for compliance determination with regard to most areas of railroad noise. Where FRA has regulatory authority to do so, FRA has also promulgated new regulations or changed existing standards for noise to accommodate new needs for public safety and occupational health.

The regulations which govern railroad noise emissions are summarized in Table 1. The scope of each railroad noise standard and/or regulation is briefly discussed in the following paragraphs. Compliance with these regulations is evaluated by FRA inspectors, and may also be evaluated by noise professionals working for railroad equipment manufacturers, or by the railroads themselves. The regulations cited in this Handbook are current as of December 31, 2007. The Federal Register and Code of Federal Regulations should be consulted for updates before any measurement program begins.

Table 1. Regulations Governing Railroad Noise Emissions

Agency	*Code of Federal Regulations (CFR) Number*	*Title*
EPA	40 CFR Part 201[5]	Noise Emission Standards for Transportation Equipment; Interstate Rail Carriers
FRA	49 CFR Part 210[6]	Railroad Noise Emission Compliance Regulations
FRA	49 CFR Part 222[7]	Use of Locomotive Horns at Public Highway-rail Grade Crossings
FRA	49 CFR Part 227[8]	Occupational Noise Exposure
FRA	49 CFR Part 228[9]	Hours of Service of Railroad Employees (Sleeping Quarters)
FRA	49 CFR Part 229[10]	Railroad Locomotive Safety Standards (Locomotive Horns and Locomotive Cab Interior Noise)

Line haul and yard operations: The noise emissions from railroad line haul and yard operations are governed by two complimentary rules: 40 CFR Part 201 – Noise Emission Standards for Transportation Equipment; Interstate Rail Carriers and 49 CFR Part 210 - Railroad Noise Emission Compliance Regulations. The EPA standards in 40 CFR Part 201 cover:

201.11 Standard for locomotive operation under stationary conditions.

201.12 Standard for locomotive operation under moving conditions.

201.13 Standard for rail car operations.

201.14 Standard for retarders.

201.15 Standard for car coupling operations.

201.16 Standard for locomotive load cell test stands.

201.23 Test site, weather conditions and background noise criteria for measurement at a 30 meter (100 feet) distance of the noise from locomotive and rail car operations and locomotive load cell test stands.

201.24 Procedures for measurement at a 30 meter (100 feet) distance of the noise from locomotive and rail car operations and locomotive load cell test stands.

201.25 Measurement location and weather conditions for measurement on receiving property of the noise of retarders, car coupling, locomotive load cell test stands and stationary locomotives.

201.26 Procedures for the measurement on receiving property of retarder and car coupling noise.

201.27 Procedures for: (1) Determining applicability of the locomotive load cell test stand standard and switcher locomotive standard by noise measurement on a receiving property; (2) measurement of locomotive load cell test stands more than 120 meters (400 feet) on a receiving property.

201.28 Testing by railroad to determine probable compliance with the standard.

The enforcement provisions contained in 49 CFR Part 210 include:

210.25 Measurement criteria and procedures.

210.27 New locomotive certification.

210.29 Operation standards (moving locomotives and rail cars).

210.31 Operation standards (stationary locomotives at 30 meters).

210.33 Operation standards (switcher locomotives, load cell test stands, car coupling operations, and retarders).

Railroad employee sleeping quarters: The noise environment in railroad employee sleeping quarters is regulated by the FRA in 49 CFR Part 228 – Hours of Service of Railroad Employees. This regulation establishes the maximum noise level which will be regarded as the level permitting "an opportunity to rest." This regulation is taken into consideration during the construction (or reconstruction) of railroad employee sleeping quarters on railroad property. This regulation was issued by the FRA on July 19, 1978, in accordance with provisions of the Hours of Services Act (Public Law 91-169). This Act made it unlawful for any common carrier "to provide sleeping quarters for employees…which do not afford such employees an opportunity for rest, free from interruptions caused by noise under the control of the railroad…"

Locomotive cab noise: The noise environment in locomotive cabs is governed by a set of complimentary FRA regulations: 49 CFR Part 227 – Occupational Noise Exposure, published on February 26, 2007, and 49 CFR Part 229 – Railroad Locomotive Safety Standards (specifically, 49 CFR Part 229.121 and Appendix H to Part 229), both of which were first enacted in 1980.

49 CFR 227 established noise exposure standards for railroad employees who regularly encounter their predominant occupational noise exposure in the locomotive cab. This rule was based on the Occupational Safety and Heath Administration's (OSHA) occupational noise standard, with certain aspect adapted to the unique circumstances of the railroad environment. It requires railroads to limit employee noise exposure to an 8-hour time-weighted average (TWA) of 90 dB(A), to develop and implement a noise monitoring program and administer an effective hearing conservation program for those employees who are exposed to noise at or above an 8-hour TWA of 85 dB(A). Although the regulation also contains provisions on the development of hearing conservation programs and audiometric testing programs, these topics are not addressed in this Handbook. Please note that noise exposure for

railroad employees whose primary occupational noise exposure does not occur inside the locomotive cab is regulated by the Occupational Safety and Health Administration (OSHA) in 29 CFR 1910.95.

The provisions of 49 CFR Part 229.121 related to Part 227, require railroads to obtain and maintain locomotives that meet specified standards for limiting in-cab noise. Pursuant to the last of these requirements, 49 CFR 229.121 presents compliance criteria for noise inside locomotive cabs during static operations. This regulation covers both new locomotives and locomotives undergoing maintenance in response to an excessive noise report. Instrumentation and test site requirements, noise measurement procedures, and record keeping guidance are all presented.

These rules, both the new Part 227 and the revisions to Part 229, were the result of direction contained in the 1992 Rail Safety Enforcement and Review Act. This Act was passed in response to concerns raised by employee organizations, Congressional members, and recommendations of the National Transportation Safety Board (NTSB) concerning crashworthiness of and working conditions in locomotive cabs. It required FRA "to consider prescribing regulations to improve the safety and working conditions of locomotive cabs" throughout the railroad industry.

Locomotive horns (audible warning devices): The sounds emitted by locomotive horns and other audible warning devices are regulated by 49 CFR Part 229 – Railroad Locomotive Safety Standards (specifically, 49 CFR Part 229.129), and 49 CFR Part 222 - Use of Locomotive Horns at Public Highway-rail Grade Crossings. These rules set both minimum and maximum sound levels for locomotive and wayside horns; describe the measurement instruments and test site requirements; and specify meteorological criteria, background noise criteria, sound level measurement procedures and record keeping procedures.

49 CFR 229 was first enacted in 1980 and required each locomotive to be equipped with a device which provided audible warning at a minimum of 96 dB(A) at 100 ft. Although this rule required the horn be placed on the locomotive, it never required its use. In 1994, congress enacted the Swift Rail Development Act (Public Law 103-440) which directed the FRA to issue regulations that require the use of locomotive horns at Highway-Railroad grade crossings. On June 24, 2005, the FRA published the Final Rule requiring the use of locomotive horn sounding for trains approaching highway-Railroad grade crossings (49 CFR Part 222 and 49 CFR 229.129). In addition to the minimum sound level requirement, this rule now specifies a maximum sound level for railroad horns, 110 dB(A). Part 222 requires sounding the horn at all public highway-railroad grade crossings, as requires the use of approved supplemental safety measures before a grade crossing can be exempted from this rule.

In addition, 49 CFR Part 222 Appendix E presents sound level criteria for wayside horns in use at highway-rail grade crossings. While this standard mostly covers operational and position requirements for the wayside horn, it does briefly address wayside horn noise measurement procedures.

2 Basic Elements of Noise Measurements

This chapter summarizes the basic elements needed for successful FRA noise compliance measurements. For the data collected to be scientifically and legally defensible for determining compliance with FRA noise regulations, the measurement instruments and their setup and performance, measurement site, meteorological and environmental conditions, and data collection methods must all comply with the criteria defined in the applicable FRA regulations and ANSI standards*. These regulations and standards provide citable criteria that ensure measurement repeatability and assure that the highest quality of noise data are collected. The basic elements summarized here include guidance on safety precautions that must be taken when working around railroad equipment, the instruments required for the noise measurements, the basic procedure to be followed for both noise measurements and personal noise exposure monitoring, and documentation requirements. This procedure is expanded upon in Chapters 3, 4, 5, and 6 when specific requirements for each regulation are discussed.

2.1 Safety Considerations

Railroad yards and areas close to railroad tracks are potentially dangerous locations, where there is a significant risk of losing life and limb. When performing any type of measurements near railroad equipment, those involved must be constantly alert and aware of the dangers of moving railroad equipment, and in some parts of the country, high voltage electrical systems. The following safety practices are recommended for all types of railroad noise measurements. In addition, be sure to always follow local safety directives.

- For non-FRA personnel, permission to be on or near railroad equipment or in a rail yard must be gained from the appropriate railroad official prior to the noise measurements, and shall be reconfirmed with the appropriate railroad personnel upon arrival to the measurement site.
- Protective clothing (such as hard hats, safety goggles, reflective clothing, ear protection and steel-toe work boots) should be worn when appropriate or required.
- Be aware of the position(s) of any cabling associated with the noise measurement instruments, it may present a tripping hazard. It is a good idea to either identify the cables with bright colors, or tape them down.
- Be alert and aware of all railroad equipment in the vicinity of the railroad tracks:
  - Look both ways when in the vicinity of a railroad track,
  - Cross tracks only when absolutely necessary, and never in the path of moving locomotives, cars, or trains,
  - Never cross under or through any rail equipment,
  - Watch your step, never step on the rail, and only walk along designated paths,
  - Never sit, stand or walk on any part of the track structure,
  - Stay outside of the clearance envelope (within 3 m [or 10 ft] of the track center line), and
  - Always be aware of moving rail equipment.

* Specific ANSI standards, along with two International Electrotechnical Commission (IEC) standards, are referenced in the FRA regulations, so the criteria set forth in those standards were incorporated into the procedures and guidance presented in this Handbook. International Standards Organization (ISO) standards are also referenced, but they were primarily incorporated into the procedures and guidance presented in this Handbook as recommended practices, not as compliance criteria.

- Position measurement instruments outside of the clearance envelope (at least 3 m [or 10 ft] from the track center line).
- Obey railroad personnel's instructions.
- Stay out of high voltage areas (e.g. third rail, substations, transformers, etc.).
- When crossing tracks in front of a stopped locomotive, stay in view of the locomotive cab so you can be seen by the crew.

2.2 Measurement Instruments

This Section discusses the instruments required to collect data for FRA regulatory compliance measurements. The ANSI standards governing these instruments, along with additional information on their specifications and use, are discussed in Chapter 8. If any questions arise about specific equipment, consult the manufacturer's documentation or contact the manufacturer for more information. Table 2 summarizes the equipment required for each type of FRA compliance measurement.

Table 2. Instruments Required for FRA Compliance Measurement by Type

Measurement Type	Sound Level Meter or Dosimeter	Microphone and Preamplifier	Calibrator	Windscreen	Wind/Temperature Measurement Instruments	Speed Measurement Instrument (Stopwatch	Batteries	Accessories (Tripod, Measuring Tape, Camera, Log Sheets,
Moving Locomotive or Railcar	X	X	X	X	X	X	X	X
Yard Operations at Sideline (Stationary Locomotive or Switcher Locomotive, Load Cell Test Stand)	X	X	X	X	X		X	X
Yard Operations at Receiving Property (Switcher Locomotive, Load Cell Test Stand)	X	X	X	X	X		X	X
Yard Operations at Receiving Property (Car Coupling, Retarders)	X	X	X	X	X		X	X
Locomotive Horn or Wayside Audible Warning Device	X	X	X	X	X		X	X
Locomotive Cab Interior	X	X	X	X			X	X
Employee Sleeping Quarters	X	X	X	X			X	X
Train Employee Personal Noise Exposure	X	X	X	X			X	X

2.2.1 Noise Measurement Instruments

There are two types of instruments which can be used for measuring railroad noise data for regulatory compliance: either a sound level meter (SLM) or a dosimeter (a specialized type of sound level meter). These instruments actually consist of three separate components: a microphone, a preamplifier, and a measurement device, represented in Figure 1. This Handbook will refer to the collective sum of these components as the 'measurement instrument'. In many cases, the manufacturer will sell these components as a set. If they are not purchased as a set, care must be taken to ensure compatibility. Each of the separate components is discussed further in the following paragraphs. This instrument also requires a windscreen to protect the microphone, a sound level calibrator to verify the accuracy of the components, and batteries to power the measurement device.

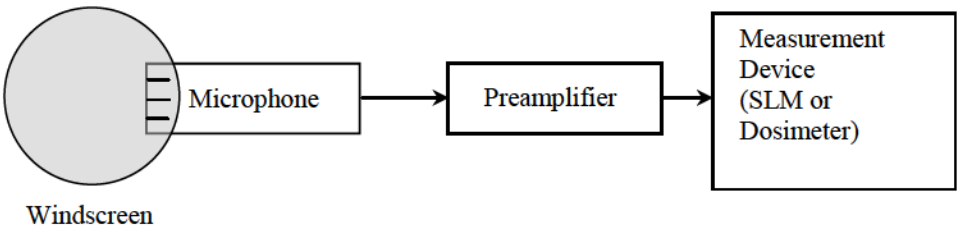


Figure 1. Typical Noise Measurement Instrument

The sound level meters, dosimeters, and microphone components must undergo periodic*, comprehensive, laboratory calibration to verify and document their accuracy[11]. Typically, these professional calibrations are performed on an annual basis, however, the manufacturers' instructions for each component should be consulted for specific time intervals. A certificate of calibration from the National Institute of Standards and Technology (NIST) is provided to the user, and this documentation should be kept on file for future reference.

Microphone: A microphone transforms sound-pressure variations into electrical signals. There are numerous types of microphones, each with a unique set of characteristics. Among these characteristics are type, size, and sensitivity (further discussion of these characteristics can be found in Chapter 8). A one-half inch diameter, electret condenser microphone is common and can be used for all FRA compliance measurements.

When conducting measurements, pay attention to the manufacturer's instructions regarding orientation of the microphone with respect to the sound source for optimum sensitivity performance (see Figure 2). For measurements of a stationary sound source, normal incidence, where the sound waves arrive at an angle perpendicular to the microphone diaphragm (the thin sheet of plastic stretched over the top of the microphone) is recommended. For moving sources, grazing incidence, where the sound waves arrive at an angle parallel to the microphone diaphragm, is preferred since the microphone presents a constant incidence angle to any source located within the plane of the

* In addition, professional instrument calibration should be conducted after an instrument is repaired or has experienced reoccurring problems during measurements.

microphone diaphragm. It is acceptable to position a microphone for grazing incidence even if it has its flattest frequency response characteristics in a normal incidence configuration*.

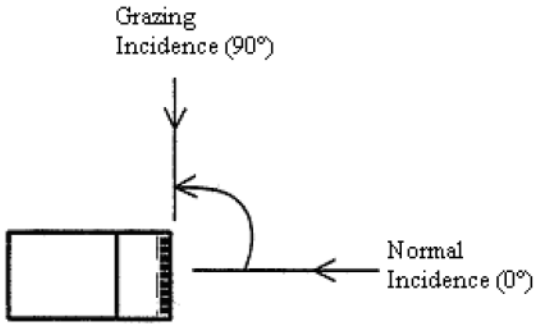


Figure 2. Microphone Incidence[12]

The microphone's performance is susceptible to environmental factors and physical damage. Therefore, care should be taken to properly handle the microphone. For example, a microphone may not operate correctly if it is exposed to excessive dust or moisture, is dropped or subjected to other damaging movements during use.

Preamplifier: A preamplifier is a device designed to amplify the electrical signal produced by the microphone, as well as to properly match the impedance of the microphone to the rest of the noise measurement instrument. The preamplifier may be part of the microphone or a separate component. Consult the microphone manufacturer's literature for recommendations on the optimum preamplifier. Often, the preamplifier also physically supports the microphone.

Sound level meter: A sound level meter (SLM) is an acoustic device designed to measure sound pressure levels. A standard SLM consists of electronic filters (for example, an A-weighting filter that allows the device to respond the same way as the human ear), appropriate exponential time-averaging circuits to calculate fast and slow responses, and a method to display the measured sound pressure level. Many SLMs have the added ability to store sound level data and internally calculate many metrics required for FRA regulations (maximum sound level, equivalent sound level, and exceedance percentile sound level). Historically, the SLM was an analog meter with a needle/dial display and no storage capabilities, but now most are digital and include some internal data storage capabilities.

SLMs used to perform measurements for compliance with FRA regulations must meet the performance specifications in the appropriate ANSI/IEC Standards[11, 13, 14, 15]. These standards characterize the SLM by its accuracy, referred to as 'type' (or 'class'). Type 1 sound level meters (or precision sound level meters) are recommended for all railroad noise measurements. The regulations allow for use of the less precise, Type 2 sound level meters if the Type 1 is not available. Use of a Type 2 meter may require the use of sound level adjustment values.

* In cases where precision measurements are required, manufacturer-published corrections should be applied.

Note that certain equipment and operations, such as heat sealers, induction furnaces, generators, transformers, electromagnets, arc welding, and radio transmitters generate electromagnetic fields that can induce current in the electronic circuitry of sound level meters and noise dosimeters and cause erratic readings. Additional information on this topic can be found in Chapter 8 under 'microphone simulators'.

Noise dosimeter: A noise dosimeter is a small device designed primarily for personal noise monitoring programs. They are usually worn by the monitoring subject, and may be designed so they cannot be turned off and the settings cannot be tampered with during the monitoring program. They are designed to measure and integrate sound pressure levels over time, to calculate noise exposure metrics such as percentage noise dose or eight-hour time weighted average. They are essentially specialized SLMs with integration, data processing and data storage capabilities, and therefore are subject to the sound level meter standards[16, 17]. Dosimeters are typically Type 2 devices, unless otherwise specified in the manufacturer's literature.

Calibrator: An acoustic calibrator is a device that provides a means of checking the instrument's sensitivity by generating a tone at known frequencies (usually between 250 Hz and 1 kHz) and a known sound pressure level (94 or 114 dB). A calibrator which meets ANSI Type 1 requirements[18], that is not pressure sensitive and that yields a 94 dB, A-weighted sound pressure level at 1 kHz, is suitable for use in FRA noise measurements[*]. It is also important to keep in mind that some types of acoustic calibrators are pressure sensitive, and may require corrections to their nominal output level to account for use at altitudes different than sea level.

Windscreen: Regardless of the type of microphone used, a windscreen is essential for both indoor and outdoor measurements. A windscreen is a porous sphere placed over the microphone to guard against wind noise and damage from dust, dirt, and human contact. When the windscreen is clean, dry, in good condition, and meets manufacturer's recommendations, it has a negligible effect on the sound level measurements. The windscreen will not protect the microphone from rain or extreme humidity. Never conduct measurements with any type of covering over the microphone (e.g., plastic bag or plastic wrap) to protect it from moisture. Such materials will distort the noise pickup, and the readings will be invalid.

Power supply: The performance of the measurement instrument is directly dependent on its power supply. Operators should regularly check the measurement instrument to ensure it has sufficient power. Most instrument manuals will include an average operational duration using a standard battery type for planning purposes. Lithium batteries are often employed in noise measurement programs because of their extended battery life in electronic equipment compared with standard batteries. Nickel-cadmium gel cell batteries are also a practical source of power.

[*] Unless otherwise recommended by the instrumentation manufacturer.

2.2.2 Meteorological Instruments

Bad weather can negatively impact a noise measurement study and damage sensitive instruments. For this reason, railroad noise regulations, various national and international standards, and most manufacturers' instructions for noise measurement instruments provide criteria governing the weather conditions during which noise measurements may occur. The regulations and standards are not specific as to how the weather data are collected, as long as the data are representative of the conditions at the measurement site. Wind speed and direction should always be collected on-site; wind speed is easily measured with a hand-held anemometer; average wind direction can be approximated. Temperature and humidity data can be collected on-site using a thermometer and psychrometer, or can be obtained from a nearby airport or meteorological station.

2.2.3 Additional Equipment

Following is a list of supplementary equipment which may be useful in a noise measurement study.

- Tripods and/or other equipment to mount and stabilize the noise measurement instrument and microphone.
- Log sheets, pens & pencils.
- A stopwatch or radar gun to measure locomotive or rail car speed.
- Electronic storage media to download and save the sound level data, such as a laptop computer.
- Spare batteries.
- A tape measure to accurately place the microphone (its height and distance from the locomotive or other sound source).
- A camera to document the measurement study.
- Spare sound level meter or dosimeter components, if available.

2.3 Procedure for Noise Measurement

This section outlines a general procedure for performing railroad noise measurements (a separate procedure for occupational noise exposure monitoring is outlined in Section 2.4). Although each type of measurement may have different requirements, there are similar elements which can be universally applied, regardless of the governing regulation. Section 2.3.1 outlines the necessary tasks that should be carried out in advance of any noise measurements. Section 2.3.2 summarizes the criteria which each noise measurement site should meet. Section 2.3.3 outlines the general procedure which should be followed when conducting noise measurements in the field. Variations on, and exceptions to, this procedure required for compliance with specific FRA regulations are discussed in Chapters 3, 4 and 5.

2.3.1 Noise Measurement Advance Planning

Before any railroad noise measurements can take place, there are necessary tasks which should be carried out in advance. Checklist 1 outlines the preliminary steps that should be taken before any noise measurement.

Checklist 1. Noise Measurement Advance Planning

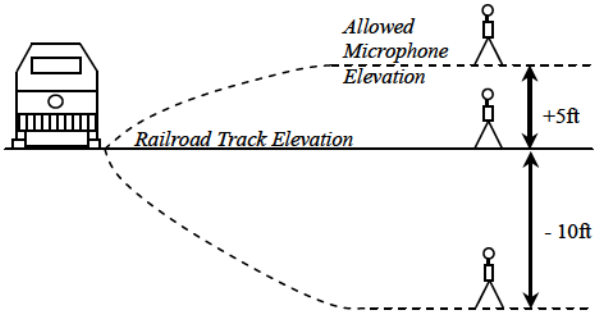
☐ Identify the type of test.
☐ Identify the railroad equipment or locations that will be the subject of the test, and determine their availability. • Locomotive location for locomotive cab interior / railroad horn measurements, • Crew boarding location for personal monitoring of occupational noise exposure, • Track wayside, rail yard, or receiving property, or • Sleeping quarters location.
☐ Determine the general location, time, and date of the measurements. Address _____ City _____ County _____ State _____ Railroad/Milepost _____ Rail Yard _____
☐ Identify and review applicable standards and regulations. CFR PART _____
☐ Review railroad safety rules and site-specific safety considerations.
☐ Identify and contact other participants who will assist.
☐ Select and prepare appropriate noise measurement and other instruments. • Check batteries • Reset / Confirm proper configuration of instruments. (weighting, response rate, etc.).

2.3.2 Specific Measurement Site Selection

Once the general location of the measurements has been chosen, a specific measurement site which meets the criteria set forth in the regulations must be located. If this is not possible, measurements at non-conforming sites may be done, but those measurements cannot be used for compliance determinations. All site conditions, especially those that make the site non-conforming, should be documented with pictures or drawings and descriptive text. Specific requirements are summarized below: Figure 3 shows the criteria for fixed-site sideline measurements, which are used for line haul pass-bys (locomotives and rail cars), some yard operations, and locomotive horns; Figure 4 shows the criteria for receiving property measurements, which are used for other yard operations, including car-coupling impacts and retarders.

Microphone Elevation at Measurement Site for Railroad Sideline Measurements

The ground must be relatively flat. That is, within +5 and -10 ft of the top of the test rail at the microphone.



Where possible, **avoid**:

- Measurements over water, wet ground, snow covered ground or high grass. Measurements over water will be higher than measurements over land due to reflection.
- Test sites less than ¼ mile from a grade crossings, to avoid noise contamination from the horn and crossing bells.
- Test sites close to antennas, power lines, generators and other sources of electromagnetic interference. Document the location of these sources if avoidance is not possible. Electromagnetic interference is discussed in more depth in Chapter 8 of this Handbook.

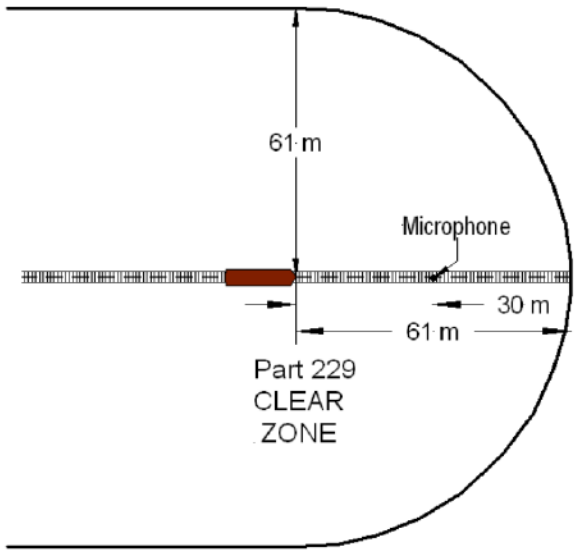
Measurement Site – Track visibility – all sites

For pass-by measurements, at least 80% of one rail along the test track must be visible from the microphone location, and no single obstruction should obscure more than 5% of the test track.

Measurement Site - Clear zone requirements – all sites

The measurement site must be free of large, reflecting objects such as buildings, hills, sign posts, bridges, parked vehicles, railroad cars and locomotives (other than the one being tested). Reflections off of these objects may increase the measured sound level.

Measurement Site Boundaries for Railroad Horn Measurements



Measurement Site Boundaries for Railroad Sideline Measurements

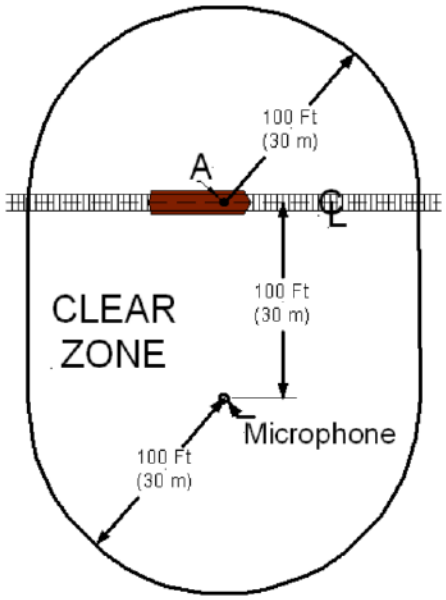


Figure 3. Test Site Requirements: Sideline Measurement Site Criteria - Line Haul Pass-By (Locomotives and Rail Cars), Yard Operations and Locomotive Horns

The microphone must be setup in a flat, open area, free of vertical surfaces larger than 1.2m (4 ft) in height within 10 m (33.3 ft) of the microphone, as illustrated, EXCEPT:

- Residential or commercial unit walls or facility noise barriers may be in closer proximity to the microphone, but still must be at least 2.0 m (6.6 ft) away from the microphone position.
- If the receiving property measurements are being made near a farm home, then one of the outer walls of the farm house *must* be within a 2.0 m to 10.0 m (6.6 ft to 33.3 ft) range of the microphone.

The microphone must be between 4 ft and 5 ft above the ground.

For car-coupling impact measurements only, the microphone must be at least 100ft from the nearest track where car-coupling occurs.

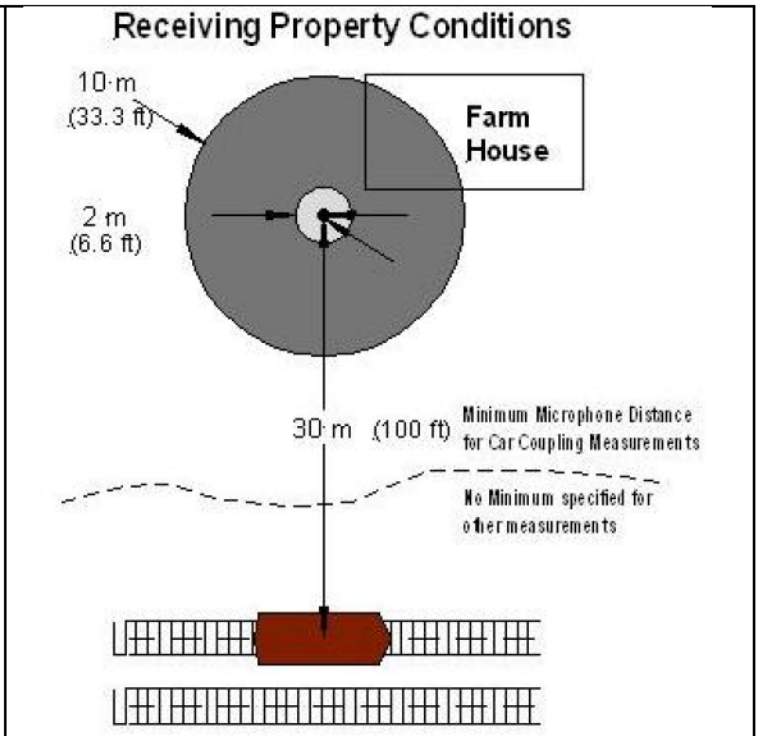


Figure 4. Test Site Requirements: Receiving Property Measurement Site Criteria

2.3.3 Field Procedure for Noise Measurements

Checklist 2, below, outlines a general, step-by-step procedure that should be followed during the course of the noise measurements. Further explanation of the more detailed steps can be found in the paragraphs that follow.

Checklist 2. Basic Procedure for Noise Measurements

Set up the noise measurement instrument(s).

☐ Verify the noise measurement instrument condition and settings:
- Full battery power,
- Frequency weighting filter (A or C),
- Dynamic response (fast, slow), and
- Measurement metric (L_{AFmx}, L_{ASmx}, L_{AeqT}).

☐ Verify time synchronization - or offset:
- Noise measurement instrument (sound level meter or dosimeter),
- Wrist watch (or cell phone), and/or
- Laptop.

☐ Mount the noise measurement instrument on a tripod (or hold at arm's length) at the height specified in the regulations.

☐ Orient the microphone according to the sound source:
- normal incidence for stationary sources, or
- grazing incidence for moving sources.

☐ Calibrate the noise measurement instrument (or verify calibration). Measure and document 10 seconds of the acoustic calibration signal. Adjust as necessary.*

☐ Place a windscreen over the microphone.

☐ **Confirm clear noise measurement pathways.**
Position observers, operators and employees away from the microphone, rail equipment and out of the direct path of the noise source.

☐ **Measure and confirm that the environmental conditions are within the specified limits.**
- Wind speed: sustained <5 m/s (12 mph), gusts <9 m/s (20 mph)
- No Precipitation

Not required for indoor measurement (cab interior, sleeping quarters)
- Temperature: 14°F to 122°F (-10° to 50°C), 36°F to 95°F (2°C to 35°C) is preferred
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

☐ **Measure and document the background noise level.** The specific procedure and metric is regulation-dependant.

Perform source noise measurements. (Refer to Chapters 3, 4, and 5 for specific procedures).

☐ Document any noticeable environmental changes, including substantial changes in weather, background noise or contamination from other noise sources.

☐ Field calibrate the noise measurement instrument at intervals not exceeding an hour for longer duration measurements. (Not required for all measurements)

Perform post-measurement checks.

☐ Measure and record the background noise level.

☐ Measure and record a calibration tone.

☐ Document the environmental conditions.

Backup data.

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

* If the acoustic calibrator uses a frequency other than 1000 Hz, the frequency-weighting in the noise measurement instrument must be set to un-weighted (rather than A-weighted) during calibration.

Noise measurement instrument setup: The instrument must be placed so the microphone is at the proper height: 1.2 m (4 ft) above the ground for line-haul and most locomotive horn measurements, 4.6 m (15 ft) above the ground for center-mounted locomotive horn measurements, between 1.2 and 1.5 m (4-5 ft) for yard operation measurements, and 0.76 and 1.45 m (2.5 and 4.75 ft) above the cab seat or floor for locomotive in-cab noise measurements (see Section 5.2.1 for further details). For best results, the entire instrument should be placed on a tripod or similar device (optionally, the microphone and preamplifier can be mounted on the tripod and connected to the sound level meter or dosimeter with the appropriate cabling). With the exception of locomotive horn measurements, FRA regulations allow for handheld noise measurement instruments, but this is discouraged due to the probability of shielding and noise produced by the instrument operator. If a handheld measurement instrument must be used, then it should be held away from the body. The operator must never stand between the instrument and the noise source.

Orient the microphone with proper respect to the sound source for optimum sensitivity performance, as described below. For measurements of a stationary sound source, normal incidence, where the sound waves arrive at an angle perpendicular to the microphone diaphragm is best. For moving sources, grazing incidence, where the sound waves arrive at an angle parallel to the microphone diaphragm, is preferred because grazing incidence will ensure a constant microphone frequency response regardless of the position of the noise source. It is perfectly acceptable to position a microphone for grazing incidence even if it has its flattest frequency response characteristics in a normal incidence configuration.

Cover the microphone with a windscreen to guard against wind noise and damage from dust, dirt, and human contact. The windscreen will not, however, protect the microphone from rain or extreme humidity. Although plastic bags are useful to have on hand to cover the microphone and windscreen in the event of sudden or intermittent rain showers, *never* conduct the measurements with this type of covering over the microphone. Such materials will distort the noise detected, and the readings will be invalid.

Field calibration: The pre-measurement field calibration is a two-step process as part of noise measurement instrument setup. Before this pre-measurement field calibration, the instrument should be allowed to adjust to the environmental conditions (especially temperature) at the site. First, place the calibrator on the microphone, and adjust the instrument so that the sound level displayed by the instrument matches the known level of the calibration tone. Since the available measurement instruments vary in operation, follow the instrument manufacturer's requirements when performing this procedure. After this adjustment, the second step of the process is to measure the calibration tone for 10 seconds after the signal has stabilized, and store the measurement within the instrument if possible. The calibration level should also be documented in the measurement log.

For measurements which continue longer than an hour, the level of the calibration tone should be measured and recorded in the measurement log at hourly intervals. This is sometimes referred to as a calibration 'check'. Not only can these additional calibration checks be used to provide verification of continued, reliable performance of the measurement instrument since the initial (or latest) calibration, but they can also be used to test the measurement instrument for faulty connections and defective operation. As such, these hourly checks will limit the amount of data loss when these types of problems arise.

A final calibration level 'check' should be performed at the end of each measurement. The comparison of calibration levels before and after the measurement is used to check the measurement instrument's precision over the course of the measurements. If these before and after levels differ by more than 1 dB (0.5 dB for locomotive horn and cab interior), the noise measurements may not be used to determine compliance with FRA regulations. In addition, if a violation occurs, it must be noted and immediately followed up by a field calibration to ensure that the violation is not due to a measurement instrument malfunction*.

The measurement instrument should also be field calibrated both before and after any changes are made to its configuration or parts. Such changes can include movement of the instrument to another location (especially if the instrument is disassembled), a change in microphone, or a change in instrument settings.

Meteorological conditions: Wind speed and direction should always be collected on-site; wind speed is easily measured with a hand-held anemometer; wind direction can be approximated. If instruments to measure wind speed and direction are not available, data from the nearest airport or meteorological station should be used. Temperature and humidity data can be collected on-site using a thermometer and psychrometer, or can be obtained from the nearest airport or meteorological station.

Background noise: The background ambient noise at a site consists of any noise (environmental, mechanical or other source) which is not directly attributable to the noise source being investigated. Background noise levels are measured both before and after the measurements to determine their influence over the course of the measurements. Most railroad noise regulations stipulate that any background noise must be at least 10 dB(A) lower than the maximum measured sound level for the measurement to be valid. If both the initial and final background noise levels are at least 10 dB(A) lower than the measured sound levels and they are stable, then it can be inferred that the background noise did not corrupt the sound levels during the measurement interval. If the background noise is not 10 dB(A) lower, note in the logbook that "the measurement is not valid and did not meet compliance due to background noise." Wait to see if the background noise goes down and repeat the measurement if possible.

If the sound level in the absence of the source is constant, the background sound level is that constant level. However, this is quite often not the case. Usually the measured sound level in the absence of the desired source varies over a range of values. In this case, it is more difficult to define precisely the background level. For the purposes of characterizing varying background noise, the L_{90} exceedance percentile sound level is often used. This is the metric that is specified in the receiving property-type measurements (see Chapter 4).

For non-regulatory measurements, if it is desirable to estimate the source level, logarithmic decibel subtraction ($L_{source} - L_{background}$) may be used when the background level is between 3 and 10 dB(A) below the measured sound level. For example, if the sound level of a passing railcar is measured at 70 dB(A), and, after the train has passed, the background level is measured to be 65 dB(A), decibel subtraction can be used to estimate the actual level of the passing railcar.

$$10\log(10^{70/10} - 10^{65/10}) = 68.3 \text{ dB(A)}$$

Background noise measurements should be made using the same measurement instrument and setup as that used for the corresponding source noise measurements. The exact metric and procedure to be used for background noise measurements is regulation specific, refer to Chapters 3, 4 and 5 for further details.

2.4 Procedure for Personal Monitoring for Determining Occupational Noise Exposure

Personal noise monitoring for FRA compliance is done on employees whose exposures occur primarily in the locomotive cab. It is usually conducted during a hearing conservation program audit, or because of an excessive noise report from an employee whose exposure occurs in the locomotive cab, and it is used to determine if employees' exposures require the establishment of a hearing conservation program. If the monitoring is due to an excessive noise complaint, it must be conducted in the specific location or equipment from which the complaint has arisen. The employee's work should not vary from the normal routine, and should be documented. In most cases, it is prudent to observe the monitoring and log the general sources of noise, especially those above the threshold level. This Section outlines a procedure for performing personal noise exposure monitoring of this group of employees. A more detailed description of this procedure can be found in Chapter 6.

2.4.1 Personal Monitoring for Determining Occupational Noise Exposure - Advance Planning

Before any employee monitoring can take place, the necessary tasks should be planned out in advance. Checklist 3 outlines the preliminary steps that should be taken before any noise measurement is conducted.

Checklist 3. Personal Monitoring for Determining Occupational Noise Exposure - Advance Planning

☐ **Determine the route details, from the employee or railroad management.**

- Boarding location. _____
- Time and date. _____
- Route and estimated time on board. _____
- Route end point - if not a round trip. _____

☐ **Non-FRA/railroad personnel should become familiar with railroad safety considerations.**

- Required personal protective equipment.
- Railroad safety rules/policy for boarding/riding in operating locomotives.

☐ **Equipment preparation - Select and prepare appropriate noise measurement and other equipment.**

- Noise dosimeters/SLM Type - S/N_____
  (Determine how many) Type - S/N_____
- Calibrator Type - S/N_____
- Tape or clips to fasten cables
- Fresh batteries
- Reset/confirm proper configuration of dosimeters/SLM. (weighting, response rate, etc.).
- Notebook/clipboards/forms for documenting measurement parameters and events.
- Laptop and required software/interface devices for download/storage of data.

☐ **Prepare personal needs for travel.**

- Gather and pack water and non-perishable food (and meds if needed) for length of trip.
- Transportation back from route end point (if not round trip on board).
- Personal communications.

Note: The above checklist presumes the monitoring will be directly observed to ensure the integrity of the measurements.

2.4.2 Personal Monitoring for Determining Occupational Noise Exposure - Field Procedure

Checklist 4 outlines a step-by-step procedure that should be followed during the course of the noise monitoring. Further explanation of the more detailed steps can be found in the following paragraphs.

Checklist 4. Basic Procedure for Personal Monitoring for Determining Occupational Noise Exposure

Set up the noise measurement instrument(s).

- ☐ Turn on and verify the measurement instrument(s) condition and settings.
  - Full battery power
  - Frequency weighting filter (A)
  - Filter Response (Slow)
  - Exchange Rate (5 dB)
  - Threshold Level (80 dB(A))
  - Criterion Level (90 dB(A))
  - Measurement Metric ($L_{TWA(8)}$)
- ☐ Verify time synchronization between noise measurement instrument, wrist watch (or cell phone), and laptop.
- ☐ Calibrate the noise measurement instrument(s) (or verify calibration). The instrument(s) should be adjusted so that the measured level matches the known level of the calibration tone. (May be done immediately before going to field).*
- ☐ Verify the instrument is reading the appropriate calibration value, then log /document 10 seconds of the acoustic calibration signal after the signal stabilizes (for each device used).
- ☐ Place a windscreen over the microphone.

Position the noise measurement instrument and begin monitoring. (Use of a dosimeter is assumed)

- ☐ Position the microphone in the employee's hearing zone, a sphere 0.6 m (2 ft) in diameter around the employee's head.
- ☐ Use tape or clips to ensure that the cable connecting the dosimeter body and microphone does not interfere with the employee's safety or performance.
- ☐ Start data logging and lock keyboard.

Observe activities and events during monitoring.

- ☐ Document the source of any noticeably loud noises, slamming doors, sounding of horn, open windows, loud radio calls, etc. (especially those potentially exceeding 115 dB(A)).
  - *Note:* Requires use of SLM or additional dosimeter to observe levels.
- ☐ If possible, periodically measure and document the temperature inside the locomotive cab.

☐ **End monitoring.**

Unlock keyboard and stop data logging.

Perform post-measurement checks.

- ☐ Measure and log /document 10 seconds of the acoustic calibration signal after the signal stabilizes.
- ☐ Confirm that this calibration level is within +/- 1 dB(A) from initial calibration level.
- ☐ Measurements may not be used for compliance if the difference is greater than 1 dB.

Backup data

- ☐ Save and/or download the data stored to memory or an external storage device.
- ☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

* If the acoustic calibrator uses a frequency other than 1000 Hz, the filter characteristics must be set to un-weighted (rather than A-weighted) during calibration.

Dosimeter placement for noise exposure monitoring: When using a dosimeter the entire measurement instrument is worn by the employee. The microphone must be placed in the employee's hearing zone, a 0.6 m (2 ft) diameter sphere around the employee's head[19]. It is usually clipped to the mid-top of the employee's shoulder (or upper lapel) and oriented according to the manufacturer's instructions (usually parallel to the wearer's shoulder). If one side of the employee is typically closer to the noise source(s), then the microphone should be attached on that side. Consult the dosimeter manufacturer's instructions for proper attachment techniques, if the microphone does not come with an attached mounting clip. The microphone is usually connected to the dosimeter with a short cable. The placement on the body of the dosimeter is not very important, only that it and the cable do not interfere with the employee's job performance or pose a potential safety hazard. Typically, the dosimeter is clipped to the employee's belt, carried in their pocket, or over their shoulder with a strap.

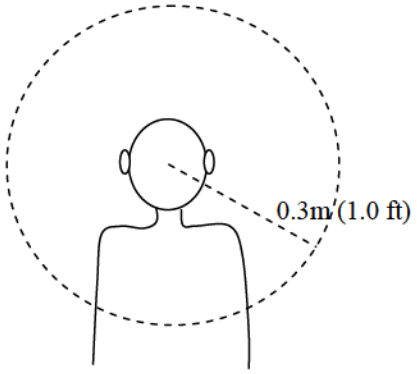


Figure 5. Hearing Zone for Microphone Placement

It is important that the employee wear the dosimeter for the entire measurement period and do not touch the measurement equipment, while they perform their duties normally. Many dosimeters have "lock functions," that prevent the settings from being altered during the course of the study. The dosimeter manufacturer's instructions should contain suggestions for protective casing, if one is not provided with the dosimeter.

To ensure the integrity of the measurements, the monitoring should be observed. In order to document events properly, the observer should have available an additional dosimeter or sound level meter so that the sound levels can be easily read from the instrument's display and correlated with actual noise events (horn soundings, etc.). If possible, without interfering with or distracting the employee, the additional instrument's microphone should be positioned near the employee, within the employee's hearing zone if practical. The approximate position of the microphone should be documented in the data logs.

2.5 Documentation

Documentation is required for all compliance measurements. Every aspect of the test location and the noise measurements must be properly documented, from the site geometry to the meteorological conditions to the actual measured sound levels. While there may be some additional documentation requirements depending on the specific regulation governing the measurements, the following information should be documented for all rail noise measurements.

- Names of equipment operators/observers.
- Date and start time of the measurements.
- List of the measurement equipment used and serial numbers.
- The railroad equipment's call number or other identifying information to trace make, model number, serial number, and date of manufacture.

- Short measurement description to identify the regulation being complied with, and to identify the primary noise source being investigated.
- Measurement site description, including:
  - Location description; and
  - Sketch of measurement site geometry, noting any conditions which make the site non-compliant (i.e., large buildings in the measurement site, or bodies of water between the noise source and microphone).
- Meteorological data, which should include, at a minimum:
  - Air temperature;
  - Wind velocity/speed and direction;
  - Relative Humidity.
- Calibration sound pressure levels. The time of day and duration corresponding to each measurement should also be documented.
- Background noise levels measured using the appropriate metric, along with the time of day and duration corresponding to each measurement.
- Results of regulation-specific noise measurement(s), along with the time of day and duration corresponding to each measurement.

The following pages contain blank log sheets that can be duplicated as necessary. Figure 6 is a general noise measurement log sheet, applicable to all noise measurements. Figure 7 is a general noise exposure monitoring log sheet, applicable to monitoring of employee personal noise exposure. Figure 8 is a site condition and meteorological data log sheet, applicable to all types of measurements. Figure 9 is a receiving property sound level log sheet, applicable only when the sound level data are not stored within the measurement instrument. Sample uses of these data log sheets are included in the applicable part of Chapters 3 to 6 for each type of measurement. These files should be maintained at Regional Offices, or follow agency documentation guidance.

Federal Railroad Administration								Page ____ of ____
General Noise Measurement Data Log Sheet								
Name(s):					Date:			
Type of Measurement:					Start Time:			
Railroad Personnel and Measurement Site Information								
Names:					Railroad Equipment:			
Location:					Comments:			
Measurement Instrumentation Information								
Meas. Device:					Calibrator:			
Serial No.		Type:			Serial No.:			
Settings:					Level:	dB	Frequency:	Hz
					Comments:			
Events and Incidents Log								
Event No.	Start Time	Stop Time	Level	Comments				

Figure 6. General Noise Measurement Data Log Sheet

Federal Railroad Administration
Noise Exposure Monitoring Data Log Sheet

Page ____ of ____

Name(s): _____	**Date:** _____
Type of Monitoring:	**Start Time:**

Monitored Railroad Employee Information

Name: _____	**Railroad Equipment:**
Job Title: _____	
Workshift Duration: _____	
Hearing Protection/Type: _____	
Location:	**Comments:**

Monitoring Instrument Information

Meas. Device: _____	**Calibrator:** _____
Serial No.: _____ **Type:** _____	**Serial No.:** _____
Settings:	**Level:** _____ dB **Frequency:** _____ Hz
	Comments:
Mic. Location:	

Events and Incidents Log

Event No.	Start Time	Stop Time	Task/Event	Event Description and Comments

Figure 7. General Occupational Noise Exposure Monitoring Data Log Sheet

Federal Railroad Administration
Measurement Site Geometry and Meteorological Conditions Log Sheet

Page ____ of ____

Name(s): _____ **Date:** _____

Type of Measurement: **Start Time:**

Railroad Personnel and Measurement Site Information

Names: _____ **Railroad Equipment:** _____

Location:

Comments:

Measurement Site Geometry ***(Plan View)***

N

Meteorological Conditions

Event No.	Time	Wind Speed	Wind Direction	Temperature	Relative Humidity	Comments

Figure 8. General Measurement Site Geometry and Meteorological Conditions Log Sheet

Federal Railroad Administration
Receiving Property Noise Measurement Data Log Sheet

Page ____ of ____

Name(s): _____ **Date:** _____

Type of Measurement: **Start Time:**

Railroad Personnel and Measurement Site Information

Names: _____ **Railroad Equipment:** _____

Location: **Comments:**

Measurement Instrument Information

Meas. Device: _____ **Calibrator:** _____

Serial No.: _____ **Type:** _____ **Serial No.:** _____

Settings: **Level:** _____ dB **Frequency:** _____ Hz

Comments:

Events and Incidents Log

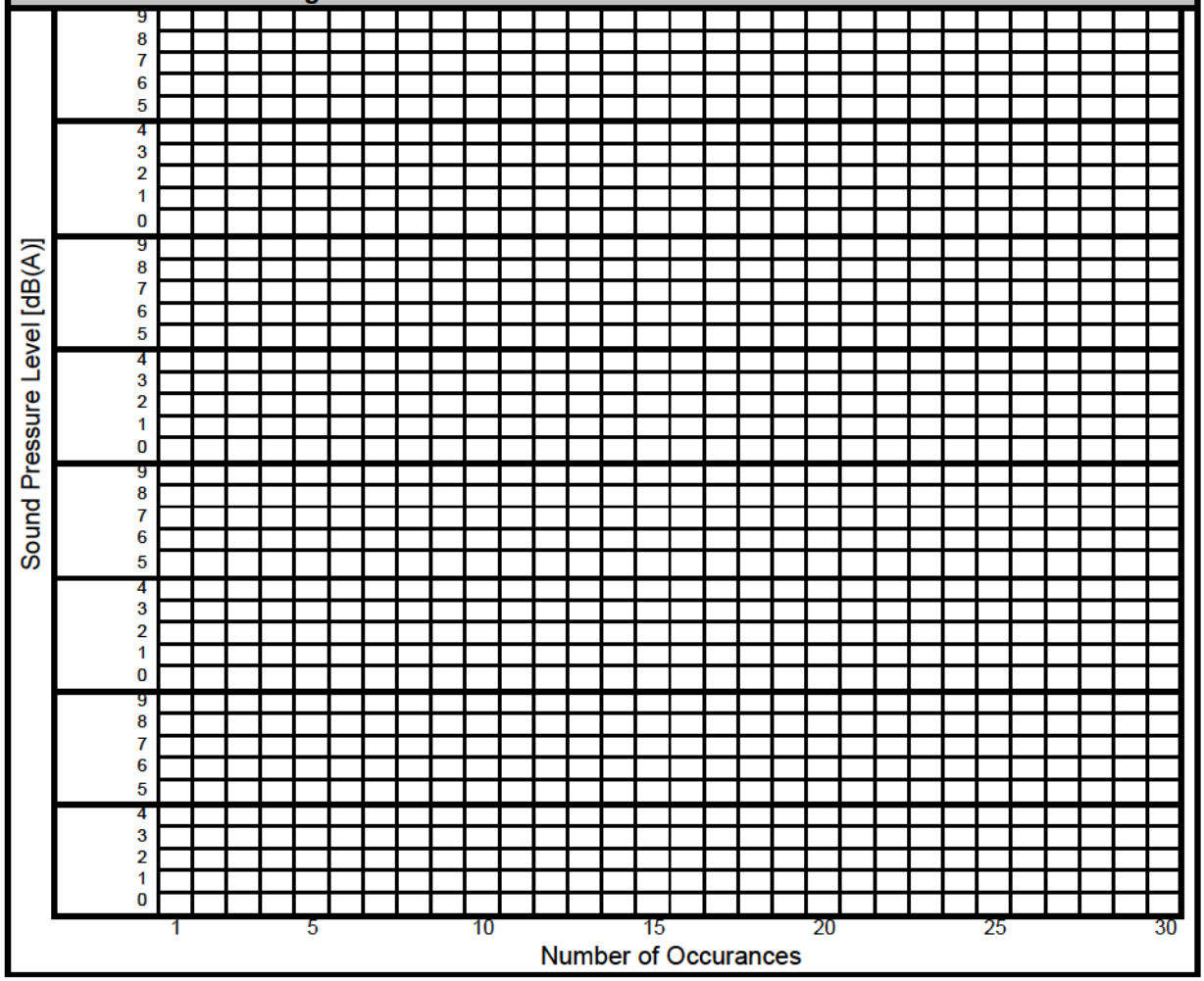


Figure 9. General Receiving Property Noise Measurement Log Sheet

3 Regulation-Specific Noise Measurement Guidance: Line-Haul Operations

This section describes the methods used to make exterior, sideline noise measurements on moving locomotives and rail cars and to determine if the resulting, measured noise levels are in compliance with the appropriate federal regulations (40 CFR Part 201.12 and 201.13). Complete checklists, incorporating the appropriate elements of both Chapters 2 and 3 for moving locomotive and rail car measurements, may be found in Appendix B.

The implementation of these procedures assumes that all the steps in the general measurement procedures presented in Chapter 2 are followed (unless otherwise specified). Table 3 is a summary of the regulation-specific settings as well as the noise level limits, measurement tolerances, etc. for all the measurements outlined in this chapter. Appendix B contains a step-by-step procedure for each compliance measurement, combining the relevant elements from Chapters 2 and 3.

Table 3. Summary of Line-Haul Measurement Regulatory Requirements

Noise Source	Governing Regulation	Compliance Level	Tolerance	Operating Condition	Duration	Measurement Location
Locomotives (including all switchers, regardless of build date)	40 CFR Part 201.12(a)	90 dB(A)	+ 2 dB	Moving	Duration of locomotive or rail car pass-by	Sideline 30 m (100 ft) microphone height 1.2 m (4 ft.)
Locomotives built before 12/31/79*	40 CFR Part 201.12(b)	96 dB(A)	+ 2 dB			
Rail cars speed ≤ 75 km/h (45 mph)	40 CFR Part 201.13	88 dB(A)	+2 dB			
Rail cars speed > 75 km/h (45 mph)	40 CFR Part 201.13	93 dB(A)	+2 dB			

* If the build date of a locomotive cannot be established, then it should be evaluated as if it had a build date before December 31st, 1979.

Locomotives: All of the sound emitted by the moving locomotive, including air conditioning system noises, should be considered part of the railroad noise being measured, except for noise from railroad warning devices such as horns. Furthermore, the locomotive may be moving at any time and be under any grade, load, acceleration, or deceleration condition during the time of these noise measurements.

The noise emission standards for moving locomotives (including switcher locomotives) specify different noise emission level compliance requirements for locomotives built after December 31st 1979 than those built on or before December 31st, 1979. Therefore, when measuring and evaluating a consist which contains multiple locomotives, the following regulatory requirements must be considered:

- If each locomotive being evaluated is separated from all other locomotives by at least ten rail car lengths or 152.4m (500ft), then the locomotives may be evaluated independently according to their individual build dates.
- If the locomotives are *not* separated by at least ten rail car lengths, the entire consist may be evaluated together against the compliance requirements of the oldest locomotive (e.g., a consist of five locomotives with one built before December 31st, 1979 would all be evaluated against the 'built on or before December 31st, 1979' requirements).

Rail cars: The majority of the noise generated by rail cars is due to wheel-rail interactions, which is dependent, in part, on the speed of the rail car. The noise emission standards for moving rail cars present criteria for:

(1) Rail cars traveling up to and including 75 km/h (45 mph); and

(2) Rail cars traveling faster than 75 km/h (45 mph).

Therefore, the speed of the moving rail cars should be measured (using a stopwatch, radar, or locomotive speedometer) and documented for evaluation. If the speed cannot be measured with an accuracy of at least ± 8 km/h (5 mph), compliance should be evaluated as if the rail car was operating at a speed greater than 75 km/h (45 mph).

There must be a separation distance of a least 152.4 m (500 ft) or 10 rail cars between the nearest operational locomotive and each rail car whose noise levels are being measured, or the measurements are invalid.

3.1 Measurement Site Selection and Setup

The measurement site for line haul operations must meet the criteria in 40 CFR Part 201.12, 201.13, and 201.23 as follows, and shown in Figure 10.

- The microphone shall be positioned at a distance of 30 m (100 ft) from, and perpendicular to, the centerline of the track.
- The test section of railroad track must be straight, such that it exhibits less than a 2 degree curve or a radius of curvature less than 873m (2865 ft).
- The track must be tie and ballast, free of special track work and bridges or trestles. If these railroad track specifications are not observed, noise resulting from undesirable track conditions, such as squeal, may have an impact on the sound level measurements.

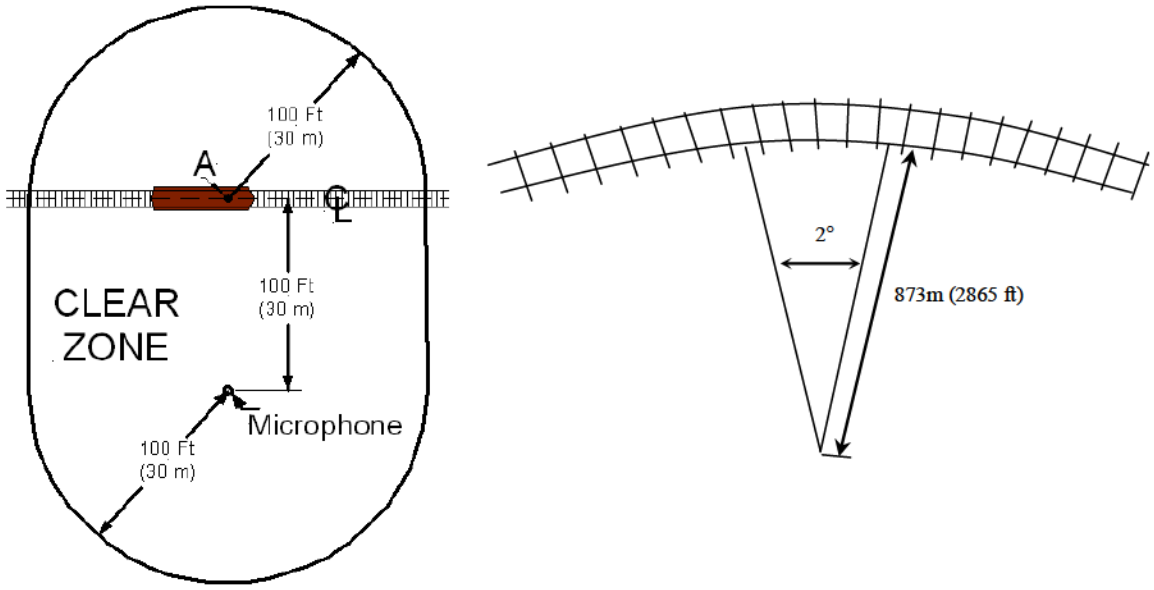


Figure 10. Clear Zone for Sideline Measurements and Radius of Curvature of Railroad Track

Measurements at non-conforming sites may be conducted, but those measurements cannot be used for compliance determinations. All site conditions, especially those that make the site non-conforming, should be documented with pictures or drawings and descriptive text.

As part of the setup procedures for rail car noise measurements, any speed detection instruments (such as a radar gun or stopwatch) should be setup and positioned. When using a radar gun, make sure to setup, orient, and calibrate it according to manufacturer's instructions.

3.2 Noise Measurement Instrument Settings

The noise measurement instrument should be set using the parameters in Table 4. If the instrument is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected for documentation and verification purposes.

Table 4. Summary of Noise Measurement Instrument Settings for Line-Haul Pass-By Measurements

Frequency Weighting	Filter Response	Metric
A	Fast	Maximum Sound Pressure Level (L_{AFmx})

3.3 Noise Measurement Procedure

The noise measurement procedure for line-haul operations is relatively straightforward, and can be summarized into the following steps, which are further detailed in the following paragraphs.

- ✓ **Measure the background noise level for 30 seconds, note the maximum.**
- ✓ **Conduct pass-by measurement. Continuously measure the sound level during the pass by, note the maximum.**
- ✓ **Check for problems.**
- ✓ **Measure the background noise level for 30 seconds, note the maximum.**

Noise levels for only a single pass-by are required for compliance with the federal regulations. For research or source noise characterization purposes, measurements of multiple pass-bys are recommended to confirm accuracy.

Measure the background noise: Background noise should be recorded well *before and after* the locomotive / consist is audible. Start the instrument, and observe the background noise level for 30 seconds. If possible, store these measurements in the instrument. Note the maximum level on the log sheet.

Conduct the pass-by measurement: Wait for the train to approach, or signal the crew to start the pass-by.

Locomotives:

- Start the instrument and begin measuring as the locomotive starts its approach, and continue until it is 10 car lengths (~500 feet) past the microphone line. A good rule-of-thumb is to begin measuring as soon as the train is clearly audible.
- Note the maximum sound level and time of maximum during the pass-by on the log sheets.

Rail cars:

- Start the instrument and begin measuring when the locomotive is at least 10 cars lengths (~500 feet) past the microphone line.

- Note the number of cars separating the test (highest noise) rail car from the operating locomotive.
- Measure the speed of the cars / consist. Either measure with a radar gun, or estimate by documenting the time the rail car passes a particular landmark, the time it passes the microphone line, and the distance between the two.
- Stop the noise measurement instrument when the train is no longer audible (or the sound level has dropped to 10 dB(A) below the maximum – this 10-dB-down 'window' is considered optimal).
- Note the maximum sound level and time of maximum during the pass-by on the log sheets.

Because both sound level and speed data must be collected during a rail car pass-by, it is helpful to have a 2-person measurement team: one to measure sound levels and count the number of cars, and another to measure speed.

Check for problems:

- ⊗ If a sound level violation occurs, the measurement instrument should be re-calibrated before proceeding with another set of measurements.
- ⊗ If an audible warning device, such as a horn or bell, is sounded during the measurement interval, or if there is any substantial contamination from outside noise sources, the noise measurement is invalid and must be repeated.
- ⊗ If there are sounds indicating abnormal performance, such as brake squeal, the noise measurement should be discarded.

3.4 Documentation

Figure 11 presents a sample usage of the forms that may be used to document the line haul measurements and noise data. Although the use of these specific forms is not required by the FRA, their use will facilitate the logging of information pertinent to the measurement in an organized manner.

Federal Railroad Administration				Page 1 of 1
General Noise Measurement Data Log Sheet				
Name(s):	Joe Noise		**Date:**	2/22/2002
Type of Measurement:	Moving Locomotive		**Start Time:**	12:22:00
Railroad Personnel and Measurement Site Information				
Names:	Frank Railroad, Bob Locmotive		**Railroad Equipment:**	Locomotive #123 & #124
Location:	Small Town, USA		**Comments:**	Brand Y
1 mile east of Main St.			Serial No. 424, 377	
Highway-Rail Grade Crossing			#123 built 7/07/1977, #124 built 7/07/97	
Measurement Instrumentation Information				
Meas. Device:	Brand X, iSLM		**Calibrator:**	Brand X
Serial No.	12345 **Type:** 1		**Serial No.:**	6789
Settings:	A-weighting		**Level:**	114.0 dB **Frequency:** 1000 Hz
Fast Response, L_{AFmx}			**Comments:**	

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:01:00	12:01:30	114.0	Calibration
1	12:22:00	12:23:05	52.3	Background Noise (Initial)
2	12:47:15	12:47:32	92.9	Locomotive #123 passby
3	12:48:05	12:48:22	81.0	Locomotive #124 passby
2	12:49:15	12:49:43	82.0	15 cars away from Locomotive #124
				speed = 50 mph
4	13:30:00	13:31:15	51.0	Background Noise (final)
CAL	13:40:03	13:40:40	114.2	Final Calibration

Figure 11. Sample Log Sheet for Moving Locomotive and/or Rail Car Noise Measurements

3.5 Procedure for Data Processing and Evaluation of Compliance

The processing and analysis of noise data collected during line-haul noise measurements should use the following steps. Each circumstance where a problem causes a non-compliant measurement or measurement condition is prefaced by ⊗.

1) Compute the difference (ΔCal) between the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the pass-by event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.

- If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Determine the maximum sound level for each pass-by event, and each background noise measurement. The measurement instrument can usually be set to automatically report/display these levels. If not, the levels must be determined from the stored data. This is usually accomplished by downloading the data to a text file or spreadsheet and comparing the timeline of the data to the field notes. The timeframe of the pass-by event is determined from the field notes. The corresponding timeframe is then identified in the measured noise data and the maximum sound level within that measurement interval is identified.

3) Verify that background noise did not contaminate the measurements. The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

⊗ If background noise contamination occurs, the measurements must not be used for compliance.

4) Compare the maximum sound level for the event to the appropriate railroad noise level criteria from Table 3. To account for the effects of variations in instrument tolerances, site topography, atmospheric conditions, reflected sound from small objects, and the common practice of reporting sound levels to the nearest decibel, 2 dB(A) may be added to the compliance level.

5) Evaluate Compliance.

⊗ If the maximum sound level is greater than the compliance level plus tolerance, then the locomotive or rail car should be considered non-compliant and the appropriate action should be taken. The regulations state that a non-compliant locomotive or rail car shall be subjected to another pass-by test prior to return to service. However, no retest is required if the cause of the noise defect is readily apparent and is corrected by the replacement of defective components or by a normal maintenance or repair procedure.

3.6 Example of Data Processing and Evaluation of Compliance

Based on the example log sheet in Figure 11:

1) Compute the difference (ΔCal) between the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the pass-by event(s).

$Cal_{Initial}$ = 114.0 dB(A) **Cal_{Final} = 114.4 dB(A)**

ΔCal = 114.4 – 114.0 = 0.4 dB(A).

Halve the difference (0.2 dB) and subtract from all of the measured data.

2) Determine the maximum sound level for each pass-by event, and each background noise measurement from log sheets or stored data.

Initial Background = 52.1 dB(A)

Final Background = 50.8 dB(A)

Locomotive #123 = 92.9 dB(A)

Railcar = 81.8 dB(A)

Locomotive #124= 80.8 dB(A)

3) Compare the maximum sound level for each event and each background noise measurement, and verify that background noise did not contaminate the measurements. The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

Locomotive #123 – Initial Background = 92.9 – 52.1 = 39.8 dB(A)

Locomotive #123 – Final Background = 92.9 – 50.8 = 41.1 dB(A)

Railcar – Initial Background = 81.8 - 52.1 = 29.7 dB(A)

Railcar – Final Background = 81.8 – 50.8 = 31.0 dB(A)

Locomotive #124 – Initial Background = 80.8 – 52.1 = 28.7 dB(A)

Locomotive #124 – Final Background = 80.8 – 50.8 = 30.0 dB(A)

✓ **All differences are greater than 10 dB(A), there is no background noise contamination.**

4) Compare the maximum sound level for the event to the appropriate railroad noise level criteria.

Event	Maximum Level (dB(A))	Compliance Level (dB(A))	Compliance + Tolerance (dB(A))	Pass?
Locomotive #123	92.9	90.0	92.0	No
Railcar, speed 50 mph	81.8	93.0	95.0	✓ Yes
Locomotive #124	80.8	90.0	92.0	✓ Yes

5) Evaluate compliance.

⊗ **After allowing for 2 dB(A) tolerance, locomotive #123 is not in compliance. This locomotive must be subjected to another pass-by test prior to return to service. However, no retest is required if the cause of the noise defect is readily apparent and is corrected by the replacement of defective components or by a normal maintenance or repair procedure.**

3.7 Representative Sound Level Data

The purpose of these data are to provide a summary of representative locomotive and rail car sound levels to which field measurements can be compared. An individual source measurement lying far above the range of values reported here should be cause for concern.

On the basis of the results of 379 locomotive pass-by noise tests reported by the FRA for the 1982 version of this handbook, the A-weighted sound levels from moving locomotive consists at a distance of 30 m (100 feet) may range from 69 to 97 dB(A) with a mean value of 87.8 dB(A). More recent data from the FTA Transit Noise and Vibration Impact Assessment Manual reports the following 'approximate' maximum sound levels at 100 ft:

Diesel Locomotives	85 dB(A),
Electric Locomotives	83 dB(A), and
Rail Cars	77 dB(A).

4 Regulation-Specific Noise Measurement Guidance: Yard Operations

Railroad yard operations include the classification of railroad cars, the performance of routine maintenance and simple repair of locomotives and railroad cars, and, in some cases, the carrying out of locomotive load tests to check the performance of locomotives. Large yards also provide more comprehensive maintenance and repair facilities, and, in some cases, dormitory facilities for locomotive crew members. In addition, many yards serve as terminal areas for trailer-on-flatcar and container-on-flatcar (TOFC / COFC) operations.

To support these operations, a yard may contain a variety of noise sources including: stationary idling locomotives, moving locomotives, load test cells, maintenance and repair facilities, and TOFC / COFC loading and unloading facilities. Although railroad car speeds within a yard are sufficiently low that wheel/rail noise is negligible, car-to-car and multiple car impacts in the classification area do generate loud impulsive sounds. Finally, in hump yards, the interaction of wheel, rail, and retarder brake shoes can produce loud squeal-type noise events.

This section describes the methods used to make exterior noise measurements on locomotives and other equipment operating within a rail yard facility, to evaluate the measured noise levels, and to determine if they are in compliance with the appropriate regulations. The implementation of these procedures assumes that all the steps in the general measurement procedures presented in Chapter 2 are followed (unless otherwise specified). Table 5 provides a summary of the regulation-specific settings as well as the noise level limits, measurement tolerances, etc. for all the measurements outlined in this chapter. Appendix B contains a step-by-step procedure for each compliance measurement, combining the relevant elements from Chapters 2 and 4.

Measurement procedures for operations inside a rail yard differ from those used for moving railroad equipment traveling along a rail corridor, since the yard operations are more event driven. The following rail yard operations, described in the following paragraphs, are covered by specific regulatory noise limits:

(1) Stationary locomotives, including switcher locomotives, operating at maximum throttle settings connected to load test cells, and at idle (40 CFR Part 201.11),
(2) Switcher locomotives performing switching operations (40 CFR Part 201.12),
(3) Car-coupling impacts (40CFR Part 201.15),
(4) Retarders (40 CFR Part 201.14), and
(5) Load Cell Test Stands (40CFR Part 201.16 and 201.27).

The noise levels from these operations are measured and evaluated using one of two primary types of measurement site criteria that are applicable to yard operations: fixed-site, sideline measurements, and receiving property measurements. Fixed-site sideline measurements are conducted at a distance of 30 m (100 ft) from the noise source within the rail yard. This type of site is applicable to stationary locomotives and load cell test stands, and is summarized in Section 4.1. Receiving property measurements, applicable to switcher locomotives, retarders, car coupling and certain load cell test stand measurements, are conducted at any property outside of the rail yard, and are summarized in Section 4.2.

Table 5. Summary of Yard Operation Regulatory Requirements

Noise Source	Operating Conditions	Governing Regulation	Compliance Level (dB(A))	Tolerance	Duration	Measurement Location
Locomotive	Stationary idle	40 CFR Part 201.11(a)	$L_{ASmx} = 70$	+2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. Ht. = 1.2 m (4 ft.)
Locomotive built before 12/31/79		40 CFR Part 201.11(b)	$L_{ASmx} = 73$			
Locomotive attached to a load cell	Stationary Any throttle setting (except idle)	40 CFR Part 201.11(a)	$L_{ASmx} = 87$	+ 2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. Ht. = 1.2 m (4 ft.)
Locomotive built before 12/31/79, attached to a load cell		40 CFR Part 201.11(b)	$L_{ASmx} = 93$			
Switcher locomotive	Stationary idle	40 CFR Part 201.11(c)	$L_{ASmx} = 70$	+ 2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. Ht. = 1.2 m (4 ft.)
Switcher locomotive	Stationary Any throttle setting (except idle)		$L_{ASmx} = 87$			
Load cell test stand	With stationary locomotive at maximum throttle setting	40 CFR Part 201.16(a)	$L_{ASmx} = 78$	+2 dB	Minimum of 30 seconds	Sideline at 30 m (100 ft) Mic. Ht. = 1.2 m (4 ft.)
Switcher locomotives ("trigger" for sideline measurements)*	Stationary, maximum throttle setting, w/o load cell	40 CFR Part 201.11(c) and 201.12(c)	$L_{90}(fast) = 65$	+2 dB	Measure at least once every 10 seconds, for 100 measurements	Receiving property, Mic. Ht. = 1.2 m (4 ft)
Car-coupling impacts	All	40 CFR Part 201.15	$L_{adjavemax}(fast) = 92$	+2 dB(A) [+4 for Type 2 meters]	Between 60 and 240 minutes	Receiving property, Mic. Ht. = 1.2 m (4 ft)
Retarders	All	40 CFR Part 201.14	$L_{adjavemax}(fast) = 83$	+6 dB [+6 for Type 2 meters]	Between 60 and 240 minutes	Receiving property, Mic. Ht. = 1.2 m (4 ft)
Load cell test stands ("trigger" for sideline measurements)*	All load cell stands in a rail yard, in conjunction with stationary locomotive at maximum throttle setting	40 CFR Part 201.16(b) & 40 CFR Part 201.27	$L_{90}(fast) = 65$	+2 dB	Measure at least once every 10 seconds, for 100 measurements	Receiving property, Mic. Ht. = 1.2 m (4 ft)

*The 65 dB(A) receiving property criteria is the 'trigger' for requiring the sideline test of switcher locomotives or load cell test stands. If the receiving property measurements are not in compliance, then both moving and stationary sideline measurements must be conducted.

Stationary locomotives: Stationary locomotives include locomotives operating at an idle throttle setting, as well as those at non-idle settings. They are distinguished from moving ones in the regulations, because idling and stationary locomotives typically operate at a low throttle setting, and may not operate under a load (unless connected to a load cell test stand). Furthermore, they do not produce additional noise resulting from interaction between the locomotive wheels and the track.

These locomotives are measured at a fixed sideline 30 m (100 ft) location and evaluated using the maximum sound level. There are different compliance limits for locomotives built on or before December 31st, 1979, and locomotives built after December 31st 1979.

Switcher locomotives*: Noise from switcher locomotives can be evaluated using either fixed-site sideline measurements or receiving property measurements. Generally, the receiving property measurement should be considered as the first option. The regulations state that noise due to all switcher locomotives that operate in a particular railroad facility are in compliance if the A-weighted sound level from the stationary switchers, (operating singly or in conjunction with other stationary locomotives) does not exceed an L_{90} of 65 dB(A) at the receiving property location. It is assumed that if the receiving property criteria have been met, than the sideline 30 m (100 ft) criteria have also been met. The receiving property measurement is given more emphasis to encourage railroads to employ noise abatement procedures, such as operational changes.

The sideline measurement criteria for switcher locomotives states that all switcher locomotives, whether moving or stationary, regardless of the build date, must meet the same noise emission criteria, using the same measurement procedures as any other type of locomotives built after December 31st, 1979. These criteria apply to independently operating, moving switcher locomotives, as well as moving switchers operating in combination with any other type of locomotive.

Load cell test stands: Load cell test stands are external, electrically resistive devices found primarily in rail yards and railroad testing facilities that simulate locomotive performance under heavy load during a stationary test. They are used for locomotive performance testing and monitoring. Many locomotives manufactured in recent years are now equipped with their own self-loading capability, which provides a method to conduct stationary tests under load in a manner that is significantly quieter than load cell test stands. There are no FRA regulations specifically addressing self-loading noise from locomotives.

Load cell test stands operated with a stationary locomotive have different noise limits than those for stationary locomotives alone. Stationary switcher locomotives operating with load cell test stands also are subject to be in compliance with stationary switcher noise regulations.

As with switcher locomotives, the receiving property measurement should be considered as the first option. The regulations state that noise due to all load cells that operate in a particular railroad facility are in compliance if the A-weighted sound level from the load cells does not exceed an L_{90} of 65 dB(A) at the receiving property location. It is assumed that if the receiving property criterion has been met, than the sideline 30 m (100 ft) criterion has also been met. The receiving property measurement is given more emphasis to encourage railroads to employ noise abatement procedures, such as operational changes.

If, however, the receiving property criterion is not met, then a suitable sideline measurements site must be used. However, due to the location of most load cell test stands (near large reflective structures), the sideline site criteria are often impossible to meet. Therefore the regulations allow for a variation on the receiving property

* A list of locomotives specifically designed as switchers can be found in 40 CFR Part 201 Appendix A.

measurements, where the microphone must be at least 120 m (400 ft) from the geometric center of the locomotive being tested with the load cell.

Car-coupling impacts: Car-coupling impacts are measured at a receiving property and evaluated using the adjusted average maximum sound level ($L_{adj\ ave\ max}$) of at least 30 consecutive car-coupling events. The adjustment factor is based on the total number of events and the duration of the measurement period. The events must occur during a measurement period of at least 60 minutes but less than 240 minutes.

A car coupling sound is defined in the regulations as 'a sound which is heard and identified by the observer as that of a car-coupling impact, and that causes a noise measurement instrument indicator (Fast) to register an increase of at least ten decibels above the level observed immediately before hearing the sound.' In most cases, the initial car-coupling impact will result in a chain-reaction-like transmission of impacts throughout the rail car consist, due to the slack action of the couplers on each car being either compressed or expanded, resulting in additional noise events. These resultant noises are typically at a lower level than the initial noise due to transmission loss between the rail cars, rolling friction, absorption and damping from car-coupling cushions. The initial car-coupling impact will most likely produce the maximum sound level for the car-coupling chain reaction, but the observer should try to document the times of the actual coupling events, if possible to help separate and identify them in the data collected.

Retarders: Retarder operations are measured at a receiving property and evaluated using the adjusted average maximum sound level ($L_{adj\ ave\ max}$) of at least 30 consecutive events. The same event-based adjustment factor used for car-coupling is also applied to retarder noise measurements.

A major source of noise present in hump yards is railroad car retarders. These devices occasionally emit high-frequency squeals due to a stick-slip process between the car wheel, the rail, and the retarder brake shoes. Retarders operate by having a movable brake shoe press each wheel against a stationary shoe. The resulting frictional forces serve to slow down the rolling car.

In an active retarder, the pressure applied to the wheels by the brake shoes is generally supplied by pneumatic or hydraulic cylinders which are controlled either manually by an operator or automatically by a computer. In an inert retarder, the brake shoes are spring-activated by the weight of the railroad car as it passes over the retarder.

The retarders in a hump yard are given different names depending on where in the yard they are located. The master retarder, which is an active retarder located a short distance past the crest of the hump, serves as the primary speed control for cars entering the classification area. All cars pass through the master retarder after which they are sent through switches to various groups of tracks.

Before entering a specific track in a group, the car passes through another active retarder called a group retarder where a second speed adjustment can be made. Generally, a master retarder will serve up to six or seven group retarders; thus, on the average, only one-sixth or one-seventh of the cars that pass through the master retarder will pass through a given group retarder.

After passing through the group retarder, the car will be directed by a series of switches to a specific track which, in most yards, it will enter uninhibited. In some yards, however, a third set of active retarders exists – one on each individual track. These retarders, called tangent point retarders, allow a third opportunity to adjust the car speed.

In most yards, an inert retarder is located at the end of each classification track to prevent the first car into the track from rolling out of the classification area. These retarders generally emit noise only when a string of cars is pulled through them for removal from the classification track. Some inert retarders are releasable, in which case they can be locked open so that they do not emit noise when cars are pulled through them.

A single retarder sound includes noises emitted from all retarders operating simultaneously in the rail yard. This conservative definition of a retarder sound accounts for and protects against overall rail car retarder noise at the receiving property.

4.1 Fixed-Site Sideline Measurements: Stationary Locomotives and Load Cell Test Stands

Stationary locomotives are subject to different limits depending on their date of manufacture and their operating state, for example locomotives operating at an idle throttle setting, as well as those at non-idle settings while connected to a load test cell. They are distinguished from moving ones in the regulations, because idling and stationary locomotives typically operate at a low throttle setting, and may not operate under a load (unless connected to a load cell test stand). Furthermore, they do not produce additional noise resulting from interaction between the locomotive wheels and the track. There are different compliance limits for locomotives built on or before December 31st, 1979, and locomotives built after December 31st 1979.

4.1.1 Measurement Site Selection and Setup

Fixed-site sideline measurements have similar criteria to line-haul measurement sites. They are conducted with the microphone at a distance of 30 m (100 ft) from a stationary source in a clear zone, defined as open space with no large reflecting objects within 30 m of the source being measured or the microphone position (illustrated in Figure 12). The specific criteria include:

- The microphone shall be positioned at a right angle to the center line between the two rails of the test track. The microphone shall be 30m (100ft) away from that line (in the direction most nearly towards the closest receiving property) at the geometric center point of the locomotive.
- The test site should be an open space free of large, sound-reflecting objects, such as barriers, hills, signboards, parked vehicles, locomotives or rail cars on adjacent tracks, bridges or buildings within clear zone boundaries.

- Within the complete test site, the top of at least one rail upon which the locomotive or train is located shall be visible (line of site) from the microphone location, 1.2 m (4 ft) above the ground, except as provided in the criteria below.
- Ground cover such as vegetation, fence posts, small trees, telephone poles, etc.., shall be limited within the area in the test site between the vehicle under test and the measuring microphone such that 80 percent of the top of at least one rail along the entire test section of track be visible from the microphone position 1.2 m (4 ft) above the ground; except that no single obstruction shall account for more than 5 percent of the total allowable obstruction.
- The ground elevation at the microphone location shall be within 1.5 m (5 ft) above and 3 m (10 ft) below the elevation of the rail in line with the microphone.

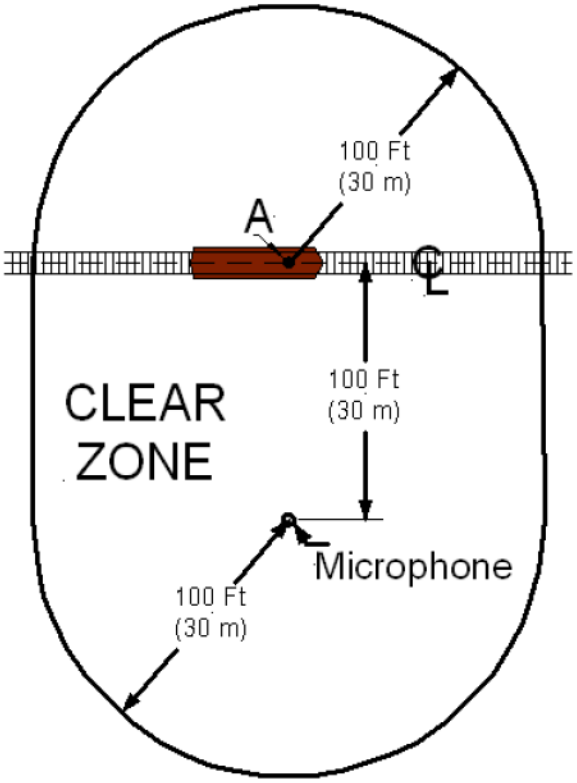


Figure 12. Fixed-Site Sideline Clear Zone

4.1.2 Noise Measurement Instrument Settings

The noise measurement instrument should be set using the parameters in Table 6. If the instrument is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected.

Table 6. Summary of Noise Measurement Instrument Settings for Fixed-Site Rail Yard Operations

Frequency Weighting	Filter Response	Metric
A	Slow	Maximum Sound Level (L_{ASmx})

4.1.3 Noise Measurement Procedure

The noise measurement procedure for fixed-site sideline measurements can be summarized into the following steps, which are further detailed in the following paragraphs.

- ✓ **Measure the background noise level for 30 seconds, note the maximum.**
- ✓ **Warm-up the locomotive**
- ✓ **Measure the locomotive noise level for 30 seconds, note the maximum.**
- ✓ **Measure the background noise level, note the maximum.**

Measure the background noise level: Background noise should be recorded before the locomotive warm-up period commences, and after the locomotive test has been completed. Start the instrument, and observe the background noise level for 30 seconds. If possible, store these measurements in the instrument. Note the maximum level on the log sheet.

Warm up the test locomotive: The engine of the locomotive must reach the normal cooling water operating temperature as specified by the locomotive manufacturer, before the noise level measurements may begin. Once the test locomotive has been set to the desired test throttle setting, a 40-second long stabilization period should be observed before the noise measurements can proceed*. All cooling fans shall be operating.

Measure the locomotive noise level: Start the measurement instrument, and measure the locomotive noise level for at least 30 seconds. Note the time, maximum sound level and operating conditions. The locomotive may be:

- Stationary, at idle.
- Stationary at any throttle setting.
- Connected to a load cell, at any throttle setting (except idle).

The particular order of these measurements is not a concern. Each of these conditions has a separate compliance limit.

4.1.4 Documentation

The following page contains an example of the use of the general log sheet for the sideline noise measurement of rail yard operations described in this Section. Figure 13 is an example of the use of the general measurement form for fixed-site sideline measurements of stationary locomotives, stationary switcher locomotives, and load cell test stands.

* In addition, if the locomotive must be turned off as it shifts from idle to the desired throttle setting, or as it is connected or removed from a load cell, then it should be allowed to warm up again before the next noise measurement.

Federal Railroad Administration
Noise Measurement Data Log Sheet

Page 1 of 1

Name(s):	Joe Noise	**Date:**	7/11/2007
Type of Measurement:	Stationary Switcher (wayside)	**Start Time:**	12:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	Locomotive #123
Location:	Small Town, USA	**Comments:**	Brand Y
Small Town Railroad Railyard			Serial No. 424
			built 7/07/1977

Measurement Instrumentation Information

Meas. Device:	Brand X, iSLM	**Calibrator:**	Brand X
Serial No.	12345 **Type:** 1	**Serial No.:**	6789
Settings:	A-weighting	**Level:**	114.0 dB **Frequency:** 1000 Hz
Slow Response, L_{ASmx}		**Comments:**	

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:08:00	12:08:37	114.0	Initial Calibration
1	12:22:00	12:24:15	34.2	Initial Background Noise
2	13:00:00	13:01:00	85.1	Stationary, Max Throttle, Load Cell (after warm up)
3	13:02:00	13:02:35	84.7	Stationary, Max Throttle, Load Cell (backup)
4	13:20:30	13:21:10	81.6	Stationary, Max Throttle, Singly (after warm up)
5	13:24:00	13:24:55	81.7	Stationary, Max Throttle, Singly (backup)
6	13:35:10	13:36:00	69.2	Stationary, Idle, Singly (after warmup)
7	13:40:30	13:41:07	68.8	Stationary, Idle, Singly (backup)
8	13:57:00	13:57:45	36.5	Final Background Noise
CAL	14:11:00	14:11:37	114.0	Final Calibration

Figure 13. Sample Log Sheet for Sideline Measurements of Stationary or Stationary Switcher Locomotives, or Load Cell Test Stands

4.1.5 Data Processing and Evaluation of Compliance

The processing and analysis of noise data collected during fixed-site sideline measurements of stationary locomotives, switcher locomotives, and load cell test stands should proceed with the following steps. Each circumstance where a problem causes a non-compliant measurement or measurement condition is prefaced by ⊗.

1) Compute the difference (ΔCal) between the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.

- If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Determine the L_{ASmx} for each event and each background noise measurement. If it was not measured directly, it must be determined from the stored data. This is usually accomplished by downloading the data to a text file or spreadsheet. The timeframe of the event is identified from the log sheets, the corresponding interval in the measured noise data is identified, and the maximum sound level within that interval is determined.

3) Verify that background noise did not contaminate the measurements. The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

⊗ If background noise contamination occurs, the measurements must not be used to evaluate compliance.

4) Compare the L_{ASmx} to the appropriate railroad noise level criteria summarized in Table 5. To account for variations in: 1) instrument tolerances, 2) site topography, 3) atmospheric conditions, 4) reflected sound from small objects, and 5) the common practice of reporting sound levels to the nearest decibel, 2 dB(A) may be added to the compliance level.

5) Evaluate compliance.

⊗ If the maximum sound level is greater than the compliance level plus tolerance, then the measurement is in violation and the appropriate action should be taken.

4.1.6 Example of Data Processing and Evaluation of Compliance

Based on the example log sheet in Figure 13:

1) Compare sound level of the calibrations before and after the event(s).

$Cal_{Initial}$ = 114.0 dB(A) **Cal_{Final} = 114.0 dB(A)**

ΔCal =114.0 – 114.0 = 0 dB(A)

✓ **No calibration adjustment is necessary.**

2) Determine the maximum sound level for each 30-second noise measurement, and each background noise measurement from the data.

Initial background = **34.2 dB(A)**

Final background = **36.5 dB(A)**

Stationary, max throttle, load cell = 85.1 dB(A)

Stationary, max throttle, single = 81.6 dB(A)

Stationary, idle = 69.2 dB(A)

3) Verify that background noise did not contaminate the measurements. The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

Stationary, max throttle, load cell – Initial background =	**85.1 - 34.2 =**	**50.9 dB(A)**
Stationary, max throttle, load cell – Final background =	**85.1 – 36.5 =**	**48.6 dB(A)**
Stationary, max throttle, single – Initial background =	**81.6 – 34.2 =**	**47.4 dB(A)**
Stationary, max throttle, single – Final background =	**81.6 – 36.5 =**	**45.1 dB(A)**
Stationary, idle – Initial background =	**69.2 – 34.2 =**	**35.0 dB(A)**
Stationary, idle – Final background =	**69.2 – 36.5 =**	**32.7 dB(A)**

✓ **These differences are all greater than 10 dB(A). These measurements have not been contaminated and may be used for compliance.**

4) Compare the maximum sound level for the event to the appropriate railroad noise level criteria and evaluate compliance.

Event	Maximum Level (dB(A))	Compliance Level (dB(A))	Pass?
Stationary, Max Throttle, Load Cell	**85.1**	**93.0**	✓ **Yes**
Stationary, Max Throttle, Single	**81.6**	**93.0**	✓ **Yes**
Stationary, Idle	**69.2**	**73.0**	✓ **Yes**

4.2 Receiving Property Measurements: Stationary Switcher Locomotives and Load Cell Test Stands

The specific site requirements, instrument settings, measurement procedures, documentation requirements, and data processing requirements specific to receiving property, yard-operation measurements of stationary switcher locomotives and load cell test stands are summarized in the following sections.

4.2.1 Measurement Site Selection and Setup

Receiving property measurements are conducted at any non-railroad property outside of the rail yard. In many cases, the rail yard may not be completely visible from the receiving property, and it may be helpful to have a second person located in or within sight of the rail yard to coordinate and document activities.

This site-type is the primary measurement option for switcher locomotives and load cells. If these measurements are non-compliant, it is necessary to measure using the fixed-site, 30 m (100 ft) sideline position. The specific criteria for receiving property sites include:

- The microphone is located on receiving property with no vertical plane surfaces exceeding 1.2 m (4 ft) in height within 10 m (33.3 ft) of the microphone position. However, residential or commercial buildings can be within the 10 m boundary as long as they are at least 2 m (6.6 ft) from the microphone position and not blocking the noise path. In addition, facility boundary noise barriers are permitted to be in the path of the sound emission.
- If the residential structure is a farm home, the microphone must be located between 2 m and 10 m away from the wall of the farm home.

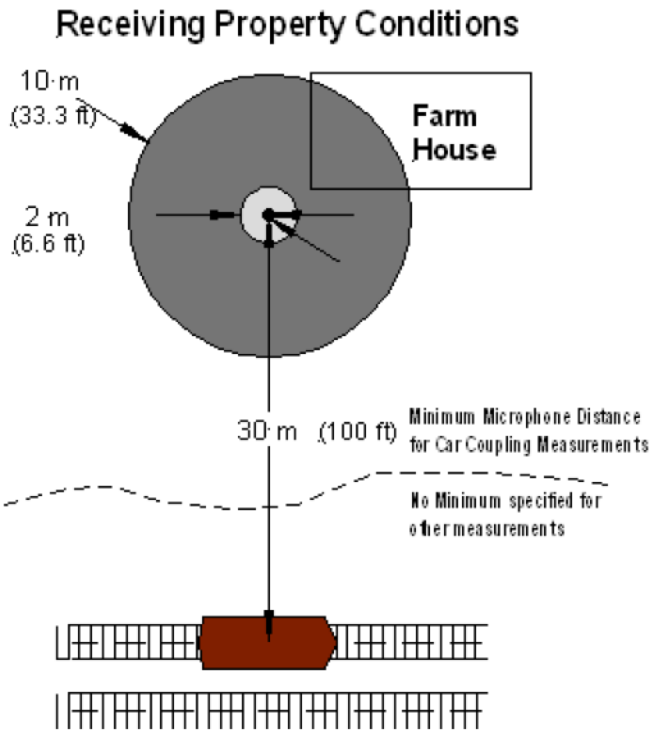


Figure 14. Receiving Property Site Requirements

For load cell test stand measurements only, when the primary receiving property measurement site is not suitable, a variation on the receiving property site criteria may be used. This variation requires the measurement microphone to be located on the receiving property *at least* 120 m (400 ft) away from the geometric center of the locomotive connected to the load cell being tested, and not simply at any point on the property.

In addition, for locomotive load cell test stand noise measurements, a third set of criteria, which is meant to simulate the acoustic field on non-railroad receiving property, allows measurements to be made by the railroad on its own property.

4.2.2 Noise Measurement Instrument Settings

For receiving property measurements, the instrument should be set using the parameters in Table 7. If the SLM is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected.

Table 7. Summary of Noise Measurement Instrument Settings for Receiving Property Measurements

Measurement Type	Frequency Weighting	Filter Response	Metric(s)
Stationary switcher locomotive	A	Fast	Exceedance percentile levels: L_{90}, L_{10}, L_{99}
Load cell test stands	A	Fast	Exceedance percentile levels: L_{90}, L_{10}, L_{99}

4.2.3 Noise Measurement Procedure

The noise measurement procedure for receiving property measurements can be summarized into the following steps, which are further detailed in the following paragraphs.

- ✓ **Measure the background noise level at least once every 10 seconds for at least 15 minutes or until 100 measurements have been obtained.**
- ✓ **Warm-up the locomotive.**
- ✓ **Measure the locomotive noise level at least once every 10 seconds for at least 15 minutes or until 100 measurements have been obtained.**
- ✓ **Check for general problems.**
- ✓ **Check for load cell operational problems. Specifically, any change of 10 dB(A)or more in load cell sound level.**
- ✓ **Measure the background noise level, at least once every 10 seconds for at least 15 minutes or until 100 measurements have been obtained.**

Measure the background noise: Measure at the receiving property*, before and after source noise measurements. For load cells, this can be during any period when the source load cell is off. Measure and record/document the A-weighted sound level at a rate of at least once every 10 seconds until 100 measurements have been obtained. If the noise measurement instrument is set to record 1-second samples, then the measurement period should be at least 15 minutes. This duration is usually necessary to arrive at a statistically valid sample; longer durations may be advisable at sites where the background sounds are intermittent / varying. If the L_{90} can be directly calculated by the instrument, note this value on the log sheet.

Warm up and stabilize the locomotive (same procedure as the stationary locomotive): The locomotive should be operating singly at maximum throttle. As part of the accepted noise environment, the railroad noise regulations allow for other stationary locomotives (including other stationary switcher locomotives) to be operating during these measurements. The regulations also allow for the operation of load cell test stands during the stationary switcher measurements.

Begin source noise measurements: Measure and record/document the A-weighted sound level at a rate of at least once every 10 seconds for at least 15 minutes or until 100 measurements are obtained. These measurements are used to calculate the validated L_{90} of the noise source. If the L_{10}, L_{90} and L_{99} can be directly calculated by the instrument, note these values on the log sheet.

Check for load cell operational problems: The sound level from load cells should be nearly steady-state. If the sound level is observed to change by 10 dB(A) or more at the receiving property measurement location, and there is

* Either before the switcher locomotive is operating or once the switcher locomotive has been moved to another location, from where it cannot be detected at the microphone location.

evidence that this change in sound level is coincident with a change in the load cell test stand operation (e.g., change in operational settings, etc.), while the stationary locomotive operation remains unchanged, then the L_{90} must be re-measured under these new load cell performance conditions.

4.2.4 Documentation

The following pages contain examples of the use of the general log sheets for the receiving property noise measurement of rail yard operations described in this Section. Figure 15 presents an example of a log sheet used during measurements where the instrument was able to automatically calculate and store/report the L_{10}, L_{90}, and L_{99} exceedance levels.

Figure 16 presents an example log sheet used during measurements where the instrument was not able to automatically calculate the exceedance levels: the user noted the sound level on the matrix once every 10 seconds by directly reading from the instrument display. In this example sheet, the L_{10}, L_{90}, and L_{99} are circled.

- The L_{10} is the level exceeded by 10% of the measurements, equivalent to the statistical 90^{th} percentile sound level or, out of 100 measurements, the 10^{th} highest sound level.
- Similarly, the L_{90} is the level exceeded by 90% of the measurements, equivalent to the statistical 10^{th} percentile sound level, or, out of 100 measurements, the 11^{th} lowest sound level.
- The L_{99} is the level exceeded by 99% of the measurements, equivalent to the statistical 1st percentile sound level, or, out of 100 measurements, the 2^{nd} lowest sound level.

During receiving property measurements, to the extent possible, document all the noise source location information on a diagram of the measurement site (rail yard and receiving property), labeling the locations of the microphones, type and locations of any and all noise sources, and approximate distance between each source type and the microphone.

Federal Railroad Administration
General Noise Measurement Data Log Sheet

Page 1 of 1

Name(s):	Joe Noise	**Date:**	2/12/2004
Type of Measurement:	Moving/Stationary Switcher (Rec. Property)	**Start Time:**	12:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	Locomotive #1231
Location:	Backyard of 225 Main St. in Small Town, USA next to Small Town Railroad Railyard	**Comments:**	Brand Y., Serial No. 4241 idle @max. throttle, no load cell built 7/07/1987

Measurement Instrumentation Information

Meas. Device:	Brand X, iSLM	**Calibrator:**	Brand X
Serial No.:	12345 **Type:** 1	**Serial No.:**	6789
Settings:	A-weighting, once every 10 sec Fast Response for 15 min L_{90} (L_{10} & L_{99}) [automatically]	**Level:**	114.0 dB **Frequency:** 1000 Hz
		Comments:	

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:08:00	12:08:37	114.0	Initial Calibration
1	12:22:00	12:38:30	43.0	Initial Background Noise (L_{90} = 43 dB(A))
				allowed locomotive to warm up
2	12:51:00	13:10:05	65.1	Stationary Switcher at max. thottle (no load cell)
				(3 other standard locomotives were simultaneously
				idling during meas.)
				L_{90} = 65.1 dB(A)
				L_{99} = 64.2 dB(A)
				L_{10} = 67.0 dB(A)
				turned off locomotive
3	13:30:00	13:48:00	42.0	final Background Noise (L_{90} = 42.0 dB(A))
CAL	13:52:30	13:53:10	114.2	Final Calibration

Figure 15. Sample Data Log Sheet for Receiving Property Switcher Locomotive Noise Measurements

Federal Railroad Administration
Receiving Property Noise Measurement Data Log Sheet

Page 1 of 3

Name(s):	Joe Noise	**Date:**	2/22/2002
Type of Measurement:	Stationary Switcher (Receiving Property)	**Start Time:**	2:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	Locomotive #1231
Location:	Backyard of 225 Main St. in Small Town, USA next to Small Town Railroad Railyard	**Comments:**	Brand Y. Serial No. 4241 built 7/071987

Measurement Instrumentation Information

Meas. Device:	Brand X, iSLM	**Calibrator:**	Brand X
Serial No.:	12345 **Type:** 1	**Serial No.:**	6789
Settings:	A-weighting, 12:22:00-12:38:30 Fast Response L, once every 10 sec for 15 min	**Level:**	114.0 dB **Frequency:** 1000 Hz
		Comments:	initial Cal 114.0 @ 12:08:00 / final Cal 114.2 @13:52:30

Events and Incidents Log

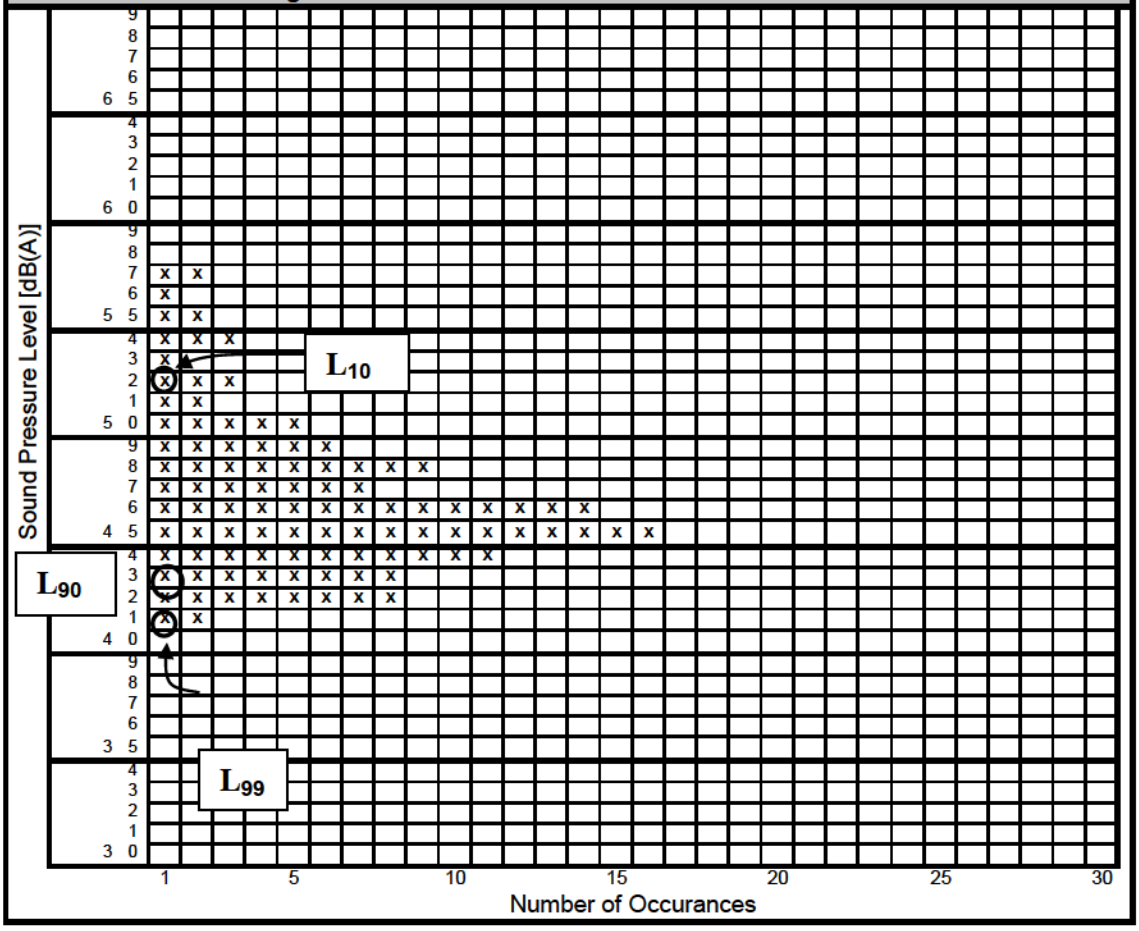


Figure 16. Sample Receiving Property Noise Measurement Log Sheet (Initial Background Noise for Stationary Switcher Locomotive Noise measurements at Receiving Property)

4.2.5 Data Processing and Evaluation for Compliance

The processing and analysis of noise data collected during receiving property measurements should use the following steps. Each circumstance where a problem causes a non-compliant measurement or measurement condition is prefaced by a ⊗.

1) Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$), during, and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.

- If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Calculate: L_{90} of the initial background noise data;
L_{90}, L_{10}, and L_{99} for the switcher locomotive or load cell* noise data; and
L_{90} of the final background noise data.

These metrics may be automatically calculated by the instrument. If not, they must be determined from the stored data or the completed log sheet (Figure 16 is an example).

a. Using stored data, the compliance level metrics can be determined by transferring the data (usually in the form of a comma-delimited file) to a spreadsheet. Sort the data from highest to lowest noise levels. The $L_{90\ is}$ the level exceeded by 90% of the measurements, or the 10th statistical percentile (in a dataset of 100 samples, this would be the 11th lowest sample). Similarly, the L_{99} is the level exceeded by 99% of the measurements, or the 1st statistical percentile, and the L_{10} is the level exceeded by 10% of the measurements, or the statistical 90th percentile.

b. Using the completed log sheet, the compliance metrics are determined by finding the 2nd lowest (L_{99}), 11th lowest (L_{90}), and 10th highest (L_{10}) values.

3) Validate the noise source L_{90} (s). The difference between the L_{10} and L_{99} must be less than 4 dB(A).

⊗ If $L_{10} - L_{99}$ is greater than 4 dB(A), the measurement shall not be used for compliance.

- The measurements may be repeated over a longer period to attempt to improve the reliability of the measurement and validate the L_{90}.

4) Assess the background noise levels (both initial and final). The difference between the validated L_{90} and the background L_{90} must be greater than 5dB(A). Differences less than 5 dB(A) indicate an unacceptable level of contamination from background noise.

⊗ If the difference is less than 5 dB(A), the measurement shall not be used for compliance.

⊗ If either requirement in step 3 or 4 can not satisfied, then the "validated" L_{90} receiving property measurement may not be used for compliance. The appropriate moving or stationary switcher locomotive pass-by/sideline measurement must be used instead.

* If two load cell measurements were collected due to a change in sound level greater than 10 dB, then both should be validated and assessed for compliance.

- However, if significant abatement actions are to be completed to reduce the noise levels at the receiving property, the FRA may allow a retest of the offending switcher locomotive(s) with receiving property measurements once the abatement has been installed.

5) Evaluate compliance.

- If two L_{90} measurements were collected due to a change in load cell sound level > 10 dB
  - Compare the L_{90} values.
  - If the second validated L_{90} measurement ($L_{90,2}$) differs from the first ($L_{90,1}$) by 10 dB(A) or more, then the larger of the two validated L_{90} measurements shall be used for assessing compliance.
  - If the difference between the two validated L_{90} measurements is less than 10dB(A), then $L_{90,1}$ may be used for assessing compliance.
- ⊗ If the validated L_{90} is greater than 65 dB(A), then the sources are in violation.
- If a violation occurs, the following evaluation must take place:
  - Listen to the sound and attempt to determine the specific source and principal direction of the nearly steady-state sound.
  - If the sound emanates from only stationary locomotives, including at least one switcher locomotive, then a violation of the 65 dB(A) criteria for these locomotives has occurred. As a result, fixed-site sideline measurements must be conducted for these locomotives.
  - If the sound emanates from only a locomotive load cell test stand and the locomotive being tested, then a violation of the 65 dB(A) criteria has occurred. The fixed-site sideline measurements must be attempted for this load cell and locomotive combination.
  - If the sound includes both a load cell test stand and at least one stationary switcher locomotive, then 3 dB(A) may be subtracted from the validated L_{90} before determining compliance with the 65 dB(A) criteria.

4.2.6 Example of Data Processing and Evaluation of Compliance

Based on the example log sheet in Figure 16,

1) Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$), during, and after (Cal_{Final}) the event(s).

$Cal_{Initial}$ = 114.0 dB(A) **Cal_{Final} = 114.2 dB(A)**

ΔCal = 114.2 - 114.0 = 0.2 dB(A)

✓ **ΔCal is less than 0.3 dB(A); no calibration adjustment is necessary.**

2) Calculate: L_{90} of the initial background noise data;

L_{90}, L_{10} and L_{99} for the switcher locomotive or load cell* noise data; and

* If two load cell measurements were collected due to a change in sound level greater than 10 dB(A), then both should be validated and assessed for compliance.

L_{90} of the final background noise data.

Initial background noise L_{90} = 43 dB(A)

Switcher locomotive max throttle, L_{90} = 65.1 dB(A)

L_{99} = 64.2 dB(A)

L_{10} = 67.0 dB(A)

Final background noise L_{90} = 42.0 dB(A)

3) Validate the noise source L_{90} (s). L_{10}-L_{99} must be ≤ 4 dB(A).

L_{10}-L_{99} = 67.0 – 64.2 = 2.8 dB(A)

✓ **The measurement may be used for compliance.**

4) Assess the background noise levels (both initial and final). The validated L_{90} – Background L_{90} must be ≥ 5dB(A).

Validated L_{90} – Initial background L_{90} = 65.1 – 43 = 22.1 dB(A)

Validated L_{90} – final background L_{90} = 65.1 – 42.0 = 23.1 dB(A)

✓ **The measurement may be used for compliance.**

5) Evaluate compliance. Compare the Validated L_{90} for the event against the appropriate railroad noise level criteria summarized in Table 5.

Event	Validated L_{90} (dB(A))	Compliance Level (dB(A))	Compliance Level + Tolerance (dB(A))	Pass?
Stationary Switcher, max throttle, no load cell	**65.1**	**65.0**	**63.1**	✓ **Yes**

4.3 Car-Coupling and Retarders: Receiving Property Measurements

The specific site requirements, instrument settings, measurement procedures, documentation requirements, and data processing requirements specific to receiving property, yard-operation measurements of car-coupling and retarders are summarized in the following Sections. Receiving property measurements are conducted at any non-railroad property outside of the rail yard. In many cases, the rail yard may not be completely visible from the receiving property, and it may be helpful to have a second person located in or within sight of the rail yard to coordinate and document activities.

4.3.1 Measurement Site Selection and Setup

The noise measurement site criteria for receiving property measurements of car-coupling and retarders is identical to the criteria for measurements of switcher locomotives and load cell test stands, re-summarized below. There is an additional criterion **for car-coupling impact** measurements only:

- The microphone on the receiving property must be *at least* 30 m (100ft) from the nearest track where car-coupling occurs. All sounds resulting from car coupling impacts that occur on tracks less than 30 m from the microphone are disregarded.

The specific criteria for receiving property sites include:

- The microphone is located on receiving property with no vertical plane surfaces exceeding 1.2 m (4 ft) in height within 10 m (33.3 ft) of the microphone position. However, residential or commercial buildings can be within the 10 m boundary as long as they are at least 2 m (6.6 ft) from the microphone position and not blocking the noise path. In addition, facility boundary noise barriers are permitted to be in the path of the sound emission.

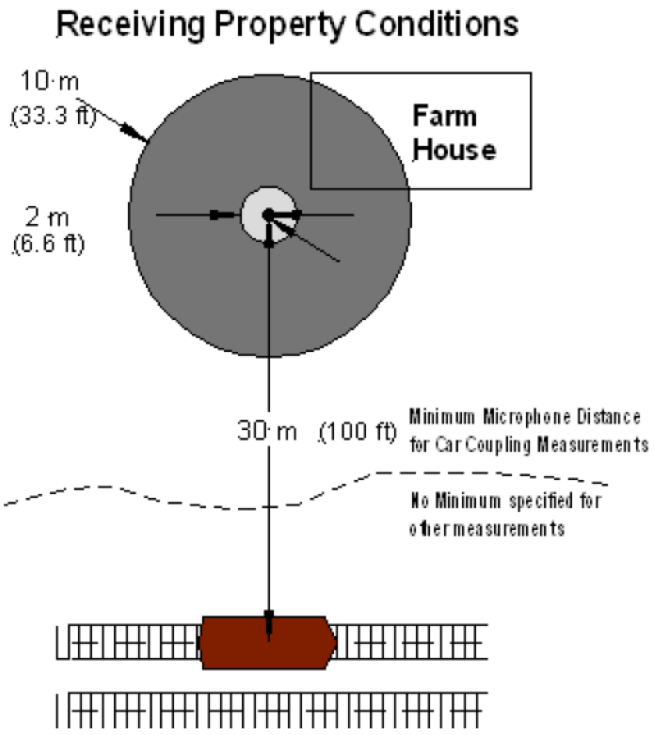


Figure 17. Receiving Property Site Requirements

- If the residential structure is a farm home, the microphone must be located between 2 m and 10 m *away* from the wall of the farm home.

4.3.2 Noise Measurement Instrument Settings

For receiving property measurements, the instrument should be set using the parameters in Table 8. If the instrument is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected.

Table 8. Summary of Noise Measurement Instrument Settings for Receiving Property Measurements

Measurement Type	Frequency Weighting	Filter Response	Metric(s)
Car-coupling	A	Fast	Maximum Sound Level (L_{AFmx})
Retarders	A	Fast	Maximum Sound Level (L_{AFmx})

4.3.3 Noise Measurement Procedure

For receiving property measurements of car-coupling impacts and retarders, the noise measurement procedure should be conducted as follows.

✓ **Measure the maximum noise level of 30 consecutive car-coupling or retarder events** over a period of at least 60 minutes but not more than 240 minutes.

Source noise measurements: Measure and record the maximum sound level (L_{AFmx}) during each of at least 30 consecutive car-coupling or retarder events over a period of at least 60 minutes but not more than 240 minutes*. A single retarder sound includes noises emitted from all retarders operating simultaneously in the rail yard. This conservative definition of a retarder sound accounts for and protects against overall rail car retarder noise at the receiving property.

Two different approaches may be used to measure the events:

a) For randomly-occurring events, measure the A-weighted sound level continuously while taking detailed notes on the time of each event. It is strongly recommended that the noise levels (and corresponding time, if possible) over the entire measurement period be recorded with and stored within the instrument or other digital storage media (such as a computer hard drive), if available. This allows for the 30 or more L_{AFmx} measurements to be identified during the post processing and analysis procedures, and frees up the measurement team to more accurately identify and document the time each event occurs. If recording devices are unavailable or impractical, the second method should be used.

b) For measuring coordinated and closely monitored events, measure the A-weighted sound level during each event. Begin data collection approximately 15 seconds before impact, and continue for at least 30 seconds or the duration of the entire event. The maximum sound level observed over this measurement interval shall be documented, along with the start time and duration of the measurement. Either close coordination between the rail yard staff and the measurement team is required, or the measurement team should be in a position to closely monitor and document all events. Make sure what you are identifying is the event, not other yard noises.

Although the regulations specify measuring 30 or more "consecutive" events, it is not always possible because of the multitude of extraneous noises in a rail yard at any given time. Therefore, individual events contaminated by additional noise sources (including background noise less than 10 dB(A) of the L_{AFmx} of the event) may be removed from the collected data, and the measurements may resume until at least 30 total valid events are measured. If a minimum of 30 valid events are not collected during the measurement period (60 to 240 minutes), then the entire measurement must be repeated at a later time, when events are more frequent. If there are never more than 29 valid events within any 240 minute period at the rail yard, then the rail yard does not violate the car-coupling or retarder noise regulations.

* The measurement period is not 60 to 240 minutes of consecutive measurements (i.e., 120 to 480 car-coupling events), but rather an overall, continuous measurement period, starting at the beginning of the first 30 second long, measurement interval and continuing until at least 30 consecutive events have been measured.

4.3.4 Documentation

The following page contains an example of the use of the general log sheets for the receiving property noise measurement of rail yard operations described in this Section.

Federal Railroad Administration
Noise Measurement Data Log Sheet

Page 1 of 3

Name(s):	Joe Noise	**Date:**	7/2/2008
Type of Measurement:	Car-Coupling Impact	**Start Time:**	12:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	N/A
Location:	227 Evergreen Terrace in Small Town, USA next to Small Town Railroad Railyard	**Comments:**	

Measurement Instrumentation Information

Meas. Device:	Brand X, SLM	**Calibrator:**	Brand X
Serial No.:	42345 **Type:** 2	**Serial No.:**	6789
Settings:	A-weighting, Fast Response, L_{AFmx}	**Level:**	114.0 dB **Frequency:** 1000 Hz
		Comments:	

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:08:00	12:08:37	114.0	Initial Calibration
1	12:22:00	12:22:51	35.0	start time, speeds ≥ 12.9 km/hr unless
2	12:37:00		90.0	otherwise noted
3	12:38:10		94.7	
4	12:38:55		92.0	
5	12:40:05		88.6	
6	12:41:15		91.3	
7	12:41:58		83.7	
8	12:46:36		90.4	
9	12:47:15		82.5	
10	12:48:02		95.2	
11	12:49:51		93.2	
12	12:52:10		95.2	
13	12:55:07		90.3	
14	12:56:43		94.1	invalid, horn sound contamination

Figure 18. Sample Data Log Sheet for Car-Coupling Impact Noise Measurements

4.3.5 Data Processing and Evaluation of Compliance

The processing and analysis of noise data collected during these yard measurements should proceed with the following steps. Each circumstance where a problem causes a non-compliant measurement or measurement condition is prefaced by a ⊗.

1) Compute the difference (ΔCal) in the sound level of the calibrations before ($Cal_{Initial}$), during, and after (Cal_{Final}) the noise event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

   - ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
   - o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Determine the maximum sound level for each event. If the sound levels were collected continuously over the entire measurement period, download the data to a spreadsheet or text file and cross-reference with the event times documented in the observer log.

   For car-coupling events, the L_{AFmx} is determined from a window at least +/- 15 seconds from the observed start time, encompassing the entire event (see Figure 19).

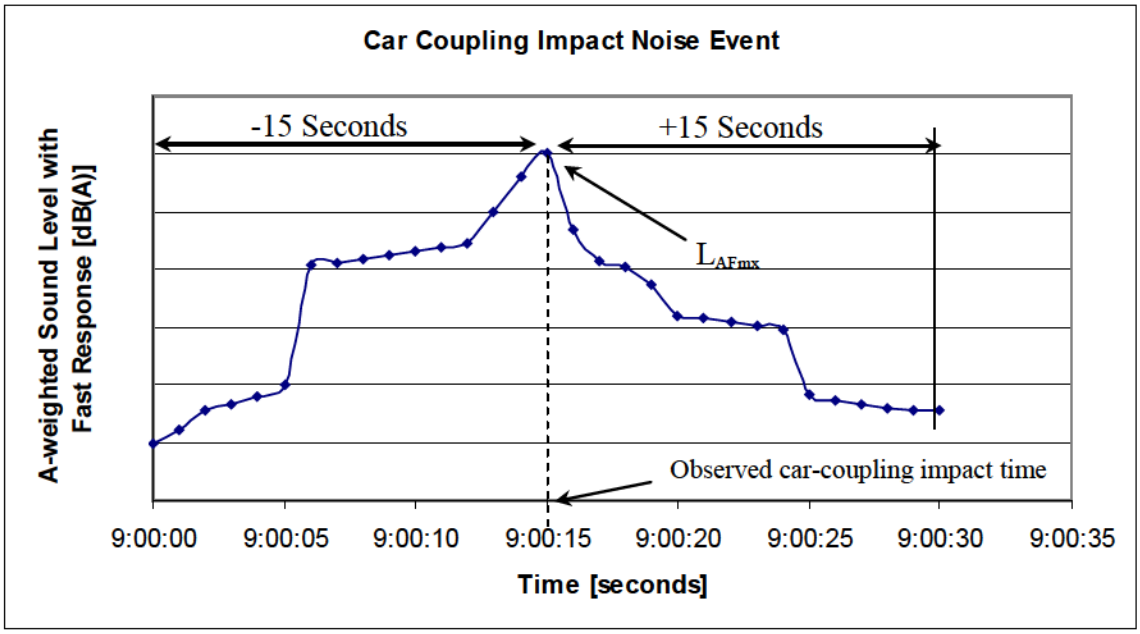


Figure 19. L_{AFmx} for a Car-Coupling Event Within a 30-Second Window of Continuous Noise Data

It is important to keep in mind that a lot of noise data can be collected with retarder noise measurements, since a retarder sound is not an impact and may last for several seconds during which additional retarders may also be activated and increase the overall sound. As such, it is very important to properly identify the L_{AFmx} for the entire retarder 'event' (see Figure 20).

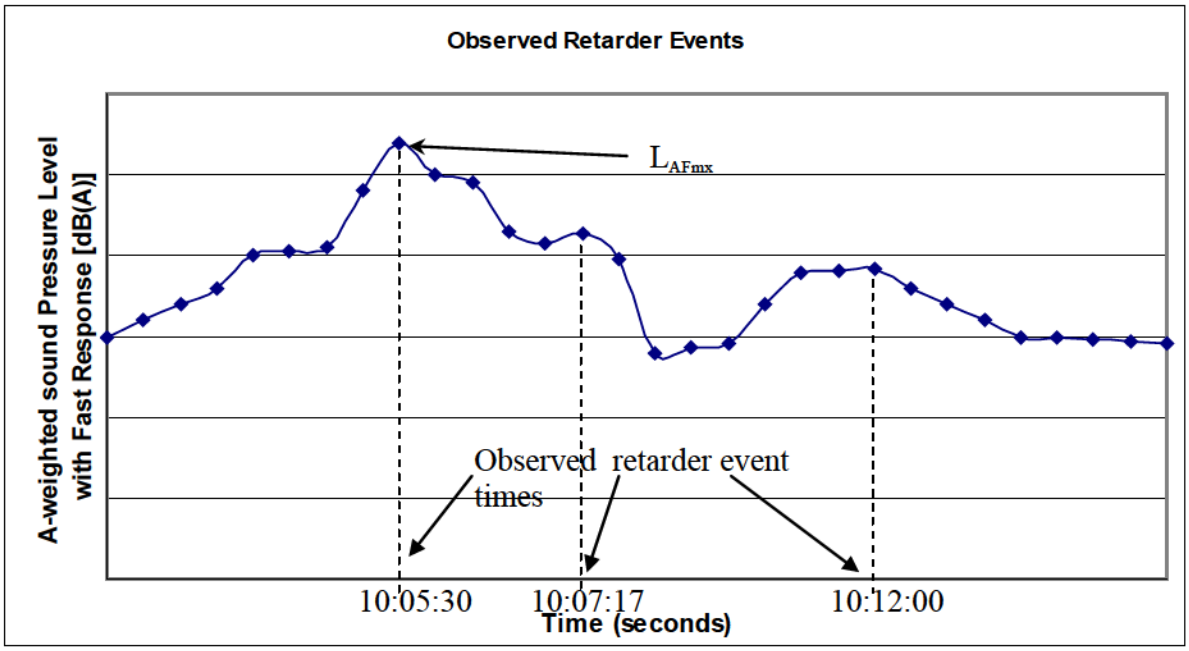


Figure 20. L_{AFmx} for Multiple Retarder Noise Events in Continuous Noise Data

3) Calculate the $L_{adj\ ave\ max}$ from the individual noise measurements.

$$L_{adj\ ave\ max} = L_{ave\ max} + C$$

Where: L_{avemax} is the energy average of the individual L_{AFmx}; and

C is the duration adjustment factor.

$$L_{ave\,max} = 10\log_{10}\left(\frac{10^{L_{AFmx1}/10} + 10^{L_{AFmx2}/10} + \ldots + 10^{L_{AFmxn}/10}}{n}\right)$$

Where: $L_{AFmx1} \ldots L_{AFmxn}$ = the individual maximum sound levels; and

n = total number of events.

C, the duration adjustment factor, is calculated as follows or estimated using Table 9.

$C = 10\log_{10}(n/T)$

Where: T = duration of the measurements [in minutes].

Table 9. Adjustment to $L_{ave\ max}$ to Obtain $L_{adj\ ave\ max}$ for Retarders and Car-Coupling Impacts

n/T	0.111 to 0.141	0.142 to 0.178	0.179 to 0.224	0.225 to 0.282	0.283 to 0.355	0.356 to 0.447	0.448 to 0.562	0.563 to 0.708	0.709 to 0.891	0.892 to 1.122	1.123 to 1.413	1.414 to 1.778	1.779 to 2.239	2.240 to 2.818	2.819 to 3.548	3.549 to 4.467
C	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6

4) Compare the $L_{adj\ ave\ max}$ for the events against the appropriate railroad noise level criteria summarized in Table 5.

For car coupling impact measurements only, if the noise measurements fail to satisfy the sound level criteria, the regulations permit the railroad to demonstrate compliance: "if the railroad demonstrates that the standard is exceeded at the receiving property measurement locations (where the standard was

previously exceeded) when cars representative of those found to exceed the standard are coupled at similar locations at coupling speeds of eight miles per hour or less."

4.3.6 Example Data Processing and Evaluation of Compliance

Based on the example log sheet in Figure 18,

1) Compute the difference (ΔCal) in the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the events.

   $Cal_{Initial}$ = 114.0 dB(A) Cal_{Final} = 113.4 dB(A)

   ΔCal = 113.4 - 114.0 = -0.6 dB(A)

   ✓ **A -0.3 dB(A) adjustment must be subtracted from all measured data.**

2) Determine the maximum sound level for each event. If the sound levels were collected continuously over the entire measurement period, download the data to a spreadsheet or text file and cross-reference with the event times documented in the observer log. The following is an example of the L_{AFmx}, adjusted for calibration, of 30 car-coupling events, measured over a period of 200 minutes.

90.0	**94.7**	**92.0**	**88.6**	**91.3**	**83.7**	**90.4**	**82.5**	**95.2**	**93.2**
95.2	**90.3**	**89.2**	**97.9**	**93.0**	**91.1**	**92.2**	**83.1**	**84.4**	**93.0**
90/7	**91.1**	**90.3**	**89.4**	**88.8**	**88.9**	**88.3**	**87.6**	**85.5**	**87.6**

3) Calculate the $L_{adj\ ave\ max}$ from the individual noise measurements using the equation in step 3) above implemented in a spreadsheet.

   $L_{ave\ max}$ = 91.4 dB(A)

   $C = 10\log_{10}(n/T)$ = 10*log10(30/200) = -8.2

   $L_{adj\ ave\ max} = L_{ave\ max} + C = 91.4 - 8.2$ = 83.2 dB(A)

4) Compare the $L_{adj\ ave\ max}$ to the appropriate railroad noise level criteria summarized in Table 5, and evaluate compliance.

Event	**$L_{adj\ ave\ max}$ (dB(A))**	**Compliance Level (dB(A))**	**Pass?**
Car coupling	**83.2**	**92.0**	**✓ Yes**

   ✓ **These events are in compliance.**

5 Regulation-Specific Measurement Guidance: Audible Warning Devices, Locomotive Cab Interior, and Employee Sleeping Quarters

This section describes the methods used to perform the appropriate exterior noise measurements of railroad audible warning devices (specifically locomotive horns), noise measurements in the interior of the locomotive cab, and noise measurements in the interior of employee sleeping quarters. The applicable standards are summarized in Table 10.

Table 10. Summary of Regulatory Requirements: Audible Warning Devices, Locomotive Cab Interior, and Employee Sleeping Quarters

Noise Source	Operating Conditions	Governing Regulation	Compliance Level (dB(A))	Adjustment	Duration	Measurement Location
Audible warning device: locomotive horn	Stable and continuous horn blast, stationary	49 CFR Part 229.129	L_{Aeq} minimum of 96 dB(A), maximum of 110 dB(A), with standard deviation ≤ 1.5 dB	0	10 seconds	30 m (100 ft) in front of the locomotive or wayside horn mic. ht. = 1.2 m (4 ft) or 4.6 m (15 ft)
Audible warning device: wayside horn		49 CFR Part 222 Appendix E	L_{Aeq} minimum of 92 dB(A), maximum of 110 dB(A), with standard deviation ≤ 1.5 dB			
Locomotive cab interior new manufacture	Self-loading, stationary at maximum throttle	49 CFR Part 229.121 (a)	L_{Aeq} ≤85 dB(A) with 99% CL ≤87 dB(A)	+3 dB(A)(added to measured level) for non-self loading locomotives	Minimum of 30 seconds	4 Positions inside the locomotive cab
Locomotive cab interior After alterations or maintenance	Self-loading, stationary at maximum throttle	49 CFR Part 229.121 (b)	L_{Aeq} ≤ 82 dB(A) or 85 dB(A), depending on the original certification level			
Employee sleeping quarters	Any, inside the railroad employee sleeping quarters	49 CFR Part 228	$L_{Aeq\ (8)} \leq$ 55 dB(A)	0	8 hours*	Hearing zone (at bed side)

*If the sleeping quarters are used more than 8 hours a day, then multiple $L_{Aeq\ (8)}$ measurements should be performed in the sleeping quarters, in order to cover all hours of use.

5.1 Audible Warning Devices

This section describes the methods used to perform the appropriate exterior noise measurements of railroad audible warning devices (specifically locomotive horns), and to evaluate the resulting measured noise levels for compliance with the appropriate federal regulations (49CFR Part 229.129 and 49CFR Part 222 Appendix E)*. Audible warning sounds are designed to be loud and distinctive in order to provide an effective warning of the approaching train to everyone near the railroad tracks and highway-rail grade crossings†. For this reason, railroad audible warning devices must adhere to relatively stringent testing and operational requirements.

Locomotive-mounted horns: There is a maximum and minimum allowable sound level output for locomotive-mounted horns. All operational locomotives manufactured after September 18, 2006 must be equipped with horns that are in compliance with the railroad noise regulations, and all locomotives built before September 18, 2006 shall

* 49 CFR Part 229.129 is the section of the railroad noise regulations pertaining specifically to locomotive-mounted audible warning devices. 49 CFR Part 222 Appendix E presents the requirements for wayside horns.
† Except in situations described in 49 CFR Part 222, where audible warning devices are prohibited (such as whistle bans).

be tested for compliance with this standard by June 24, 2010. Also, any locomotives rebuilt according to the FRA brake system safety standards* must also be in compliance with this regulation. Although the condition and operation of locomotive-mounted audible warning devices or horns is determined by FRA regulation 49 CFR 222 and a myriad of state and local ordinances, all sound levels output by those horns are subject to the FRA safety standard 49 CFR 229.129.

Wayside horns (grade-crossing mounted): On many occasions, a wayside audible warning device may be used as the primary audible warning when a whistle ban is in effect at a grade crossing. Wayside horns are designed to alert vehicles and pedestrians of the presence of an approaching train, performing the same safety and warning functions as the locomotive horns. Noise from wayside horns is treated in much the same manner as noise from locomotive horns.

5.1.1 Measurement Site Selection and Setup

Audible warning device sound level compliance measurements are conducted at a sideline location with the horn mounted on a stationary locomotive, or properly installed at the grade crossing. The measurement site criteria for sideline measurements are summarized below.

- The test site shall be free of large reflective structures, such as barriers, hills, billboards, tractor trailers or other large vehicles, locomotives or rail cars on adjacent tracks, bridges or buildings, within 61 m (200 ft) to the front and sides of the locomotive or horn. The locomotive shall be positioned on straight, level track.
- The microphone may be positioned at an angle of no greater than 20 degrees from the centerline of the track, at a distance of 30 m (100 ft) from the front knuckle of the locomotive or wayside horn (see Figure 21).
- For horns mounted on the cab, forward of the cab, or wayside horns, the microphone should be mounted at a height of 1.2 m (4 ft) above the ground.
- For horns mounted behind the locomotive cab, the microphone should be mounted at a height of 4.6 m (15 ft) above the ground.

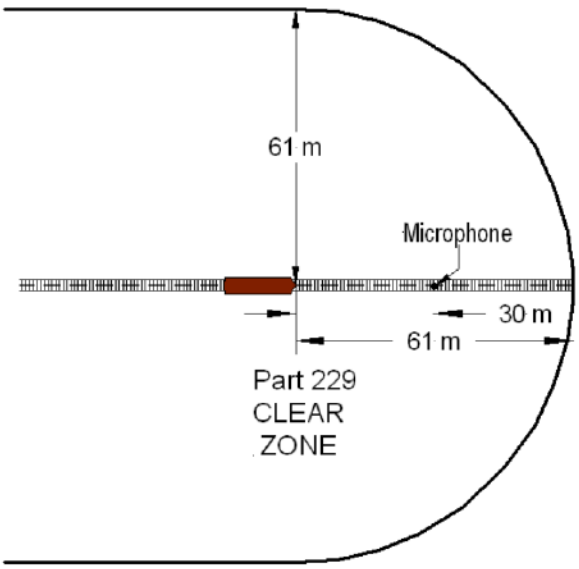


Figure 21. Part 229 (Audible Warning Device) Required Measurement Clear Zone

* 49 CFR Part 232.5 Brake System Safety Standards for Freight and Other Non-Passenger Trains and Equipment; End-of-Train Devices.

- Proper safety equipment (e.g. hearing protection) should be worn during this measurement.

5.1.2 Noise Measurement Instrument Settings

For audible warning device measurements, the instrument should be set using the parameters in Table 11. If the instrument is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected. Note that the audible warning device regulations specify IEC Standards[15] for sound level meters and calibrators, rather than ANSI for the measurement of locomotive horn sound levels.

If the same meter is to comply with both ANSI and IEC SLM standards, then it is generally more important to comply with the ANSI criteria. The main differences between ANSI 1.4-1983 (r2001) and IEC 61672-1 Ed. 1 (2002) are listed below.

- The ANSI standard categorizes meter tolerance limits in terms of meter Type (i.e., Type 0, Type 1 and Type 2), whereas the IEC standard categorizes meter tolerance limits in terms of meter Class (i.e., Class 1 and Class 2). Type 1 SLMs essentially correspond to Class 1 SLMs, and Type 2 SLMs essentially correspond to Class 2 SLMs, as far as tolerance limits and directional response are concerned. However, if the same meter is to comply with both ANSI and IEC SLM standards, then it is more important to comply with the ANSI tolerance and directional response criteria, because they are slightly more stringent over the audible frequency range.
- Although both standards define A-, and C-weighting adjustments that are equivalent, the ANSI standard provides B-weighting adjustments, whereas the IEC standard provides a definition of Z-weighting.
- Although both standards specify relatively comparable environmental requirements, if the same meter is to comply to ANSI and IEC SLM standards, then it is more important to comply with the ANSI environmental criteria, because they are slightly more stringent.

Table 11. Summary of Noise Measurement Instrument Settings for Audible Warning Device Measurements

Frequency Weighting	Filter Response	Metric	Recommended Sampling Rate
A	Slow	Equivalent Sound Pressure Level (L_{Aeq})	1-second

5.1.3 Noise Measurement Procedure

For locomotive horn noise measurements, the general measurement procedure should commence as follows:

- ✓ **Measure the background noise level for 30 seconds; note the equivalent sound level (L_{Aeq}).**
- ✓ **Conduct horn sound level measurement. Continuously measure the sound level for 10 seconds, note the equivalent level.**
- ✓ **Repeat horn sound level measurement until six, 10-second equivalent level readings have been obtained.**
- ✓ **Measure the background noise level for 30 seconds; note the equivalent sound level (L_{Aeq}).**

Measure and record the A-weighted background noise level over a period of at least 30 seconds, both before and after the horn sound level measurements. The metric to document for this measurement is the equivalent sound level, L_{Aeq}. This metric is recommended because the source noise metric of interest is also L_{Aeq}.

Source Noise Measurements:

a. Signal the locomotive crew to start the locomotive horn. Once the horn has reached a steady-state output, the sound level should be measured for 10 seconds ($L_{Aeq,\ 10s}$). This can be either done automatically using an integrating-averaging sound level meter, or it can be done indirectly by measuring and documenting the sound level once per second for 10 seconds, and then calculating $L_{Aeq,\ 10s}$ using a spreadsheet or calculator.

b. Repeat this measurement a minimum of five more times for the same locomotive horn, so a total of at least six $L_{Aeq,\ 10s}$ levels are measured and documented for each individual locomotive horn.

c. If a bi-directional horn is being tested, then the measurements need to be conducted twice; once for each end of the locomotive. This requires that the test must be conducted in an area that is clear of large, reflecting objects up to 61 m (200 ft) forward of both ends of the locomotive.

Note that the temperature and relative humidity criteria are both a little more stringent for locomotive horn measurements. Regulations specify that the ambient air temperature be between 2°C and 35°C (36°F and 95°F) and relative humidity be between 20% and 95% for the duration of the locomotive horn measurements.

5.1.4 Documentation

Figure 22 is an example of the use of the general log sheet for the locomotive horn sound level measurements described in this Section.

Federal Railroad Administration
Noise Measurement Data Log Sheet

Page 1 of 1

Name(s):	Joe Noise	**Date:**	2/22/2009
Type of Measurement:	Locomotive Horn	**Start Time:**	12:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	Locomotive #227
Location:	Small Town, USA	**Comments:**	Brand Z. Serial No. 6543-A
Small Town Railroad Railyard			Built 6/15/1994, Center mounted
			5 Chime Front Facing Horn, Brand J., Serial No. 55512

Measurement Instrumentation Information

Meas. Device:	Brand X, iSLM	**Calibrator:**	Brand X
Serial No.	12345 **Type:** 1	**Serial No.:**	6789
Settings:	A-weighting,	**Level:**	114.0 dB **Frequency:** 1000 Hz
	Slow Response, L_{Aeq} (automatically)	**Comments:**	

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:08:00	12:08:37	114.0	initial Calibration
2	12:45:00	12:45:22	99.7	#1 $L_{Aeq, 10s}$
3	12:47:30	12:47:00	99.4	#2 $L_{Aeq, 10s}$
4	12:48:45	12:49:06	99.6	#3 $L_{Aeq, 10s}$
5	12:51:00	12:51:23	105.6	invalid, another horn sounded during measurments
6	12:53:10	12:53:31	100.3	#4 $L_{Aeq, 10s}$
7	12:55:20	12:55:45	99.8	#5 $L_{Aeq, 10s}$
8	12:56:10	12:56:30	99.6	#6 $L_{Aeq, 10s}$
9	12:58:00	12:58:25	100.1	(extra) $L_{Aeq, 10s}$
CAL	13:21:10	13:21:55	114.0	final Calibration

Figure 22. Sample Data Log Sheet for Locomotive Horn Noise Measurements

5.1.5 Procedure for Data Processing and Evaluation of Compliance

The processing and analysis of noise data collected during locomotive horn sound level measurements should proceed with the following steps. Each circumstance where a problem may cause a non-compliant measurement or measurement condition is prefaced by a ⊗.

1) Compute the difference (ΔCal) between the sound level of the calibrations before (initial) and after (final) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

   - ⊗ If ΔCal is more than ±0.5 dB, the measurements must not be used for compliance.
   - o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) If the $L_{Aeq,\ 10s}$ measurements were not calculated directly by the measurement instruments, they must be determined from the stored or tape-recorded data. Identify each locomotive horn event in the measured noise data by referencing the noise measurement start and stop times in the observer log and calculate the $L_{Aeq,\ 10s}$:

$$L_{AeqT} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

   Where: N=number of 1-second samples (at least 10),
   T= the duration of the measurement interval (in seconds), and
   L_{Ai}= the ith A=weighted sound pressure level (in dB(A)).

3) Algebraically average and calculate the standard deviation of the six (or more) $L_{Aeq,10s}$ levels using a scientific calculator or spreadsheet (examples of these calculations can also be found in Appendix C).

4) Compare these values against the compliance criteria in Table 10. Specifically,

   For locomotive horns: 96 dB(A) ≤ $L_{Aeq,\ 10s}$ ≥ 110 dB(A) with standard deviation < 1.5 dB(A)
   For wayside horns: 92 dB(A) ≤ $L_{Aeq,\ 10s}$ ≥ 110 dB(A) with standard deviation < 1.5 dB(A)

If the horn sound level output fails to satisfy the compliance criteria, then the horn system itself should be investigated. For example, both horn noise levels that exceed the maximum sound level allowed and horn noise levels that fail to meet the minimum criteria may be the result of incorrect pressure levels for pneumatic horns or incorrect power for transducer-based horns. The air pressure or voltage and current to the locomotive horn should be tested and compared against the manufacturer's operating requirements for the warning device. Different horn placement configurations on the locomotive may also resolve some compliance problems. Center-mounted locomotive horns failing to meet the minimum requirements of the regulation could be repositioned closer to the front of the locomotive, and similarly, locomotive horns exceeding the maximum requirements could be repositioned further back on the locomotive. After investigating all of these options, repaired, repositioned, or alternative horns should be considered if the locomotive horn still fails to meet the regulatory requirements.

5.1.6 Example Data Processing and Evaluation of Compliance

Using the example log sheet in Figure 22:

1) Compute the difference between the calibrations before and after the events.

$$\mathbf{Cal_{Initial} = 114.0\ dB(A)} \qquad \mathbf{Cal_{Final} = 114.0\ dB(A)}$$

$$\mathbf{\Delta Cal = 114.0 - 114.0 = 0}$$

✓ **No adjustment for calibration is necessary**.

2) Calculate and document the six $L_{Aeq,\ 10s}$ measurements.

99.7 dB(A) 99.4 dB(A) 99.6 dB(A) 100.3 dB(A) 99.8 dB(A) 99.6 dB(A)

N = 6

3) Algebraically average and calculate the standard deviation of the six (or more) $L_{Aeq,\ 10s}$.

$$\textbf{Average } L_{Aeq,\ 10s} = (99.7 + 99.4 + 99.6 + 100.3 + 99.8 + 99.6) / 6 = 99.7\ \text{dB(A)}$$

$$\textbf{Standard Deviation} = \sqrt{\frac{(99.7-99.7)^2+(99.4-99.7)^2+(99.6-99.7)^2+(100.3-99.7)^2+(99.8-99.7)^2+(99.6-99.7)^2}{6-1}}$$

$$= 0.29\ \text{dB(A)}$$

4) Compare these values against the compliance criteria in Table 10.

Event	$L_{Aeq,\ 10s}$ dB(A)	Compliance Level (dB(A))	Standard Deviation (dB(A))	Compliance Std Deviation (dB(A))	Pass?
Locomotive Horn – 6 Events	99.7	$96 \le L_{Aeq,\ 10s} \ge 110$	0.29	< 1.5 dB(A)	✓ Yes

✓ **This locomotive horn is in compliance.**

5.2 Locomotive Static In-Cab Noise Measurements

A locomotive cab can be a noisy environment in which to work. In an effort to limit noise levels inside newly constructed locomotives, FRA published revised regulations in October 2006 to include a specific section addressing locomotive in-cab noise (49CFR Part 229.121). These measurements might be performed under three circumstances:

(1) By the manufacturer for a newly-designed locomotive (manufactured after January 1st, 2005);

(2) By the railroad for evaluation of the effects of repairs, maintenance and alterations; and

(3) By the FRA for evaluation of a locomotive in response to a noise complaint from a railroad employee.

Locomotive in-cab noise measurements use a stationary locomotive operating at its highest horsepower or throttle setting; either under self-loading conditions or with the engine operating at maximum RPM with no electrical load. Other aspects of locomotive cab noise measurements, such as in-cab microphone placement, are fairly unique and are discussed in greater detail in the following sub-sections.

The compliance levels for newly-designed locomotives consist of an average of in-cab sound levels for all locomotives of a specific design or model and an upper 99% confidence limit. It is intended for the locomotive manufacturer to assess the compliance of a specific model of locomotives with the railroad noise regulations.

The railroad noise regulations further stipulate the railroads shall not make alterations or repairs to locomotives manufactured after October 29th, 2007 which increase the in-cab noise levels. If the average in-cab noise levels were lower than 82 dB(A) when manufactured, then the noise levels after the repairs, maintenance or alterations may not exceed 82 dB(A). If the average cab noise level was between 82 dB(A) and 85 dB(A), then the noise levels after repairs, maintenance or alterations may not exceed 85 dB(A). This means that the railroads must also be prepared to perform the measurements, as necessary.

5.2.1 Measurement Site Selection and Setup

The following measurement site criteria are unique to static in-cab noise measurements.

1) The locomotive may not be positioned within 7.6 m (25 ft) of any large reflective surfaces, including other locomotives or rail cars on adjacent railroad tracks (see Figure 23).
2) The locomotive may not be tested on a site specifically designed to artificially lower in-cab noise levels, such as elevated track structures.
3) Measurements may be conducted indoors (e.g.: railroad maintenance facility), as long as the test area complies with the 7.6 m (25 ft) criteria.

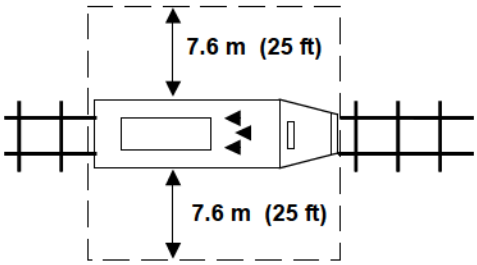


Figure 23. Measurement Site for Locomotive In-Cab Noise Measurements

4) Four microphones shall be positioned inside the locomotive cab (see Figure 24 and Figure 25):
   - Position A. 0.76 m (2.5 ft, or 30 in) above the center of the left seat;
   - Position B. 1.45 m (4.75 ft, or 56 in) above the floor in the center of the locomotive cab between the two seats;
   - Position C. 0.76 m (2.5 ft, or 30 in) above the center of the right seat; and
   - Position D. 1.45 m (4.75 ft, or 56 in) above the floor and 0.3 m (1.0 ft) from the center of the back interior wall inside the locomotive cab.

Measurements may be conducted using either four separate instruments or one instrument moved from one location to the next. If multiple instruments are employed, they may be operated simultaneously. Only two people are permitted in the locomotive cab: a railroad employee to operate the locomotive and the person performing the noise measurements. These measurements are normally done in a maintenance facility or rail yard, so that the operators

can be positioned as far away from the microphone positions as possible. All windows, doors, cabinet seals, etc. inside the locomotive cab must be installed and fastened shut prior to any in-cab noise measurements, to prevent excess rattle and to block the direct path of noise into the locomotive cab.

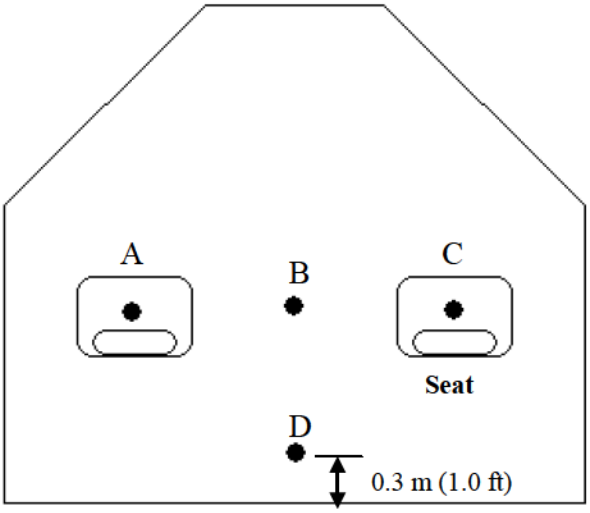


Figure 24. Microphone Locations Inside the Locomotive Cab for In-Cab Noise Measurements.

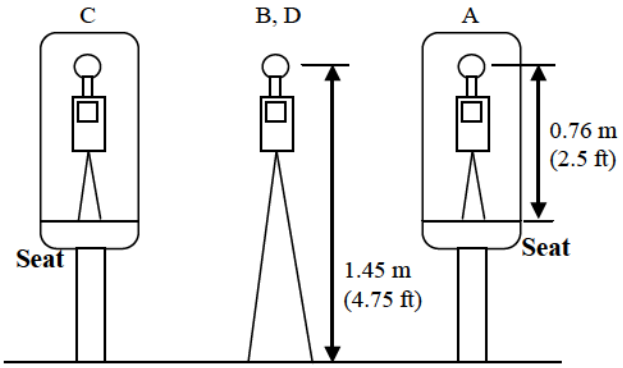


Figure 25. Microphone Heights Inside a Locomotive Cab for In-Cab Noise Measurements.

5.2.2 Noise Measurement Instrument Settings

For static in-cab measurements, the instrument should be set using the parameters in Table 12. If the instrument is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected. The meter may be set to automatically calculate the L_{Aeq} metric for each microphone position.

Table 12. Summary of Noise Measurement Instrument Settings for Locomotive Cab Noise Measurements

Frequency Weighting	Filter Response	Metric	Sampling Rate
A	Slow	Equivalent Sound Pressure Level ($L_{Aeq,T}$)	1 second (30 second minimum duration)

5.2.3 Noise Measurement Procedure

For locomotive static in-cab noise measurements, the measurement procedure should commence as follows:

- ✓ **Measure and record the A-weighted sound level for 30 seconds at each of the four microphone positions.**
- ✓ **Check for problems.**

Source noise measurements: Before noise data are collected, the locomotive should be allowed to warm up and stabilize at its normal operating temperature at highest horsepower or throttle setting. The HVAC system should be operated on high, and all doors and windows should be closed. The 30-second sound level measurements at each position may be conducted simultaneously or consecutively.

Check for problems: If conditions arise that could potentially, negatively impact the locomotive cab noise levels being recorded (adverse weather conditions, additional noise sources, audible operational changes in the locomotive's performance, etc.) and the resulting $L_{Aeq,T}$ levels fail to comply with the railroad noise regulations, the measurements may be repeated under more desirable conditions. Furthermore, if the additional noise is mechanically related to the operation of the locomotive, the source of the noise should be investigated and the mechanical problem should be repaired before the in-cab noise measurements are repeated. All instances where the noise measurements fail to comply with the railroad noise regulations should be documented, along with a description of the source of the failure, if apparent (even if the measurements were repeated, and the locomotive passed).

5.2.4 Documentation

Figure 26 presents an example of the forms which may be used to document the static in-cab noise measurements. Although not required by the FRA, the use of these forms will facilitate the logging of information important to the measurement in an organized manner.

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General Noise Measurement Data Log Sheet

Name(s):	Joe Noise	**Date:**	2/22/2002
Type of Measurement:	Locomotive - Cab Noise	**Start Time:**	12:22:00

Railroad Personnel and Measurement Site Information

Names:	Frank Railroad	**Railroad Equipment:**	Locomotive # 1277
Location:	Small Town Railroad Railyard	**Comments:**	Brand J. Serial No. 111A1
in Small Town, USA		Built 12/15/1996, original L_{Aeq} = 85.0 dB(A)	
		self-loading, stationary at max throttle, retesting after repairs	

Measurement Instrumentation Information

Meas. Device:	Brand X, iSLM		**Calibrator:**	Brand X	
Serial No.	12345	**Type:** 1	**Serial No.:**	6789	
Settings:	A-weighting, Equivalent Sound Level		**Level:**	114.0 dB	**Frequency:** 1000 Hz
Slow Response, L_{Aeq}			**Comments:**		

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments
CAL	12:01:00	12:01:30	114.0	Calibration
				warmup locomotive
1	12:22:00	12:22:45	82.4	Position A
2	12:25:10	12:26:10	83.1	Position C
3	12:35:00	12:35:32	80.7	Position B
4	12:38:30	12:39:15	84.8	Position D
CAL	12:55:00	12:55:45	133.6	final Calibration
				Note: 0.4 dB Calibration Drift

Figure 26. Sample Data Log Sheet for Locomotive Cab Noise Measurements

5.2.5 Data Processing and Evaluation of Compliance

The analysis procedure for evaluating locomotive cab noise data uses the metric $L_{Aeq,T}$:

1) Compute the difference (ΔCal) between sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±0.5 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Calculate the $L_{Aeq,T}$ metric for each of the four microphone positions. If not calculated by the instrument, it can be calculated from the 1-second sound level data.

$$L_{AeqT} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

Where: N=number of 1-second samples (at least 30);
T= the duration of the measurement interval (in seconds); and,
L_{Ai}= the ith A=weighted sound pressure level (in dB(A)).

3) Add a 3 dB(A) adjustment factor if the locomotive was not self-loading.

4) Check the measured values against the appropriate noise level criteria and evaluate compliance.

a. To assess the locomotive's compliance with the railroad noise regulations after maintenance or alterations, use the highest of the four $L_{Aeq,T}$ values. This value should be less than or equal to 82 dB(A) if the value provided by the manufacturer was less than 82 dB(A). If the manufacturer provided $L_{Aeq,T}$ value is between 82 dB(A) and 85 dB(A), the value after alterations must be less than 85 dB(A).

b. To assess a newly manufactured locomotive model or design, the highest of the four $L_{Aeq,T}$ values for each locomotive should be averaged (using algebraic averaging) across all the locomotives being tested, and the upper 99% confidence limit (CL) should be calculated as follows:

$$Upper\ 99\%\ CL = \left(\frac{1}{N}\sum_{i=1}^{N}L_i\right) + t\left(\sigma/\sqrt{N}\right)$$

Where: L_i = i-th sound level in the data set;
N = number of samples in a data set;
t = the critical value of the t-distribution for a 99% confidence interval
= 2.326 when the sample size is large; and
σ = standard deviation of the data set (see Appendix C for calculation example).

Once $L_{Aeq,T}$ (and the upper 99% confidence limit, if applicable) has been computed, the results should be documented, even if the locomotive fails to comply with the regulation. If $L_{Aeq,T}$ is greater than the criteria in the railroad noise regulations, then the measurement team has the option to retest the locomotive(s) under more desirable conditions, once the exceeded noise level has been documented along with the source of the excess noise

levels, if known. This could be due to adverse weather conditions, additional nearby noise sources, mechanical problems, etc. If the failure to comply with the railroad noise regulations is related to mechanical or operational factors involving the test locomotive, then the source of the noise should be investigated and the problem should be repaired before the in-cab noise measurements are repeated. This documentation must remain part of the paperwork associated with that particular locomotive, even if the locomotive complies with the FRA regulation upon retesting.

5.2.6 Example Data Processing and Evaluation of Compliance

The analysis procedure for evaluating locomotive cab noise data uses the metric $L_{Aeq,T}$: From the example log sheet in Figure 26:

1) Compare sound level of the calibrations before and after the event(s). If these levels differ by more than 0.5 dB, the measurements must not be used for compliance.

   $Cal_{Initial}$ = 114.0 dB(A) **Cal_{Final}=113.6 dB(A)**

   $\Delta Cal = 113.6 - 114.0 = -0.4$ dB(A)

   ✓ **A -0.2 dB(A) adjustment must be subtracted from all measurements**

2) Calculate or document the $L_{Aeq,T}$ metric for each of the four microphone positions.

   Position A = 82.4 – (-0.2) = 82.6 dB(A)

   Position B = 80.7 – (-0.2) = 80.9 dB(A)

   Position C = 83.1 – (-0.2) = 83.3 dB(A)

   Position D = 84.8 – (-0.2) = 85.0 dB(A)

3) Add a 3 dB(A) adjustment factor if the locomotive was not self-loading.

   Locomotive was self-loading, no adjustment necessary.

4) Check the measured values against the appropriate noise level criteria.

   Locomotive was tested after maintenance. Original $L_{AeqT} \leq 85$ dB(A).

   Therefore, current test L_{AeqT} must be ≤ 85 dB(A).

   Highest test L_{AeqT} was at position D: 85.0 dB(A).

   ✓ **This locomotive is in compliance.**

5.3 Railroad Employee Sleeping Quarters

Noise levels inside the railroad employee sleeping quarters* (including camp cars) are regulated by the FRA in 49CFR Part 228. This regulation states that the railroad must provide persons covered by the Hours of Service Act with sleeping quarters that are "free from interruptions caused by noise under control of the railroad." Sleeping quarters are not considered to be free from interruptions if the noise levels attributable to noise sources under the control of the railroad exceed an $L_{Aeq(8)}$ value of 55 dB(A). Under these regulations, the noise levels might be evaluated under the following circumstances:

* Sleeping quarters are defined as any "crew quarters, camp or bunk cars, and trailers" provided to railroad employees as a location to spend off duty hours and rest in between work shifts. The sleeping quarters in question are sleeping quarters provided by the railroad for its employees on railroad property, or on railroad equipment when considering camp or bunk cars. Although railroad sleeping quarters are not as common as they once were, all existing railroad run sleeping quarters are subject to the noise criteria stipulated in FRA Regulations governing the hours of service of railroad employees (49 CFR Part 228).

1) By the railroad, if they are petitioning to construct or reconstruct sleeping quarters within ½ mile of any area where railroad switching or humping operations are performed.
2) By FRA inspectors during an audit or after an employee complaint.

Sleeping quarters facility measurements should be conducted in each sleeping quarter, during a time when the noise levels are considered representative of the noise levels typically observed in those sleeping quarters. There is little regulatory guidance on how and when these measurements should be conducted. The 1982 version of this Handbook[1] recommended three consecutive $L_{Aeq\,(8)}$ measurements to evaluate each of the railroad employee's sleeping quarters. Although railroad noise levels (and therefore railroad sleeping quarter's noise levels) may vary with time of day, it is unnecessary to perform 24-hour-long noise measurements in railroad employee sleeping quarters that are not used 24 hours a day. Therefore, FRA recommends that the noise levels in the railroad employee sleeping quarters be measured only during the hours they are normally used (e.g., 10:00 PM to 6:00 AM), when evaluating compliance with the railroad noise regulations. If the railroad employee sleeping quarters are used more than 8 hours a day, then multiple $L_{Aeq\,(8)}$ measurements should be performed to cover all hours of use. The railroad employees using the sleeping quarters during the measurements should be notified beforehand, and instructed not to disturb the noise measurement instrument and to act as they normally would in the facility. However, it may be advisable for measurement personnel to observe the measurements and monitor the instruments, and document any noise sources which are not within the railroad's control. The need for observation can be evaluated on a case-by-case basis.

5.3.1 Measurement Site Selection and Setup

Noise levels in each sleeping quarter must be monitored for an 8-hour-long period, during which the noise levels are typical for noise levels observed in that area. The noise measurement instrument should be set up at the expected noisiest sleeping location inside the sleeping quarters. The noisiest location in each of the sleeping quarters can either be determined by a subjective evaluation of noise levels by the measurement team or by conducting a spot check of noise levels with the noise measurement instrument. The microphones should be set up at a height that approximates the hearing zone of an off-duty employee at rest.

The railroad noise regulations specify that all measurements should be taken with the windows closed. Closed windows provide some noise abatement by reducing railroad noise levels from outside. HVAC systems should not be considered a 'noise source under control of the railroad'.

5.3.2 Noise Measurement Instrument Settings

Sound level meters, integrating-averaging sound level meters and dosimeters may all be used to monitor noise levels in the railroad employee sleeping quarters, provided that they can be set up, mounted and oriented properly on a tripod or similar type of instrument stand. The measurement instrument should be set as in Table 13.

Table 13. Summary of Noise Measurement Instrument Settings for Sleeping Quarters Measurements

Frequency Weighting	Filter Response	Metric	Recommended Sampling Rate
A	Slow	Equivalent Sound Pressure Level (L_{Aeq})	1 second

5.3.3 Noise Measurement Procedure

The noise measurement procedure is fairly straightforward and should proceed as follows:

- ✓ **Conduct noise measurements: collect at least 8 hours of representative data.**
- ✓ **If desired, station an observer within the quarters to document all non-railroad - related noise events.**

Conduct noise measurements: Once the instrument has been positioned and calibrated, the measurement portion of the general procedure consists only of ensuring that at least 8 hours of representative data are collected. In most instances, the measurement team will not be on site for the measurement. However, if noise sources outside of the railroad's control are suspected to be significant, then an observer may wish to be present within the quarters for the duration. During these observed measurements, the observer shall document all non-railroad noise events and the corresponding time that they occurred.

5.3.4 Documentation

Figure 27 presents an example of the sleeping quarter's measurement log sheet. Although not required by the FRA, the use of these forms will facilitate the logging of information important to the measurement in an organized manner.

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General Noise Exposure Monitoring Data Log Sheet					1 of 1
Name(s):	Joe Noise		**Date:**	03/03/2003-03/04/2003	
Type of Monitoring:	Sleeping Quarters		**Start Time:**	8:00:00	
Monitored Railroad Employee Information					
Name:	Frank Railroad		**Railroad Equipment:**		
Job Title:	N/A		N/A		
Workshift Duration:	N/A				
Hearing Protection/Type:	N/A				
Location:	Employee Sleeping Quarters		**Comments:**		
near Closed Window					
Monitoring Instrumentation Information					
Meas. Device:	Brand X, iSLM		**Calibrator:**	Brand X	
Serial No.:	1234577	**Type:** 1	**Serial No.:**	6789	
	12446 for $L_{Aeq(0.5)}$		**Level:**	114.1 dB **Frequency:**	1000 Hz
Settings:	A- weighting, Slow Response,		**Comments:**		
	$L_{Aeq(8)}$				
Mic. Location:	1 m from Closed Window				

Events and Incidents Log				
Event No.	**Start Time**	**Stop Time**	**Task/Event**	**Event Description and Comments**
CAL	7:00:00	7:00:35	Calibration	114.4 dB(A)
1	8:00:00	6:00:00	$L_{Aeq(8)}$	54.6 dB(A)
2	12:00:00	12:31:30	$L_{Aeq(0.5)}$	only railroad nosie incidents, 47.8 dB(A)
CAL	16:05:00	16:05:45	Calibration	114.3 dB(A), saved data
3	16:10:00	24:10:00	$L_{Aeq(8)}$	48.2 dB(A)
CAL	24:13:00	24:13:35	Calibration	114.2 dB(A), saved data, switched batteries
4	24:15:00	8:15:00	$L_{Aeq(8)}$	52.1 dB(A)
5	6:00:00	6:45:30	$L_{Aeq(0.5)}$	incidents below, 58.7 dB(A), before incidents remove
	6:13:35	6:15:57		non-railroad noise incident
	6:32:10	6:33:50		non-railroad noise incident
CAL	8:25:10	8:26:00	Calibration	114.2 dB(A), saved data

Figure 27. Sample Noise Monitoring Data Log Sheet for Railroad Employee Sleeping Quarters

5.3.5 Data Processing and Evaluation of Compliance

The processing and analysis of noise data collected during employee sleeping quarters monitoring should proceed as follows:

1) Compare sound level of the calibrations before (initial) and after (final) the monitoring.

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Calculate the $L_{Aeq\ (8)}$ metric(s), if not automatically reported on the instrument, from the collected data for each railroad sleeping quarter.

$$L_{Aeq\ T} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

Where N = number of samples;
T = entire duration of the measurement interval [in seconds]; and
L_{Ai} = the i-th A-weighted sound pressure level [in dB(A)].

3) Check the $L_{Aeq(8)}$ against the appropriate noise level criteria. The regulations state that the $L_{Aeq(8)}$ shall not exceed 55 dB(A) (from noise sources under the railroad's control) with windows closed and exclusive of cooling, heating, and ventilating equipment.

The $L_{Aeq\ (8)}$ value(s) is representative of the noise levels experienced for a given day in that specific railroad sleeping quarter. If the railroad sleeping quarters do not meet the noise criteria, and measurements were not monitored or observed, noise sources outside of the railroad's control may have unknowingly negatively impacted the $L_{Aeq\ (8)}$ measurements. Under these circumstances, measurements shall be repeated with an observer documenting all non-railroad noise events and the corresponding time that they occurred. When processing the sleeping quarter's noise data, all noise events corresponding with non-railroad noises documented in the observer log should be removed from the data set, before the $L_{Aeq\ (8)}$ metric is calculated. This new $L_{Aeq\ (8)}$ metric is representative of noise in the railroad employees sleeping quarters, due to noise sources under the railroad's control, and should be evaluated for compliance with the railroad noise regulations.

5.3.6 Example Data Processing and Evaluation of Compliance

1) Compare sound level of the calibrations before and after the event(s).

$Cal_{Initial}$ = 114.0 Cal_{Final} = 114.3

ΔCal = 114.3 – 114.0 = 0.3 dB(A)

- ✓ **ΔCal is less than or equal to 0.3 dB; no calibration adjustment is necessary.**

2) Calculate/document the $L_{Aeq\ (8)}$ metric(s).

$L_{Aeq(8)}$ 1 = 54.6 dB(A), $L_{Aeq(8)}$ 2 = 48.2 dB(A), $L_{Aeq(8)}$ 3 = 52.1 dB(A)

3) Check the $L_{Aeq(8)}$ against the appropriate noise level criteria.

Measurement	$L_{Aeq(8)}$	Compliance Level	Pass?
Employee Sleeping Quarters	**54.6** **48.2** **52.1**	**55.0**	✓ **Yes**

$L_{Aeq(8)} < 55$ dB(A) from noise sources under the railroad's control.

All $L_{Aeq(8)}$ measurements are less than 55 dB(A).

✓ **This sleeping quarters is in compliance**

6 Personal Monitoring for Determining Occupational Noise Exposure

This chapter describes the methods used to perform personal monitoring for determining occupational noise exposure, and to evaluate the measured noise data for compliance with the appropriate federal regulations (49CFR Part 227). Personal noise monitoring is usually conducted 1) by a railroad to determine if a hearing conservation program is needed or 2) by a railroad inspector as part of an investigation.

The personal noise exposure of employees is specifically covered by the FRA regulations due to the unique circumstances of the railroad environment, to protect the occupational health and safety of employees whose duties require frequent work in the locomotive cab and whose predominant noise exposure is reasonably expected to be experienced in the locomotive cab. Occupational noise exposure and hearing conservation for employees not covered by this subpart is governed by the appropriate occupational noise exposure regulation of the U.S. Department of Labor, Occupational Safety and Health Administration located at 29 CFR 1910.95.

Personal noise monitoring is used to assess exposure to noise levels that might damage a person's hearing. The majority of the noise exposure criteria covering railroad employees are based on OSHA employee noise exposure regulations. The permissible limits for exposure to noise in these environments are based on the average level of exposure over an 8 hour work shift. For shifts less than or over 8 hours in length, the permissible noise exposure that is permitted varies depending on the actual time of exposure. This exposure can be seen in Tables A-1 of the regulation (see Appendix D), a portion of which is reprinted below in Table 14. This exposure level is derived from monitoring all continuous, intermittent and impulsive sounds within the range of 80 to 140 dB(A).

Table 14. Permitted Sound Level Durations
(Reprinted from 49 CFR Part 227, Table A-1)

A-weighted sound level, L (decibel)	Duration permitted, T (hour)
80	32
85	16
90	8
95	4
100	2
105	1

Therefore, for an 8-hour shift, the employee's $L_{TWA(8)}$ must not exceed 90 dB(A). If this level is exceeded, the employee is required to use hearing protection, and the railroad is encouraged to use noise operational controls to mitigate the exposure. FRA's noise exposure regulation has established an "Action Level" of an 8-hour time weighted average (TWA) of 85 dB(A). At or above this level, the employee is required to use hearing protection and must be included in the railroad's hearing conservation program. A hearing conservation program is a program, which:

(1) Protects the hearing of railroad employees through the training and use of hearing protection; and

(2) Monitors each employee's hearing through periodic audiometric testing and documentation[30].

The FRA regulations thoroughly detail the requirements for establishing and executing an employee hearing conservation program, so the responsibility to actually implement the program is left to each individual railroad. For this reason, it is beyond the scope of this Handbook to present procedures for setting up a hearing conservation program. If the details concerning a specific hearing conservation program are needed, then the details should be gathered from the prevalent railroad or organization directly.

Due to the unique environment in the locomotive cab, train employees are allowed limited exposure to noise levels ranging from 115 dB(A) to less than or equal to 120 dB(A), if the total daily duration does not exceed 5 seconds. During monitoring, an observer should be present to document any event which causes a noise level reading over 115 dB(A) (such as the horn or crossing bell). In addition, the regulations allow for the identification and removal of measurement 'artifacts' which cause noise level readings above 115 dB(A). Artifacts include events such as unintentionally coughing into or brushing against the dosimeter microphone. If additional events were later discovered which could not be explained by his or her record of the run, they could be removed and the TWA(8) could be recalculated.

6.1 Noise Measurement Instrument Settings

Both of the basic noise measurement instruments can be used to measure train employee personal noise exposure, either the sound level meter or the noise dosimeter. Noise dosimeters are the preferred method since the appropriate calculations are done by the dosimeter itself. If dosimeters are used, the instrument settings should be:

Table 15. Summary of Noise Measurement Instrument Settings for Occupational Noise Exposure Monitoring

Frequency Weighting	Filter Response	Exchange Rate	Threshold Level	Criterion Level	Metric	Recommended Sampling Rate
A	Slow	5 dB	80 dB(A)	90 dB(A)	8-Hour Time-Weighted Average $L_{TWA(8)}$	1 second

All sound pressure levels between 80 dB(A) and 140 dB(A) shall be monitored. If the noise measurement device is equipped with data storage capabilities, then it is strongly recommended that one-second noise data are collected.

6.2 Noise Monitoring Procedure

Begin monitoring at the beginning of the work shift, and continue for the duration of the work shift. Document employee exposure to sound levels between 115 dB(A) and 120 dB(A), along with a description of the noise source (if discernable) and the duration of the noise. Any continuous noises exceeding 120 dB(A) should also be documented. This additional task may be accomplished through supplemental monitoring with a second, manned sound level meter and a log sheet, or by simply noting the start time of every significantly loud noise event during the monitoring period, and then cross-checking those times against time history data saved by the instrument.

Periodically check the instrument over the course of the noise exposure monitoring to ensure that it is oriented and positioned properly.

6.3 Documentation

Figure 28 presents an example of the form to document the personal noise exposure monitoring measurements and other data collection. Although not required by the FRA, the use of these forms will facilitate the logging of information pertinent to the measurement in an organized manner.

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General Noise Exposure Monitoring Data Log Sheet					
Name(s):	Joe Noise		**Date:**	3/3/2003	
Type of Monitoring:	Personal Noise Exposure (Locomotive Personnel)		**Start Time:**	8:00:00	
Monitored Railroad Employee Information					
Name:	Frank Railroad		**Railroad Equipment:**		
Job Title:	Engineer		Locomotive #123		
Workshift Duration:	8 Hours		Brand Y. Serial No: 424		
Hearing Protection/Type:	None				
Location:	en route between		**Comments:**	Personal Monitoring	
Small Town, USA to Big City, USA					
and return					
Monitoring Instrumentation Information					
Meas. Device:	Brand X, Dosimeter		**Calibrator:**	Brand X	
Serial No.:	1234577	**Type:** 2	**Serial No.:**	6789	
Settings:	A weighting, 5 dB exchange Rate,		**Level:**	114.1 dB **Frequency:**	1000 Hz
Slow Response Threshold Level = 80 dB(A)			**Comments:**		
$L_{TWA(8)}$	Criterion Level = 90 dB(A)				
Mic. Location:	Lapel, in hearing zone				

Events and Incidents Log				
Event No.	**Start Time**	**Stop Time**	**Task/Event**	**Event Description and Comments**
CAL	7:30:05	7:30:45	Calibration	114.4 dB(A)
1	8:00:00	17:05:00	Data	Continuosly Monitored Locomotive Employee
				(incidents logged below)
	8:10:25	13:07:47		travel from Small Town to Big City
	10:25:17	10:26:10		Horn Sound L_{AFmx} = 118.2 dB(A)
	12:07:45	12:09:06		Horn Sound L_{AFmx} = 117.8 dB(A)
	13:00:47	14:03:10	(Break)	Lunch (off-duty), train stopped
	14:03:10	17:05:00		travel from Big City to Small Town
	15:36:00	15:38:37		invalid, accidentally talked into radio near mic
	16:10:12	16:41:42		Horn Sound L_{AFmx} = 118.6 dB(A)
CAL	17:25:00	17:26:10	Calibration	114.2 dB(A)

Figure 28. Sample Personal Monitoring for Determining Occupational Noise Exposure Data Log Sheet

6.4 Data Processing and Evaluation of Compliance

The data processing and analysis method associated with occupational exposure monitoring of train employees for compliance is presented below.

1) Calculate the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) during, and after (Cal_{Final}) the monitoring.

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

2) Calculate the $L_{TWA(8)}$ metric. In many cases, the instrument may have been setup ahead of time to automatically calculate either percent dose (D) or $L_{TWA\ (8)}$. The results from these automatic calculations are acceptable, if:

- The initial and final field calibrations were not incorporated into the data set used to determine noise exposure and a calibration adjustment can be applied to the data if necessary;
- The data meet all the applicable criteria (A-weighting, etc.); and
- Dose measurements are converted to $L_{TWA\ (8)}$.

$$L_{TWA(8)} = 16.61 \times \log_{10}\left(\%Dose / 100\right) + 90$$

If these metrics are not computed automatically by the instrument, then they must be calculated from the collected noise exposure data.

$$L_{TWA(8)} = 16.61 \times \log_{10}\left(\frac{1}{T_c}\sum_{i=1}^{N} T_i \times 2^{L_i/5}\right)$$

Where: N = number of samples/tasks;

T_i = measurement duration which corresponds to the measurement resulting in L_i [in hours];

T_c = criterion duration [in hours] (i.e.: 8 hours); and

L_i = A-weighted sound pressure level (above the 80 dB(A) threshold level only).

3) The excessive noise (>115 dB(A)) criterion in the railroad noise exposure must still be addressed. The collected noise exposure data and corresponding log sheet must be evaluated, and all instances of noise levels exceeding 115 dB(A) but less than or equal to 120 dB(A) should be noted. The employee's noise exposure does not comply with the regulation if:

- ⊗ Any sound levels exceed 120 dB(A)
- ⊗ Exposure to noise levels between 115 dB(A) and 120 dB(A) exceeds 5 seconds.

4) Once the desired metrics have been calculated, they are evaluated for compliance with the appropriate noise exposure regulations. All railroad employees with $L_{TWA\ (8)}$ greater than or equal to 85 dB(A) must be included in the railroad's hearing conservation program.

6.5 Example Data Processing and Evaluation of Compliance

Based on the example in Figure 28, the data processing and analysis method associated with occupational exposure monitoring of train employees for compliance is presented below.

1) Compare sound level of the calibrations before (initial), during, and after (final) the monitoring.

$Cal_{Initial}$ = 114.1 dB(A), Cal_{Final} = 114.2 dB(A)

ΔCal =114.2 – 114.1 = 0.1 dB(A)

✓ **No adjustment for calibration is necessary.**

2) Calculate the $L_{TWA(8)}$ metric.

The $L_{TWA(8)}$ metric was automatically calculated. However, one incident (talking) must be removed from data, and the metric should be re-calculated in a spreadsheet. As an example:

- **Assume the $L_{TWA(8)}$ measured by the instrument was 83.6 dB(A), representing 8 hours or 28800 seconds of data.**
- **Assume 5 seconds of a talking incident were identified in the data, with levels of 101, 102, 103, 102, and 101 dB(A).**
- **These levels can be removed through decibel subtraction:**
  $10\log\{28800*10^{\wedge(83.6/10)} - 10^{\wedge(101/10)} - 10^{\wedge(102/10)} - 10^{\wedge(103/10)} - 10^{\wedge(102/10)} - 10^{\wedge(101/10)}\}$
  =83.5 dB(A).

3) The excessive noise (>115 dB(A)) criterion in the railroad noise exposure must still be addressed. The collected noise exposure data and corresponding log sheet must be evaluated, and all instances of noise levels exceeding 115 dB(A) but less than or equal to 120 dB(A) should be noted. Any sound levels that exceed 120 dB(A) or the 5 second overall limit on exposure to noise levels between 115 dB(A) and 120 dB(A) indicate that the corresponding employee's noise exposure does not comply with the regulation, and the employee must be included in the hearing conservation program.

The 3 horn soundings in the data must be examined to determine how long (in seconds) each event exceeded 115.0 dB(A). According to the log sheet, sound levels never exceeded 120 dB(A). If the total time between 115 and 120 dB(A) exceeds 5 seconds, the appropriate action must be taken.

4) Once the desired metrics have been calculated, they are evaluated for compliance with the appropriate noise exposure regulations. All railroad employees with $L_{TWA\,(8)}$ greater than or equal to 85 dB(A) must be included in the railroad's hearing conservation program.

7 Acoustics – Basic Concepts

This Chapter provides a basic introduction to acoustics, which may be useful in understanding some of the concepts and terminology discussed in Chapters 2 and 3. First, the physical descriptions of sound waves and pressure are presented, along with the parameters used to define their behavior. The concept of sound pressure levels and the corresponding engineering units of decibels are discussed, followed by a straight-forward presentation of logarithmic mathematics. The spectral representation of sound is introduced, along with the concepts of frequency bands and weighting schemes. Finally, common noise level descriptors (or metrics) are presented.

7.1 Sound Waves and Pressure

Sound is defined in the American National Standard Institute's (ANSI) Standard S1.1-1994 (r2004) - Acoustical Terminology, as the auditory sensation evoked by the oscillation in pressure of a medium (such as air)[20]. Sound waves are typically caused by a moving or vibrating source, which temporarily displaces the molecules or atoms making up a medium from their normal configurations[21]. This displacement or sound wave then moves away from the sound source through the surrounding medium.

A standard analogy for a sound wave is the displacement caused by a stone thrown into a body of water. Think of the impact of the stone with the water as the sound source, and the waves in the water radiating away from the location of this impact as sound waves in the given medium, keeping in mind that sound waves radiate in all 3 dimensions spherically, instead of just two (see Figure 29[21]).

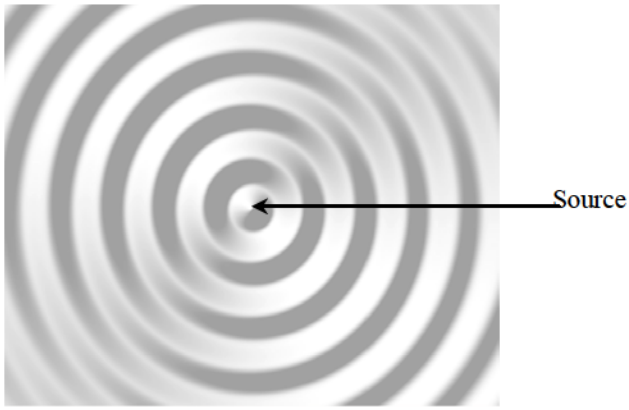


Figure 29. Expanding Sound Waves

For simplicity, the cross section of a sound wave may be represented by a trigonometric sine wave and is described by its frequency and amplitude. A sine wave is a periodic function, and the rate at which it repeats itself is known as its period (see Figure 30). Frequency is defined as the number of cycles of a periodic waveform that pass through a fixed point each second, which is expressed in Hertz (Hz) and related to period by the following equation:

$$f = 1/T$$

Where, f = frequency [in Hz]; and

T = period [in seconds].

When a noise is considered to sound high frequency or have a high pitch (e.g., sound from a flute or police whistle), the corresponding sound waves have high frequency components, whereas sounds with a low pitch (e.g., sound from a tuba or rumbling tractor-trailer) have low frequency components.

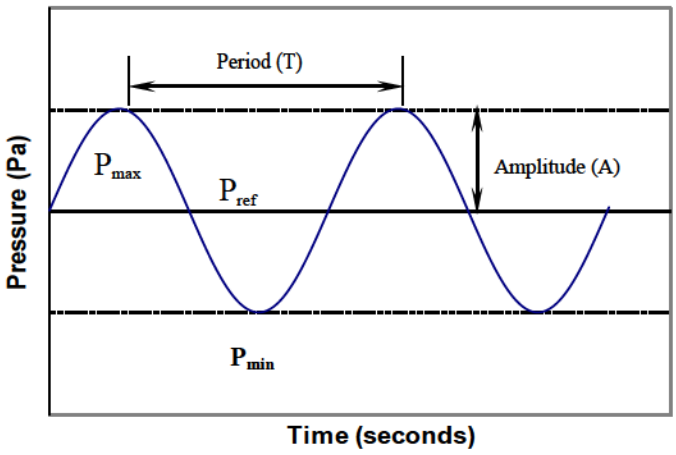


Figure 30. Sine Wave Representation of a Sound Wave

The wavelength of a sound wave is the physical distance between two pressure wavefronts making up one period of the sine wave. Therefore, the frequency of the sound wave is based on its wavelength and the speed at which that sound wave travels through the medium, or speed of sound.

$$f = c/\lambda$$

Where c = speed of sound [in m/s] = 331.4 +0.607*Temperature (°C);[22] and

λ = wavelength [m].

The speed of sound is dependent on the medium, ambient pressure and temperature, but a standard, accepted value for speed of sound in air at 20 degrees Celsius at sea level is 343 m/s (1125 ft/s)[23].

The amplitude of a sound wave is the difference between the instantaneous pressure of a given cycle of the wave and the ambient pressure at a moment in time, and is a measure of the strength of the sound wave ($p_{max} - p_{min}$ in Figure 30). When the amplitude of a sound wave increases, the corresponding perceived volume or loudness also increases. The standard parameter used to quantify the amplitude of a sound wave is the root-mean-square pressure, p_{rms}, which is the square-root of the time-averaged, squared pressure amplitude over a given time interval. When considering a pure tone sound wave, the p_{rms} over a cycle of the waveform is:

$$p_{rms} = A/\sqrt{2}$$

Where p_{rms} = root-mean-square pressure [in Pa]; and

A = pressure amplitude of the sound wave [in Pa].

Sound pressure is expressed in units of force per unit area; typically Pascals (Pa) or Newtons per meters-squared (N/m^2).

7.2 Sound Pressure Levels and Logarithmic Mathematics

Sound pressure amplitudes cover a wide range of values over several orders of magnitude; from the thousandths to the hundreds of thousands. Furthermore, the human ear does not perceive sound linearly. In order to account for these two phenomena, a logarithmic scale is used to measure sound pressure. Examples of logarithmic mathematics are presented in Appendix C.

The most common, logarithmic metric for expressing sound pressure is the sound pressure level, which is defined as:

$$L = 10\log_{10}\left(\frac{p^2_{rms}}{p^2_{ref}}\right)$$

Where L = sound pressure level [in decibels, dB]; and

p_{ref} = 20 μPa, which is approximately equal to the threshold of human hearing at 1 kHz.

Sound pressure level is a commonly used to quantify the strength of a sound wave, so it is important to understand how it relates to the human perception of sound. Loudness is a subjective description of the strength of a sound, and the perception of loudness changes with the frequency content of a sound as well as with the absolute level of that sound. However, several general, objective descriptors have been developed as the result of extensive subjective evaluations, in order to relate perceived change in loudness with approximate change in sound pressure level. Those descriptors and the corresponding approximate levels are presented in Table 16.

Table 16. Relationship Between Approximate Change in Sound Pressure Level and Perceived Change in Loudness

Change in Sound Pressure Level	Perceived Change in Loudness
+3 dB	Barely perceptible increase
+5 dB	Noticeable increase
+10 dB	Twice as loud
+20 dB	Four times as Loud

It is important to note, that the descriptors in do not directly equate to the equivalent change in sound energy. As shown earlier, the combination of two equal sound pressure levels, or a doubling of sound energy, results in a 3 dB(A)increase in the combined sound pressure level, which does not equate to a doubling in perceived loudness. In fact, the energy of a sound wave needs to increase approximately tenfold, for an observer to perceive the resulting sound as twice as loud.

To further illustrate the relationship between sound pressure level and relative loudness, as well as to provide concrete examples of average transportation sound pressure levels, a comparison between the sound pressure levels of typical sound sources relative to each other is presented in Table 17.

Table 17. Comparison Between Sound Pressure Levels of Typical Sound Sources

SPL (dB)	Noise Source
140	Threshold of Pain
120	Jet Take-off, 61 m (200 ft)
110	Thunder
100	Rail Car Coupling Impact, 30 m (100 ft)
80	Alarm Clock
70	Vacuum Cleaner
60	Idling Locomotive, 30 m (100 ft), Conversational Speech
50	Business Office Light Traffic, 30 m (100 ft)
30	Whispering
0	Threshold of Hearing

Logarithmic mathematics – adding or combining sound levels: When multiple sound sources contribute to an overall sound at a given point, their sound pressure levels combine, resulting in an overall sound pressure level. However, these levels may not be combined by normal addition; e.g., two normal conversations of approximately 60 dB(A)taking place next to each other do not result in an overall sound pressure level of 120 dB(A)(equivalent to the sound pressure level of a jet take-off at 60 m (200 ft)). Sound pressure levels must be converted back to sound energy, summed together, and converted back to the logarithmic decibel value*.

$$L_{total} = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10} + ... + 10^{L_n/10}\right)$$

Where $L_{1...n}$ = the 1 - n-th sound pressure levels [in dB];and

L_{total} = the total sound pressure level from multiple sound sources [in dB].

Using this equation, the combination of two 60 dB(A)sounds results in a combined sound level of 63 dB(A). This process may also be used for the subtraction of sound pressure levels.

Logarithmic mathematics – averaging sound levels: There are two methods that are commonly used to average multiple sound pressure levels: algebraic averaging and energy averaging. Algebraic averaging is used to evaluate locomotive horn and locomotive cab interior compliance. It is simply the mean of the data set, where the sound pressure levels in dB are averaged directly.

$$L_{ave} = \frac{L_1 + L_2 + ... + L_n}{n}$$

Where n = number of sound pressure levels being averaged; and

L_{ave} = averaged sound pressure level for multiple sound sources [in dB].

Typically, algebraic averaging is utilized to average sound levels across data sets or events. Furthermore, an algebraically averaged data set can be used to calculate other useful statistical metrics, such as standard deviation and 99% confidence interval.

* This assumes that the sound waves are incoherent and not effected by destructive interference

Energy-averaging is used in the calculation of L_{avemax} for car-coupling impact and retarder noise. Energy averaging is done is a manner similar to logarithmic addition. The sound pressure levels are converted back to a linear scale before they are combined, then they are averaged, and the end result is converted back to the logarithmic scale to yield the average sound pressure level.

$$L_{ave} = 10\log_{10}\left(\frac{p_{ave}^2}{p_{ref}^2}\right) = 10\log_{10}\left(\frac{10^{L_1/10} + 10^{L_2/10} + \ldots + 10^{L_n/10}}{n}\right)$$

where p_{ave} = average sound pressure for multiple sound sources [in Pa].

With energy averaging, the louder sound pressure levels more prominently influence the average level, which is why it is utilized to calculate energy averaged metrics, like equivalent sound pressure level. However, statistical metrics such as standard deviation and 99% confidence interval are not as meaningful from data that has been energy averaged.

7.3 Spectral Representation of Sound

In Section 7.1, the concept of frequency was introduced as a component of a sound wave. Most sound waves are relatively intricate, containing numerous frequency components. A plot of these frequency components weighted according to the amount of sound power at each frequency is known as a spectrum (see Figure 31). The range of frequencies audible to humans is from 20 to 20,000 Hz, so these frequencies are the main concern of most noise studies, and frequencies outside of this range can be ignored, in most cases. In fact, for many practical situations it is common to limit the frequencies of interest to between 50 and 10,000 Hz. Sound spectra may be used to identify specific noise sources, such as vibrating machinery, and can be very useful when considering noise abatement options (e.g., barriers to block specific noise sources, maintenance of specific equipment, changing operational procedures, etc.).

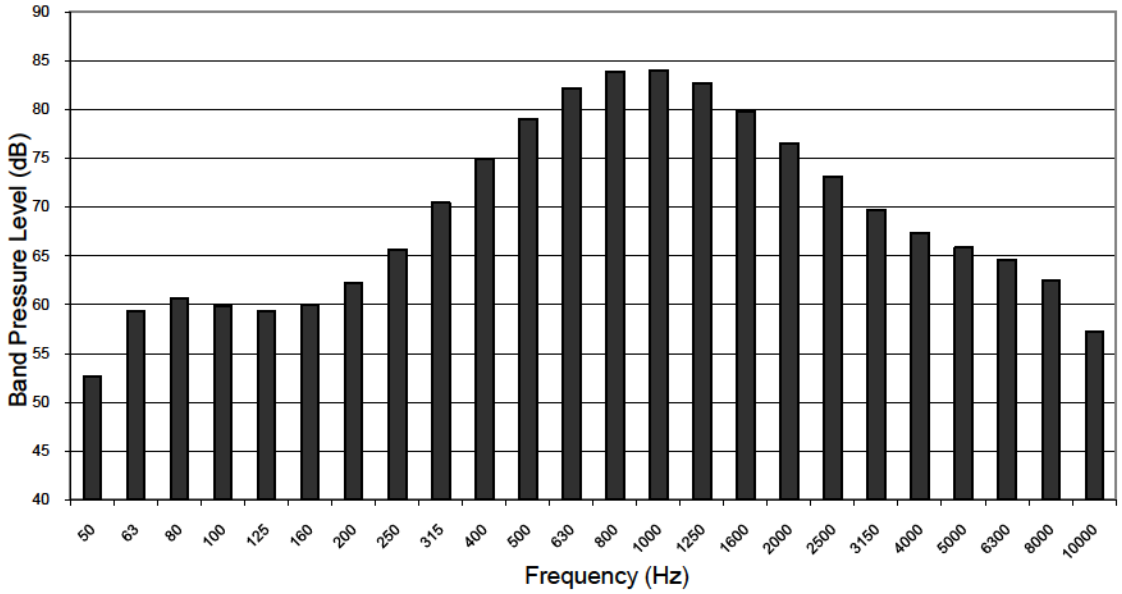


Figure 31. Sample Frequency Spectrum (in One-Third Octave-bands)

Since the range of audible frequencies for humans covers thousands of discrete frequencies, frequency spectra are typically presented on a logarithmic scale and analyzed in terms of frequency bands. The two most common frequency bands used for sound pressure level measurements are octave-bands and one-third octave-bands. Octave-bands break up the audible frequency spectrum into eleven frequency bands (20 Hz to 20,000 Hz), each with a bandwidth where the upper edge frequency is twice that of the lower edge frequency of the band,

$$f_2 = 2f_1$$

and a center frequency equal to the geometric mean of the upper and lower edge frequencies[24].

$$f_c = \sqrt{f_1 f_2}$$

Where f_c = center frequency of an octave-band [in Hz];

f_1 = lower edge frequency of an octave-band [in Hz]; and

f_2 = upper edge frequency of an octave-band [in Hz].

For the sake of continuity, the center frequency of an octave-band (and one-third octave-band is rounded to an acceptable nominal frequency specified in ANSI S1.6-1984 (r1997) Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements[25].

Whenever a finer increment of detail is desired in a noise study, one-third-octave-bands may be utilized. There are thirty-four one-third octave-bands in the audible spectrum, where the upper edge frequency of each band is the cube root of two times the lower edge frequency and the center frequency is still the geometric mean of the band.

$$f_2 = 2^{1/3} f_1$$

The octave-bands and one-third octave-bands are presented in Table 18, along with the corresponding preferred center, upper and lower edge frequencies[25].

Table 18. Octave and One-Third Octave-band Frequencies

Octave-bands (Hz)			One-Third Octave-bands (Hz)		
Lower	Center	Upper	Lower	Center	Upper
			9.2	10	10.9
11	16	22.4	10.9	12.5	14.3
			14.3	16	17.9
			17.9	20	22.4
22.4	31.5	45	22.4	25	28
			28	31.5	35.5
			35.5	40	45
45	63	90	45	50	56
			56	63	71
			71	80	90
90	125	180	90	100	112
			112	125	140
			140	160	180
180	250	355	180	200	224
			224	250	280
			280	315	355
355	500	710	355	400	450
			450	500	560
			560	630	710
710	1000	1400	710	800	900
			900	1000	1120
			1120	1250	1400
1400	2000	2800	1400	1600	1800
			1800	2000	2240
			2240	2500	2800
2800	4000	5600	2800	3150	3550
			3550	4000	4500
			4500	5000	5600
5600	8000	11200	5600	6300	7100
			7100	8000	9000
			9000	10000	11200
11200	16000	22400	11200	12500	14000
			14000	16000	18000
			18000	20000	22400

Octave-band and sound pressure level data can be calculated from one-third octave-band data. However, it is important to note that the reverse is not true: one-third octave-band data may not be generated from octave or sound pressure level data.

7.4 Weighted Sound Levels

The response of the human ear is not flat. Normally, human hearing is most sensitive between 1 and 6.3 kHz, and is much less sensitive at low frequencies and very high frequencies. For this reason, many regulations, standards and policies require the use of A-weighted sound level. A-weighting is based on "an approximation of equal loudness perception characteristics of human hearing for pure tones relative to a reference of 40 dB SPL at 1 kHz" [13]. A-weighting is a series of adjustments to an un-weighted frequency spectra (see Table 19), which are algebraically added to the corresponding frequency band data. A-weighted sound pressure levels are identified with the units

dB(A). Although other weighting curves do exist (such as B-weighting and C-weighting*), A-weighting is by far the most commonly used weighting metric. An un-weighted frequency spectrum is known as a Z-weighted (or flat). Figure 32 presents a comparison between the frequency responses of A-, B-, and C-weighting curves†[13].

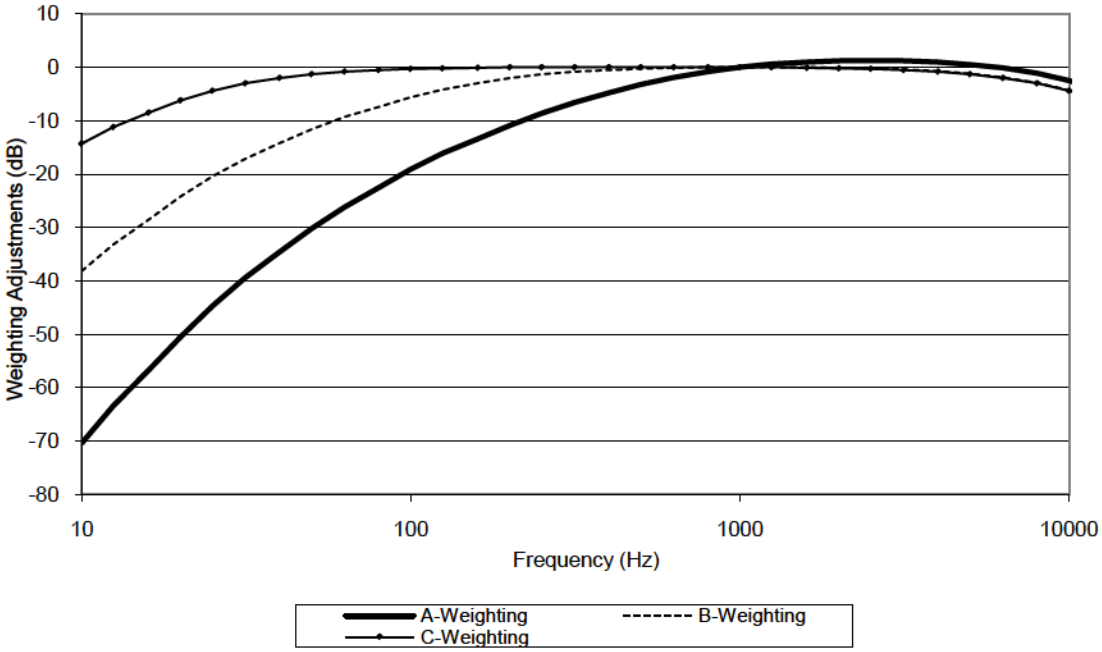


Figure 32. A-, B-, and C-Weighting Curves

* The response of the human ear changes with absolute level of the sound, which is why multiple weighting schemes have been developed. B-weighting and C-weighting are based on equal loudness perceptions characteristics of human hearing relative to 1 kHz reference tones of 70 dB and 100 dB respectively.

† It is important to note that the response for the A-, B-, C-, and Z-weighting curves are all referenced to 1 kHz, and therefore all have 0 dB weighting at 1 kHz.

Table 19. A, B and C Frequency-Weighting Adjustments (One-Third-Octave-bands, with Octave-bands in Bold)

Band Center Frequency (Hz)	Weighting Adjustments (dB)		
	A	B	C
10	-70.4	-38.2	-14.3
12.5	-63.4	-33.2	-11.2
16	-56.7	-28.5	-8.5
20	-50.5	-24.2	-6.2
25	-44.7	-20.4	-4.4
31.5	-39.4	-17.1	-3
40	-34.6	-14.2	-2
50	-30.2	-11.6	-1.3
63	-26.2	-9.3	-0.8
80	-22.5	-7.4	-0.5
100	-19.1	-5.6	-0.3
125	-16.1	-4.2	-0.2
160	-13.4	-3	-0.1
200	-10.9	-2	0
250	-8.6	-1.3	0
315	-6.6	-0.8	0
400	-4.8	-0.5	0
500	-3.2	-0.3	0
630	-1.9	-0.1	0
800	-0.8	0	0
1000	0	0	0
1250	0.6	0	0
1600	1	0	-0.1
2000	1.2	-0.1	-0.2
2500	1.3	-0.2	-0.3
3150	1.2	-0.4	-0.5
4000	1	-0.7	-0.8
5000	0.5	-1.2	-1.3
6300	-0.1	-1.9	-2
8000	-1.1	-2.9	-3
10000	-2.5	-4.3	-4.4
12500	-4.3	-6.1	-6.2
16000	-6.6	-8.4	-8.5
20000	-9.3	-11.1	-11.2

7.5 Sound Level Descriptors

Most sounds that occur in the environment are not constant, but rather their sound level varies over time. In order to characterize the level of such sounds, various descriptors, or metrics, have been developed. Five such metrics, which are commonly used for regulatory purposes, will be described here. These are the maximum sound level

(L_{Amx}), equivalent sound level (L_{Aeq}), the exceedance percentile sound levels (L_{10}, L_{50} and/or L_{90}), the noise dose, and the time-weighted average level. Appendix C contains example calculations of these metrics.

Maximum sound level (L_{AFmx} or L_{ASmx}): The maximum sound level associated with a given event.

Equivalent sound level ($L_{Aeq,T}$, also often referred to as LEQ): The equivalent sound pressure level is a single level, whose energy would be equivalent to the energy found in the actual, A-weighted sound pressure levels within the specified time interval, T, if that single level remained constant over the entire time interval.

Because the L_{AeqT} metric is so highly dependent on the duration of the time interval, over which it is calculated, T is written as part of the metric; e.g., the A-weighted, equivalent sound pressure level over 30 seconds is $L_{Aeq\ 30sec}$. Due to varying terminology used in the FRA regulations, the equivalent sound pressure level may also be written as $L_{Aeq\ (T)}$ or $L_{Aeq,\ T}$. Examples of calculating L_{AeqT} are presented in Appendix C.

Exceedance percentile sound level: The exceedance percentile sound level, L_x, is the sound level that is exceeded x-percent of the time during the measurement period. For example L_{10} is the sound level that is exceeded 10 percent of the time. Most integrating sound level meters will compute the various exceedance percentile sound levels. If they are not computed directly, they can be computed from the statistical percentile levels available in most spreadsheet programs. Four exceedance percentile sound levels are commonly used:

- L_{90}, the sound level exceeded 90 percent of the time, represents the background level for which no single source is identifiable.
- L_{50}, the sound level exceeded 50 percent of the time, is the median sound level during the measurement period.
- L_{10}, the sound level exceeded 1 percent of the time, represents the rare loud noise events which occurred.
- L_1, the sound level exceeded 1 percent of the time, represents the rare loud noise events which occurred.

Noise dose (D): A noise exposure expressed as a percentage of the allowable daily exposure. A 100% noise dose equals an 8-hour exposure to a continuous 90 dB(A) noise. A 50% dose is an 8-hour exposure to an 85 dB(A) noise or a 4-hour exposure to a 90 dB(A) noise. It is a summation of a series of ratios of time intervals. If a series of A-weighted sound levels (L_1, L_2, ….L_n) occurs during the time of interest, the percent noise dose received during that time is defined as:

$$D = 100X\left[C(L_1)/T(L_1) + C(L_2)/T(L_2) + \ldots + C(L_n)/T(L_n)\right]$$

Where $C(L_i)$ is the actual time interval over which level Li occurred, and
$T(L_i)$ is the allowed time interval for that level

8-hour time weighted average ($L_{TWA(8)}$): The value, expressed in dB (A), representing the noise level exposure over an 8-hour period.

8 Additional Topics

This Chapter provides information on some additional topics which may be useful when conducting more detailed railroad noise measurements, such as may be necessary to conduct assessments of environmental impact. Included is information on additional measurement equipment, such as spectrum analyzers and recording devices, and measurement issues, such as the electronic noise floor and electromagnetic interference. The health effects caused by exposure to noise are discussed, to provide additional motivation for encouraging good noise control practices. Finally, this chapter discusses numerous noise control options, organizing them according to source, path and receiver controls. This is meant to present an overview of possible noise control options as an initial design step; it does not go into the development and implementation of these options in great detail. Once the possible railroad noise control options have been considered and narrowed down, then the development and implementation of those noise abatement measures should be assigned to an experienced noise professional.

8.1 Optional Acoustic Measurement Instrument Components

The information contained in this section addresses additional information on acoustic instrumentation and its use. Although the instruments and procedures covered herein are not required for FRA regulatory compliance measurements, they may be useful to those involved in a broader-scope noise study where detailed analyses are desired, or if instrument problems arise during the course of a compliance measurement.

Recording devices: A recording device is any instrument designed to actually record noise data as heard by the human ear, instead of measuring sound pressure levels and computing noise metrics. Audio recording allows for the repeated playback of the noise data at a later date, which could be used to further investigate a questionable data point or to perform more detailed analysis at a later date. For this reason, a recording device may be a useful addition to the measurement instruments, even though it is not essential for compliance with any FRA regulation.

There are essentially two main types of recording devices; digital and analog. These range from magnetic tape recorders to recording software on a personal computer. When selecting a recording device for a measurement program, recorder type (digital or analog) needs to be taken into consideration, along with the associated sampling rate, dynamic range, storage capabilities and price. Table 20 presents a comparison of digital and analog reorders.

Table 20. Comparison of Digital and Analog Recorders

Parameter	Digital	Analog
Dynamic Range	Digital recorders have a larger dynamic range than Analog.	
Frequency Response	Wider range than Analog	Poor in low frequencies
Distortion	Digital has less distortion than Analog	
Sample Rate	Must be twice the highest frequency of interest (Devices commonly have sample rate of 44 – 48 kHz)	
Overload Handling	"Hard" limited – signal is chopped off at the maximum level, which results in distortion	"Soft" limited – distortion occurs about 6 dB above the top of the dynamic range, with a gradual increase in distortion as the level rises

Parameter	Digital	Analog
Storage Method	A series of 16- or 32- bit words (Binary)	Continuous variations in a magnetic storage medium
Storage Capacity	Size of disk or tape length	Size of magnetic medium
Cost	Analog recorders are generally cheaper, which is the only benefit over digital equivalents.	

Spectrum analyzers: Spectrum analyzers are devices that measure the frequency characteristics of noise as well as sound pressure level. A spectrum analyzer may prove to be a useful tool for identifying specific railroad noise sources by their frequency components. Noise metrics calculated by a spectrum analyzer may be used for determining compliance with the FRA regulations, as long as the analyzers comply with the appropriate regulations.[26] When selecting a spectrum analyzer for use on a railroad noise measurement program, the method the frequency information is handled by the analyzers should be taken into consideration.

Microphone simulators: A passive microphone simulator (otherwise known as a dummy microphone) is a small capacitive device that affixes to the preamplifier in place of the microphone. By replacing the measurement microphone with a microphone simulator, the electronic noise floor of the measurement instrument can be established, as recommended in ANSI S1.13-1995 (r1999)[27]. The establishment of the noise floor is necessary to accurately measure very low level sounds.

It is recommended that a microphone simulation check be performed in the field before measurements commence. The equivalent sound pressure level measured during this time interval shall be used as the measure of compliance with the electronic noise floor criteria. By making a microphone simulation check part of the initial calibration procedure, the collected data can be used to verify that the measurement instrument's noise floor did not have an effect on the measured sound pressure levels.

When performing a microphone simulation check, it is important to monitor the input to the measurement instrument with audio headphones, if the measurement instrument is equipped with such monitoring capabilities. Monitoring can detect extraneous signals that might be picked up by the measurement instrument, such as electromagnetic interference (or hum) from nearby antennae, power lines, generators, etc. Electromagnetic interference and other extraneous signals are considered to be part of the electronic noise floor, and should be eliminated, or minimized to a level that has a negligible effect on the measurements. Measurement instruments can pick up extraneous signals or electromagnetic interference from nearby antennae, power lines, generators, etc. Examples of electromagnetic interference include broadcast signals from radio stations and hum from high-voltage power lines. In many cases, this electromagnetic interference is exacerbated by long microphone cables or metallic tripods acting as antennae.

If the interference due to electronic noise is detected, attempts should be made to eliminate or reduce it to a negligible level. Since long microphone cables might be picking up the electromagnetic interference, the use of shorter microphone lines or shielded, balanced microphone lines are two possible methods to reduce the level of the

impinging electromagnetic interference. It is also a good idea to check and clean all of the grounding contacts interconnecting the measurement instruments to make sure the connections are solid, and to be certain that none of the interconnections are coming into direct contact with tripods or any other metallic or conductive surface. Other good practices are to re-orient the measurement instruments and microphone cables or, in cases of extreme electromagnetic interference, move to a different measurement site farther away from the source of interference.

Pink noise generators: A pink noise generator is a small electronic device that generates pink noise. Pink noise is a random, narrowband signal, having an approximately flat response across all frequency bands on an un-weighted, one-third octave-band spectral analyzer. Measurement of this signal allows verification of the frequency response characteristics of the measurement instrument. This is particularly important when collecting frequency data, because the measurement instrument's compliance with the appropriate ANSI standards may be verified.

Additional information on microphones

The performance of a microphone is defined by its operational parameters: type, frequency response, stability, directivity and dynamic range (or sensitivity), which are presented in the manufacturer's literature for the microphone. Table 21 shows the factors to consider when choosing a microphone.

Table 21. Microphone Information

Operational Parameter	Parameter Type	Affect on Microphone	Specific use/ Considerations
Type	Conventional condenser	• Flat frequency response • Highly stable • Delicate and very sensitive to moisture (can invalidate measurements)	Requires a polarization voltage
	Electret condenser (Electret)	• Robust with respect to moisture • Less stable over long time periods (Cal Drift)	Pre-polarized
Size (diameter)	Small diameter (Generally 1/2")	• Frequency range increases • Dynamic range decreases	Sufficient for most railroad noise measurements
	Large diameter (Generally 1")	• Frequency range decreases • Dynamic range increases	Low frequency or low sound level measurements
Directivity	Normal incidence (0°)	Flat response when measured sound waves are perpendicular to the plane of the microphone diaphragm.	Stationary noise measurements
	Grazing incidence (90°)	Flat response when measured sound waves are parallel to the plane of the microphone diaphragm.	For a source moving in a plane, such as a moving locomotive or rail car.
	Random incidence	Sensitivity that is essentially constant to random incident sound waves, as a function of frequency over a specified frequency range.	Anytime random incidence sound waves will be measured (unknown source direction)

8.2 Health Effects of Noise

Noise is not only undesirable sound, but it may also have negative heath effects on humans. These health effects can be broken down into physiological effects, such as hearing impairment and sleep disturbance, and psychological

effects, such as annoyance and speech interference. This Section presents a brief explanation of noise-related health effects, in order to better understand the importance of railroad noise control.

Noise has been seen to have numerous negative physiological effects on human health; the most prominent one being hearing loss. Exposure to very loud sounds can cause a person's inner ear to physically change, resulting in either a temporary or permanent negative impact on their hearing. While not all exposure to very loud noise levels results in permanent hearing loss, continued or repeated exposure to high level noise can result in permanent hearing damage. Hearing damage is often found to start with the decreased ability to hear higher frequencies, 4000 Hz and above, and may be accompanied by a ringing in the person's ears, known as tinnitus[28,29]. Since most human speech falls within the range of 200 to 6000 Hz[21], this may also result in a reduction of a person's speech comprehension. Hearing loss due to noise exposure may not only be problematic and frustrating in its own right, but it inevitably leads to increased stress levels. In turn, this may produce numerous stress-related health problems, such as high-blood pressure, heart disease and ulcers.

OSHA has attempted to limit the amount of hearing loss due to noise exposure in the workplace, by establishing a series of maximum permissible durations to be exposed to specific sound pressure levels[30]. Although compliance with this regulation does not definitively protect everyone from noise-induced hearing loss, especially since everyone's hearing is unique and may not be affected the same way by the same noise, it does provide a measure of protection for all employees, which may be supplemented with hearing protection, if necessary. If the railroad noise in a given work area cannot be sufficiently abated by other means, the noise experienced by each individual railroad employee can be addressed through the use of hearing protection*. Hearing protection usually comes in one of two forms; ear muffs or ear plugs. Ear muffs are large foam or liquid-filled shells that cover the wearer's ear completely, forming a seal and resembling large audio headphones. Ear plugs are designed to fit inside or block the opening to the wearer's ear canals only, and are typically made from a moldable material, like rubber, foam or silicon. Two main factors should be taken into consideration when selecting hearing protection; comfort (which is self explanatory) and noise reduction rating. The noise reduction rating (NRR) is a measure of the performance of hearing protectors, as specified by EPA regulation 40 CFR Part 211 – Product Noise Labeling[35, 31,†]. The following equation provides a method for determining the approximate noise exposure an employee will experience if they use hearing protectors with a specific noise reduction rating in a given workplace noise environment,

$$\mathbf{L_{HP} = L_A - (NRR - 7\ dB)}$$

Where L_{HP} = Estimated Noise Exposure with Hearing Protection [in dB(A)];

L_A = Workplace Noise Level [in dB(A)];

NRR = Noise Reduction Rating; and

* It is important to note that hearing protection should only be considered a noise abatement option for railroad employees. It should not be considered as a viable noise control option for residents neighboring railroad facilities and routes.

† 40 CFR Part 211 also presents methods for calculating NRR, if it is not provided the hearing protector manufacturer.

7 dB = an adjustment factor to conservatively account for the C-to-A-weighting difference in the NRR[35*].

Therefore, the above equation may be used to determine the effectiveness of a certain type of hearing protector in a specific noise environment at reducing noise exposure to an acceptable level. Regardless of the type of hearing protection used by an employee, they must be trained in its proper use.

Exposure to noise during the nighttime hours may result in sleep disturbance. Noise may awaken a sleeping person, as well as reduce the quality of their sleep and increase the time it takes to fall asleep[32]. Although some people become accustomed to many rhythmic, background noise sources at low to moderate sound pressure levels during the nighttime hours, noise, especially impulsive and unfamiliar noise, can negatively impact on a person's sleeping patterns. Sleep disturbance can lead to increased fatigue, depressed moods, decreased productivity, increased stress, increased blood pressure and a decrease in a person's overall quality of life.

Noise has also been seen to have numerous negative psychological effects on human health, such as speech interference and annoyance. Simply put, speech interference is the result of speech being masked by other simultaneously-occurring sounds, such as noise, which may result in misunderstandings, reduced speech comprehension and even failed communication. Furthermore, noise may mask other important acoustical signals, like alarms and other warning signals. Speech interference becomes especially problematic when the interfering noise occurs over the same frequencies as human speech, 200 to 6000 Hz[28]. Failure to communicate properly in a noisy environment may not only cause frustration, but it may also effect the performance of one's job, one's ability to learn in a classroom environment and even present a safety issue, if warning sounds are masked.

Speech interference may be reduced by speaking louder, standing closer to the listener, or reducing the level of the interfering noise. ANSI S3.14-1977 (r1997) American National Standard for Rating Noise with Respect to Speech Interference presents a relation between the relative voice level of a speaker, the distance from the speaker to the listener and the approximate A-weighted sound pressure level of the interfering noise in order to insure effective communication[33]. These approximations are summarized in Figure 33[33,34].

The reduction of speech interference in the workplace is one of the impetuses behind the FRA's employee noise exposure regulations (49 CFR Parts 227 and 229), including the in-cab static measurement procedures for locomotives.

* NRR is based on C-weighted data. A variation on Equation 23 for C-weighted noise levels is: L_{HP} [in dB(C)] = L_C [Workplace Noise Level in dB(C)] - NRR.

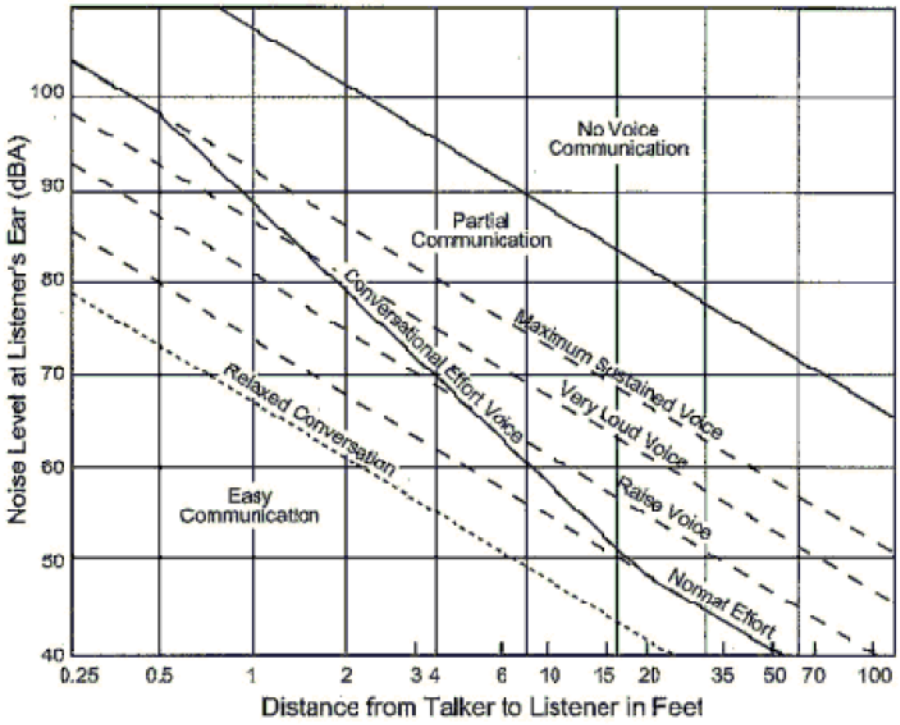


Figure 33. Noise Level Effects on Speech Interference[33]

Annoyance is another psychological effect due to noise, which has been seen to reduce the quality of life of those affected. Unfortunately, annoyance is very subjective, and varies from person to person. Some of the factors seen to contribute to a person's annoyance with noise are: noise level and frequency content, whether the noise is constant or fluctuates with time, the duration of the noise, source of noise, familiarity with noise, importance of noise (e.g., police siren), and predictability of noise (e.g., randomly vs. once an hour)[29]. Annoyance due to noise might also result in some physiological effects, such as sleep deprivation and increased stress levels. Although annoyance due to noise is difficult to quantify, it is an important factor to keep in mind when assessing transportation noise sources, especially those located in close proximity to private residences, like homes located near rail yards.

8.3 Noise Abatement

The worst case scenario for any railroad noise measurement or monitoring study is for the resulting sound levels to not be in compliance with the applicable FRA regulations. If such a scenario occurs, then measures must be taken to abate the offending noise. Noise abatement (or noise control) measures are subdivided into three categories; source controls, path controls and receiver controls. Source controls describe changes to the noise source itself, in order to reduce noise levels. Path controls describe measures used to block or attenuate noise on the path between the source and the receiver. Receiver controls describe abatement measures performed at the receiver location, in order to reduce noise levels.

Any of these three types of noise control measures (or a combination thereof) may be implemented, as long as they reduce the railroad noises to acceptable levels. Recommendations on specific noise controls, that may be more effective for abating certain types of railroad noise, will be presented throughout this chapter. Once implemented, the reduced noise levels due to noise abatement measures must be verified by repeating the appropriate noise measurement procedures presented in Chapter 3 of this Handbook, to reassess compliance with the applicable FRA noise regulations.

8.3.1 Source Controls

Although the regulation-specific railroad noise measurement and monitoring procedures in Chapter 3 help to identify general railroad operations or pieces of railroad equipment that may have noise issues, like car-coupling or a load cell test stand, they don't always pin-point the actual noise source(s). Locomotive noise may have a variety of sources, which can be put into two main categories; vehicle propulsion noise and wheel-rail interaction noise. Vehicle propulsion noise is dominated by diesel-engine exhaust noise for locomotives, but also includes gear noise and noise from cooling fans[2,3]. Vehicle propulsion noise is the main noise source for locomotives (both stationary and moving), however wheel-rail interaction noise also contributes to the overall noise emitted from moving locomotives, and is the dominant source of noise from moving rail cars[35]. Wheel-rail interaction noise is caused by rolling noise due to roughness or corrugation on the railroad tracks, impact noise due to wheel flats or rail junctions, and squeal noise from friction on tight curves in the railroad tracks.

Offending railroad noise sources are typically identified by railroad employees, or by complaints from local residents. Once the noise measurements have been conducted, the noise data has been processed, and it has been determined that the railroad noise source is not in compliance with the applicable FRA regulations, then it should be addressed. If the noise source is due to some problematic railroad equipment (such as a specific locomotive or section of track), then it may be appropriate to implement source controls to address the noise issue.

Source controls describe any changes to the noise source itself, in order to reduce associated noise levels. They are typically the most desirable form of noise abatement. Source controls can take two major forms when applying them to railroad noise sources; modifications to railroad equipment and changes to railroad operations.

Since the equipment operated by the railroad is the source of the noise, it makes sense that the implementation of newer, quieter equipment is a possible solution. However, in many cases, it may not be reasonable or feasible to replace existing, functional railroad equipment, like entire locomotives and load cell test stands, with newer, quieter equipment. Another option may be to make modifications to the current railroad equipment, in order to reduce the noise levels generated by its operation. This may include replacing or repairing noisy and/or defective equipment, like fans, gear boxes, brakes, rattling windows, door seals, etc., or adding additional noise-dampening equipment, like mufflers and insulation.

Often, the noisy railroad equipment in need of replacement or repair is easily identifiable with the human ear. If not, it may be necessary to incrementally remove, insulate, or turn off specific pieces of equipment that may be causing

the excess noise, and then re-measure the sound levels for compliance with the appropriate FRA regulation. This process may be further supplemented by performing a frequency analysis of the noise data (with a spectrum analyzer), which will identify specific frequency bands contributing to the excessive overall noise levels, and the effects of any of the modifications to the railroad equipment on the resulting noise levels.

Modifications to railroad equipment may be a useful solution for almost any type of railroad noise. Noise from locomotives (moving and stationary, including switchers) and load cell test stands may be reduced by the addition of a newer muffler, checking all seals, tightening loose parts, and keeping up with locomotive maintenance and lubrication[1]. If wheel-rail interaction noise is the primary issue, damped wheels could be used to reduce squeal on track curves, wheel flats could be removed by truing the wheels and future flats could be prevented through the implementation of spin-slide control systems*, and rolling noise could be reduced by grinding down the roughness on the tracks[3]. Implementing low-noise brake shoes and keeping up with the proper amount of lubrication may effectively reduce noise from retarders. If noise levels are too high or too low from a locomotive horn, changes in mounting position and operational air pressure should be considered, as well as the replacement of the horn with another model that might better meet the FRA requirements.

Changes to railroad operations may also reduce the overall noise emitted from the railroad noise source(s). This includes changes in the method and frequency of a task. Changes in the speed, and therefore throttle setting, will change the noise levels generated by moving locomotives (including switchers), as well as by moving rail cars, retarder operations and car-coupling operations, where the resulting noise levels are typically lower when the operations are conducted at lower speeds. Since employee noise exposure measurements are typically conducted over an eight-hour-long monitoring period and the railroad operations that occur in the vicinity of that employee directly impact their noise exposure, spacing out noisy railroad operations or reducing their operation time, like load cell test stand use, so fewer noise events occur over each eight-hour work shift will also help reduce employee noise exposure.

8.3.2 Propagation Path Controls

Noise propagates from its source to the receiver, and any noise control measures taken to block or attenuate noise on this path are known as path controls. When sound propagates, it is spreads out from the source radially. As the sound propagates away from the source, the overall sound level at any given point is affected by the:

(1) divergence caused by geometrical spreading;
(2) attenuation due to air absorption and meteorological effects;
(3) attenuation due to ground surfaces (reflections off of hard ground, and absorption due to soft ground); and
(4) shielding of the receiver from the source by a barrier or structure, that disrupts the line-of-sight between them[1,21].

These factors indicate that the physical location of the noise source and the line-of-sight between the source and the receiver are integral in determining noise levels at selected receivers due to railroad equipment and operations.

* Trains operating with smooth wheel treads may be up to 20 dB(A) quieter than those operating with wheel flats.

Therefore, the relocation of noisy railroad equipment away from potential receivers and/or blocking the line-of-sight of those receivers to the railroad noise sources are both effective propagation path controls. The major disadvantage for these propagation path controls is that they may restrict certain types of railroad/rail yard operations to certain locations, and they may only benefit a small subset of the exposed population.

Noise barriers are often an effective propagation path control for reducing railroad noise levels. Barriers block the line-of-sight between the receiver and the noise source. Earth berms and buildings are also often used in the same manner as (or in substitution of) noise barriers a way to effectively block the line-of-site between receivers and noise sources. Although this Handbook does discuss railroad noise control issues and solutions, it is beyond the scope of this Handbook to go into the numerous factors that go into designing an effective noise barrier.

Effective noise barrier design and construction should be left up to experienced acoustical engineers. However, a 5 dB(A) reduction in noise levels at the receiver is an accepted, rule-of-thumb for barriers just blocking the line-of-sight between the noise source and receiver, with an estimated additional 1.5 dB(A) reduction for each additional 1 m of barrier height above the line-of-sight[36]. Barriers that are made of absorptive material or have absorptive layers facing the noise source may provide additional noise reduction. These estimated sound level reductions should be taken into consideration along with cost, when comparing the potential effectiveness of a noise barrier with other noise abatement options. Along the same lines, enclosures around certain rail yard noise sources, such as load cell test stands and maintenance shops, may also be effective propagation path controls for limiting railroad-related noise levels.

While the relocation of railroad equipment away from noise-sensitive receivers can imply the relocation of entire rail yards or railroad tracks, it is more commonly used to describe the relocation of railroad operations and equipment inside the confines of the existing rail yard. By moving noisy rail yard operations, like car-coupling, load cell testing and the use of retarders (i.e., the hump yard), to another portion of the rail yard farther away from nearest potential receivers (including railroad employee sleeping quarters), the sound pressure levels observed at that receiving property measurement location will be reduced.

A noise study should be conducted by an experienced noise-compatible land-use planning professional, in order to determine the optimum relocation site for railroad noise sources as a noise abatement measure. When computing approximate reductions in sound pressure level per doubling of distances over relatively flat areas without any intervening objects blocking the propagation path, a general, approximation value is 6 dB(A) per doubling of distance for point sources, such as load cell test stands, and 3 dB(A) for line sources, such as consists of moving locomotives and rail cars[21, 36]. These approximations should be taken as general rules-of-thumb, when considering railroad noise source relocation as a propagation path control.

Along the same lines, noise-compatible land-use planning practices in the areas surrounding rail yards and railroad tracks may also be an effective tool in reducing noise levels at the nearest receivers, because it helps to insure that the nearest potential receivers are farther away from the noise source. As far as directional railroad noise sources,

such as locomotive horns, are concerned, the orientation of the noise source with respect to potential receivers should be considered as a noise abatement measure.

8.3.3 Receiver Controls

As mentioned at the beginning of this Chapter, receiver controls describe noise abatement measures performed at individual receivers. Receiver controls are typically the least desirable form of noise abatement, because they primarily deal with the way a noise source effects an individual receiver or location, and do not address the source of the noise. Two different types of receiver controls are typically utilized to address railroad noise issues; insulation of buildings and work areas, and implementation of hearing protection and hearing conservation programs.

One method of reducing railroad noise levels inside a building or work area, such as railroad employee sleeping quarters or a receiving property building, is the installation of insulation. In an enclosed work area, the sound pressure level due to outside noise is a function of the transmission loss of the material comprising the building structure. Transmission loss is a measure of the sound insulation properties of a wall or partition, and is calculated as follows:

$$TL = 10 \log_{10}\left(\frac{10^{L_S/10}}{10^{L_R/10}}\right)$$

where TL = Transmission Loss [in dB(A)];
L_S = Sound Pressure Level on the Source Side of the Partition [in dB(A)]; and
L_R = Sound Pressure Level on the Receiver Side of the Partition [in dB(A)][35].

As a general rule-of-thumb, heavier materials have a higher transmission loss. Not only does a noise insulation process include the use of building materials with high transmission loss, but it also includes sealing all cracks, holes and other noise leaks in the work area's walls, including the seals around the windows and doors. This may include replacing existing windows and doors with ones that have higher transmission losses and resealing all open cracks and gaps around each window and door, as well as implementing air-conditioning, so the residents no longer have to keep open their windows in warm weather and thus experience increased sound pressure levels from the railroad noise sources.

Appendix A: Glossary

This Appendix presents pertinent, technical terminology used throughout this Handbook, organized alphabetically. These definitions are generally consistent with those presented in the applicable FRA regulations and American National Standard Institute (ANSI) standards, including ANSI S1.1-1994 (r2004) Acoustic Terminology[20].

A

A-WEIGHTING: A weighting methodology used to account for changes in human hearing sensitivity as a function of frequency. The A-weighting network de-emphasizes the high (6.3 kHz and above) and low (below 1 kHz) frequencies, and emphasizes the frequencies between 1 kHz and 6.3 kHz, in an effort to simulate the relative response of human hearing. Adjustment factors for A-weighting are presented on page 93 of this Handbook. *See also frequency weighting.*

ACOUSTIC ENERGY: Also identified as sound energy, or just energy. Commonly referred to as the mean-square sound-pressure ratio, sound energy, or just plain energy, acoustic energy is the squared sound pressure (often frequency weighted), divided by the squared reference sound pressure of 20 μPa, the threshold of human hearing. It is algebraically equivalent to $10^{L/10}$, where L is the sound level, expressed in decibels.

ACOUSTICAL SHADOW: Area without direct line-of-sight of the noise source (or diffracted noise source) characterized by lower sound levels.

ACOUSTICS: The science of sound.

AMBIENT NOISE: All-encompassing sound at a specific place, which may be the result of numerous noise sources. Railroad noise sources being measured according to this Handbook are not part of the ambient noise.

AMPLITUDE: The maximum value of a sinusoidal quantity. For a sound wave, the amplitude is the difference between the instantaneous pressure of a given cycle of the wave and the ambient pressure at a moment in time.

ANGLE OF INCIDENCE: The angle at which a sound wave comes in contact with a surface.

ANNOYANCE: Any bothersome or irritating occurrence.

ANXIETY: A feeling of apprehension, uncertainty, and fear without apparent stimulus. It is associated with physiological changes (sweating, tremor, etc.) - the source of which is often nonspecific or unknown to the individual.

AUDIBILITY: The ability of a human observer to detect an acoustic signal in the presence of noise (e.g., aircraft detection in the presence of ambient noise).

AUDIBLE SPECTRUM: The range of frequencies audible to humans; 20 Hz to 20,000 Hz.

AUDIOMETRY: Measurement/testing of the hearing, including aspects other than hearing sensitivity.

AUDITORY THRESHOLD: Minimum audible perceived sound. Also referred to as the threshold of hearing.

B

BACKGROUND NOISE: Total of all the sources of noise interference for a measurement in a given environment, not including the railroad sound source of interest. This includes ambient noise as well as electronic noise from the measurement instrument.

BAND PRESSURE LEVEL: Sound pressure level for a sound contained within a specific frequency band.

BARRIER: *See noise barrier.*

BASE-10 LOGARITHM: $\log_{10}(x)$.

BERM: A mound or wall of earth.

C

CAR COUPLING: The act of connecting two rail cars

CAR COUPLING EVENT: A sound which is heard and identified by the observer as that of car coupling impact.

CARRIER: A carrier by railroad, or partly by railroad and partly by water, within the continental United States, excluding street, suburban, and interurban electric railways unless operated as a part of a general railroad system of transportation.

CONFIDENCE INTERVAL: A measure of data repeatability, which indicates that there is a specific percentage probability that the average of another data set collected from the same or similar source under similar circumstances as the first data set will fall within this interval. Confidence interval is expressed as the X% Confidence Interval; e.g., 85% Confidence Interval or 85% CI. FRA Regulation 49 CFR Part 229.121 specifically calls for the use of an upper 99% confidence limit, which is based on the upper 99% confidence interval for a data set. *See upper 99% confidence interval.*

CONFIDENCE LIMIT: A measure of data repeatability based on a specific percentage upper confidence interval, which indicates that there is a specific percentage probability that the average of another data set collected from the same or similar source under similar circumstances as the first data set will fall above or below this limit. Confidence limit is expressed as the X% Confidence Limit; e.g., Upper 95% Confidence Limit or Upper 95% CL. FRA Regulation 49 CFR Part 229.121 specifically calls for the use of an upper 99% confidence limit. *See upper 99% confidence limit.*

CONSIST OF A LOCOMOTIVE AND RAIL CARS: One or more locomotives coupled to a rail car or rail cars.

CONTAMINATION: *See Noise Contamination.*

CRITERION SOUND LEVEL: Level of sound which produce 100% noise dose over the course of eight hours. The criterion sound level according to FRA Regulation 49 CFR Part 227 is 90 dB(A).

D

D: *See percentage noise dose.*

DAT: Digital audio tape.

DATA LOGGER: A device to store or log data.

dB(A): An abbreviation meaning A-weighted sound level in decibels, referenced to 20 μPa.

DECIBEL, dB: A unit of measure of sound level. The number of decibels is calculated as ten times the base-10 logarithm of the square of the ratio of the mean-square sound pressure (often frequency weighted), and the reference mean-square sound pressure of 20 μPa, the threshold of human hearing.

DEGRADATION: The increase in noise levels at receivers due to conditions such as reflections from a single barrier, multiple reflections of the noise between parallel barriers, noise leaks in a barrier, etc.

DIFFRACTED WAVE: A sound wave whose front has been changed in direction by an obstacle in the propagation medium, where the medium is air for the purposes of this document.

DIRECTIONAL MICROPHONE: Microphone whose performance depends on the direction of the incident sound.

DIVERGENCE: The spreading of sound waves from a source in a free field environment.

DOSE: *See percentage noise dose.*

DOSIMETER: A device that measures and integrates sound pressure over a specified period of time, in order to determine sound exposure. Dosimeters must conform to ANSI S1.25-1991 (r2002)[16].

DYNAMIC RANGE: The algebraic difference between the highest input sound pressure level achievable without exceeding a specified non-linearity or distortion of the output signal, for a specified frequency range, and the lowest input sound pressure level for which the level linearity is within specified tolerances.

E

EARMUFF: Hearing protector worn over the outside of the ear.

EARPLUG: Hearing protector that is placed inside the ear canal.

EIGHT-HOUR TIME-WEIGHTED AVERAGE, $L_{TWA\ (8)}$: The A-weighted constant sound pressure level that would expose a person in eight hours to the same dose as did the actual time-varying sound pressure level.

ENERGY AVERAGE LEVEL: A quantity calculated by taking ten times the base-10 logarithm of the algebraic average of the anti-logs of one-tenth of each of the levels being averaged. The levels may be of any consistent type, e.g. maximum sound levels, and sound exposure levels.

ENERGY SUMMATION OF LEVELS: A quantity calculated by taking ten times the base-10 logarithm of the sum of the anti-logs of one-tenth of each of the levels being summed. The levels may be of any consistent type, e.g., equivalent sound level.

EQUIVALENT SOUND PRESSURE LEVEL, $L_{Aeq\,T}$: Ten times the base-10 logarithm of the square of the ratio of time-mean-square, instantaneous A-weighted sound pressure, during a stated time interval, T , divided by the

squared reference sound pressure of 20 µPa. The equivalent sound pressure level is a single level, whose energy would be equivalent to the energy found in the actual, A-weighted sound pressure levels within the specified time interval, if that single level remained constant over the entire time interval. *Also known as the time-interval equivalent continuous A-weighted sound pressure level.*

EXCEEDANCE PERCENTILE SOUND PRESSURE LEVEL, L_x: The level in decibels that is exceeded in a stated percentage (x) of the duration of the measurement period. For instance, L_{90} is the sound pressure level exceeded 90% of the time over a measurement interval. Therefore, if 100 consecutive, sound pressure levels were measured over a measurement interval and arranged from highest to lowest level, then the 90^{th} sample from the highest value would be the L_{90}.

EXCHANGE RATE: The amount a sound level is increased or decreased to preserve a certain noise exposure when the exposure duration is doubled or halved. For example, if the exchange rate is 5 dB, then the calculated noise dose for a noise of level X dB(A) for a duration of Y hours would be the same as the noise dose of a noise of level X + 5 dB(A) for a duration of Y/2 hours. A 5 dB exchange rate is used for calculating noise dose for compliance with FRA regulations, but some other applications do call for 3 dB and 4 dB exchange rates. The use of a 3 dB exchange rate indicates that the measured sound pressure levels are unmodified in the calculation of the noise exposure metric.

EXISTING LEVEL: The measured or calculated existing noise level at a given location.

F

FAR FIELD: That portion of a point source's sound field in which the sound pressure level (due to this sound source) decreases by 6 dB per doubling of distance from the source; i.e., spherical divergence. For a line source, the far-field is the portion of the sound field in which the sound pressure level decreases by 3 dB per doubling of distance.

FARM HOUSE: A dwelling on farm, which is typically solitary structure or small grouping of structures in a rural area (i.e., not part of a large grouping of houses in a community).

FAST METER RESPONSE: Means that the "fast" response of the sound level meter shall be used. Fast response characteristics effectively damp a signal as if it were to pass through a low-pass filter with a time constant of 125 milliseconds. Fast response is typically used to characterize brief sounds that change noticeably over the measurement interval. The fast dynamic response shall comply with the meter dynamic characteristics in the ANSI Specification for Sound Level Meters, ANSI S1.4-1983 (r2001)[13].

FLAT FREQUENCY RESPONSE (OR WEIGHTING): *See Frequency Weighting or Z-weighting.*

FREQUENCY: The number of cycles of repetition per second or the number of wavelengths that have passed by a stationary point in one second.

FREQUENCY WEIGHTING: A method used to account for changes in level sensitivity as a function of frequency. Three standard weighting networks, A, B, and C, are used to account for different responses to sound

pressure levels. Adjustment factors for A-, B- and C-weighting are presented in ANSI S1.4-1983 (r2001) and IEC 61672-1 Ed. 1 (2002), and are reprinted on page 93 of this Handbook. Note: The absence of frequency weighting is referred to as Z-weighting (also known as a "flat" frequency response or weighting). *See also A- and Z-weighting.*

G

GRAZING INCIDENT (SOUND): Sound waves that strike a receiver at an angle parallel to the angle of incidence. Also referred to as 90-degree incidence.

GROUND ATTENUATION: The change in sound level, either positive or negative, due to intervening ground between source and receiver. Also referred to as ground effect.

H

HARD GROUND: Any highly reflective surface in which the phase of the sound energy is essentially preserved upon reflection; examples include water, asphalt, and concrete.

HEARING IMPAIRMENT: A decreased ability to perceive sounds as compared with what the individual or examiner would regard as normal. The result is an increase in the threshold of hearing.

HEARING THRESHOLD: For a given listener and specified signal, the minimum:

(1) sound pressure level; or

(2) force level that is capable of evoking an auditory sensation in a specified function of trials.

HERTZ, Hz: Unit of frequency, the number of times a phenomenon repeats itself in a unit of time.

HUMP YARD: A rail yard consisting of several parallel tracks, used for making up rail car consists, where the rail cars must be pushed over a summit, or hump, beyond which they are moved by gravity.

HVAC: Heating, ventilation and air conditioning system.

I

IDLE: The condition where all engines capable of providing motive power to the locomotive are set at the lowest operating throttle position; and where all auxiliary non-motive power engines are not operating.

INSPECTOR: FRA Inspectors or FRA specialists.

INTEGRATING-AVERAGING SOUND LEVEL METER: A device used to measure and integrates sound pressure levels over a stated time interval, which conforms to ANSI S1.43-1997[14].

L

L_{10}: A statistical descriptor describing the sound level exceeded 10 percent of a measurement period. *See also exceedance percentile sound pressure level.*

L_{90}: A statistical descriptor describing the sound level exceeded 90 percent of a measurement period. *See also exceedance percentile sound pressure level.*

L_{99}: A statistical descriptor describing the sound level exceeded 99 percent of a measurement period. *See also exceedance percentile sound pressure level.*

$L_{adj\ ave\ max}$: The adjusted average maximum A-weighted sound pressure level, which is specific to the evaluation of car-coupling impact and retarder noise. It is calculated by applying an adjustment factor, based on the number of total car-coupling events divided by the measurement period (C), to the $L_{ave\ max}$ metric. *See also $L_{ave\ max}$.*

L_{AeqT}: *See equivalent sound pressure level.*

L_{AFmx} and L_{ASmx}: *See maximum sound pressure level.*

$L_{ave\ max}$: The average maximum A-weighted sound pressure level, which is specific to the evaluation of car-coupling impact and retarder noise. It is comprised of an energy-average of the A-weighted maximum sound levels collected during at least 30 consecutive car-coupling or retarder events.

$L_{TWA\ (8)}$: *See eight-hour time-weighted average.*

L_x: *See exceedance percentile sound pressure level.*

LINE-OF-SIGHT: Refers to the direct path from the source to receiver without any intervening objects, topography.

LINE HAUL: The movement over the railroad tracks of a carrier from one city to another, not including switching.

LINE SOURCE: Multiple point sources moving in one direction; e.g., a consist of rail cars. Note: As a rule of thumb, sound pressure levels measured from a line source decrease at a rate of 3 dB per doubling of distance.

LOAD CELL: A device external to the locomotive, of high electrical resistance, used in locomotive testing to simulate engine loading while the locomotive is stationary. (Electrical energy produced by the diesel generator is dissipated in the load cell resistors instead of the traction motors). *See also locomotive load cell test stand.*

LOCOMOTIVE: For the purpose of this Handbook, a self-propelled vehicle designed for and used on railroad tracks in the transport of rail cars, including self-propelled rail passenger vehicles.

LOCOMOTIVE LOAD CELL TEST STAND: The load cell and associated structure, equipment, track and locomotive being tested.

M

MAXIMUM SOUND LEVEL, L_{AFmx} or L_{ASmx}: The maximum, A-weighted sound pressure level associated with a given time interval. Maximum sound levels are characterized as having either a fast or slow response. Fast response (L_{AFmx}) and slow response (L_{ASmx}) characteristics effectively damp a signal as if it were to pass through a low-pass filter with a time constant of 125 and 1000 milliseconds, respectively. Slow response is typically utilized for more continuous sounds, whereas fast response better characterizes brief sounds that change noticeably over the

measurement interval. When compared directly, L_{AFmx} may be slightly higher than L_{ASmx} for the same sound over the same time interval, because the smaller averaging interval used by fast response might better characterize a short peak in sound pressure levels.

MEASUREMENT PERIOD: A continuous period of time during which noise of railroad yard operations is assessed, the beginning and ending times of which may be selected after completion of the measurements.

MICROPHONE: Electro acoustic transducer designed to output electrical signals in response to an acoustic or pressure input.

MOTIVE POWER: The power used to drive self-propelled railroad equipment, like locomotives.

N

NOISE: Broadly described as any unwanted sound. "Noise" and "sound" are often used interchangeably. In the case of the railroad industry, railroad noise may be considered to be any sound generated by railroad equipment or operations.

NOISE BARRIER: The structure, or structure together with other material, that potentially alters the noise at a site.

NOISE CONTAMINATION: Any noise event, other than that which is intended for measurement. Contamination typically occurs when the background noise is within 10 dB of the noise produced by the source intended for measurement.

NOISE DEFECTIVE: The condition in which railroad equipment is found to exceed the Railroad Noise Emission Standards, 40 CFR part 201.

NOISE DOSE: *See percentage noise dose.*

NOISE DOSIMETER: *See dosimeter.*

NOISE EXPOSURE: The integral over a given time interval of the instantaneous, frequency weighted sound pressure. This is often translated as the amount of noise a person is exposed to over a specific period of time.

NORMAL INCIDENT (SOUND): Sound waves that strike a receiver at an angle perpendicular, or normal, to the angle of incidence. *Also referred to as 0-degree incidence.*

O

OCTAVE: Frequency interval between two frequencies with a base of two.

OMNIDIRECTIONAL MICROPHONE: Microphone with a response that is essentially independent of the direction of an incident sound.

ONE-THIRD OCTAVE: Frequency interval between two frequencies with a base of two to the one-third.

P

PEAK SOUND PRESSURE LEVEL: Level of the peak sound pressure with stated frequency weighting, within a stated time interval.

PERCENTAGE NOISE DOSE, D: The ratio of (a) the time integral of the squared, A-weighted sound pressure over a given time, and (b) the product of the criterion duration and the sound pressure corresponding to the criterion sound level, as a percentage. It is a measure of an individual's total permissible noise exposure as a percentage.

PERSONAL NOISE MONITORING: The act of monitoring the noise exposure for a specific person (or persons) over a specified period of time (usually an eight hour work day/shift).

PINK NOISE: A random signal for which the spectrum density, i.e., narrow-band signal, varies as the inverse of frequency. In other words, one-third octave-band spectral analysis of pink noise yields a flat response across all frequency bands.

POINT SOURCE: Source that radiates sound spherically. Note: As a rule of thumb, sound pressure levels measured from a point source decrease at a rate of 6 dB per doubling of distance.

R

RAIL CAR: A non-self-propelled vehicle designed for and used on railroad tracks.

RAILROAD: All the roads in use by any carrier operating a railroad, whether owned or operated under a contract, agreement, or lease.

RAILROAD EQUIPMENT: Rail cars, locomotives, active retarders, and load cell test stands.

RANDOM INCIDENT (SOUND): Sound waves that strike a receiver randomly from all angles of incidence. Such waves are common in a diffuse sound field.

RECEIVING PROPERTY: Any residential or commercial property that receives the sound from railroad facility operations, but that is not owned or operated by a railroad; except that occupied residences located on property owned or controlled by the railroad are included in the definition of "receiving property." For purposes of this definition railroad crew sleeping quarters located on property owned or controlled by the railroad are not considered as residences.

RECEIVING PROPERTY MEASUREMENT LOCATION: A location on receiving property that is on or beyond the railroad facility boundary and that meets the receiving property measurement location criteria.

REVERBERATION: Sound that persists in an enclosed space, as a result of repeated reflection or scattering, after the source has stopped.

RETARDER: A device or system for decelerating rolling rail.

RETARDER SOUND: A sound which is heard and identified by the observer as that of a retarder, and that causes a sound level meter indicator at fast meter response to register an increase of at least ten decibels above the level observed immediately before hearing the sound.

S

SELF-LOADING: The capability for some locomotives to simulate engine loading while remaining stationary, without the aid of an external device.

SLOW METER RESPONSE: Means that the "slow" response of the sound level meter shall be used. Slow response characteristics effectively damp a signal as if it were to pass through a low-pass filter with a time constant of 1000 milliseconds. Slow response is typically used to characterize relatively continuous sounds. The slow dynamic response shall comply with the meter dynamic characteristics in the ANSI Specification for Sound Level Meters, ANSI S1.4-1983 (r2001) [13].

SOUND ENERGY: *See acoustic energy.*

SOUND EXPOSURE: *See noise exposure.*

SOUND LEVEL METER (SLM): A device used to measure sound pressure levels, that conforms with ANSI S1.4-1983 (r2001) [13].

SOUND PRESSURE: The root-mean-square of the instantaneous sound pressures during a specified time interval in a stated frequency band.

SOUND PRESSURE LEVEL, L (SPL): Ten times the base-10 logarithm of the square of the ratio of the mean-square sound pressure, in a stated frequency band (often weighted), and the reference mean-square sound pressure of 20 μPa, which is approximately equal to the threshold of human hearing at 1 kHz. Sound pressure level is expressed in decibels.

SOUND PRESSURE LEVEL (A-WEIGHTED), L_A: The A-weighted sound pressure level is the difference between instantaneous pressure of a sound wave and the ambient pressure at a moment in time in decibels, adjusted for A-weighting, and measured by instrumentation which satisfies the requirements of the ANSI Standard for Sound Level Meters S1.4-1983 (r2001)[13]. For the purpose of these procedures the sound level is to be measured with A-weighting and either the "fast" or "slow" dynamic averaging characteristics, as designated by the FRA regulations.

SPECIAL TRACK WORK: Track other than the normal tie and ballast bolted or welded rail or containing devices such as retarders or switching mechanisms.

SPECTRUM: A signal's resolution expressed in component frequencies, octave or fractional octave-bands.

SPECTRUM ANALYZER: A device used to measure frequency spectra, as well as sound pressure levels.

SPEED OF SOUND: The speed at which sound travels through a medium. The speed of sound is dependent on the medium, ambient pressure and temperature, but a standard, accepted value for speed of sound in air at 20 degrees Celsius at sea level is 343 m/s (1125 ft/s)[16].

STANDARD DEVIATION, σ: Measure of how widely the values in a data set vary from the average value.

STANDARDS: The Railroad Noise Emission Standards.

STEADY STATE NOISE: Continuous noise.

STRESS: The sum of the biological reactions to any adverse stimulus, physical, mental, or emotional, internal or external, that tends to disturb the organism's state of stability.

SWITCHER LOCOMOTIVE: Any locomotive designated as a switcher by the builder or reported to the Interstate Commerce Commission as a switcher by the operator-owning-railroad and including.

T

THRESHOLD LEVEL: The sound level below which the dosimeter disregards when calculating percentage noise dose.

THRESHOLD OF HEARING: *See Hearing Threshold*

TRANSMISSION LOSS (TL): The loss in sound energy, expressed in decibels, as sound passes through a barrier or a wall.

U

UPPER 99% CONFIDENCE INTERVAL: A measure of data repeatability, which indicates that there is a 99% probability that the average of another data set collected from the same or similar source under similar circumstances as the first data set will fall within this interval.

UPPER 99% CONFIDENCE LIMIT: A measure of data repeatability based on the upper 99% confidence interval, which indicates that there is a 99% probability that the average of another data set collected from the same or similar source under similar circumstances as the first data set will fall below this upper limit.

V

"VALIDATED" L_{90}: A statistical descriptor describing the sound level exceeded 90 percent of a measurement period for a steady state sound, which is specific to the evaluation of railroad noise at receiving property locations, as defined in the switcher locomotive and load cell test stand noise regulations. *See also exceedance percentile sound pressure level and L_{90}.*

W

WARNING DEVICE: A sound emitting device used to alert and warn people of the presence of railroad equipment.

WAVELENGTH: The physical distance between two pressure wave fronts making up one period of the sine wave.

Z

Z-WEIGHTING: The absence of frequency weighting. Also known as a "flat" frequency response or weighting. See also frequency weighting.

Appendix B: Blank Log Sheets and Checklists

This Appendix presents copies of the general log sheets first presented in Chapter 2, along with a series of checklists that summarize each of the general and regulation specific railroad noise measurement and noise exposure monitoring procedures presented in Chapters 2 – 6, along with the corresponding data processing and analysis procedures.

Federal Railroad Administration
Noise Measurement Data Log Sheet

Page ____ of ____

Name(s): _____	**Date:** _____
Type of Measurement:	**Start Time:**

Railroad Personnel and Measurement Site Information

Names: _____	**Railroad Equipment:** _____
Location:	**Comments:**

Measurement Instrument Information

Meas. Device: _____	**Calibrator:** _____
Serial No.: _____ **Type:** _____	**Serial No.:** _____
Settings:	**Level:** _____ dB **Frequency:** _____ Hz
	Comments:

Events and Incidents Log

Event No.	Start Time	Stop Time	Level	Comments

General Noise Measurement Data Log Sheet

Federal Railroad Administration
Noise Exposure Monitoring Data Log Sheet

Page ____ of ____

Name(s): _____	**Date:** _____
Type of Monitoring:	**Start Time:**

Monitored Railroad Employee Information

Name: _____	**Railroad Equipment:**
Job Title: _____	
Workshift Duration: _____	
Hearing Protection/Type: _____	
Location:	**Comments:**

Monitoring Instrument Information

Meas. Device: _____	**Calibrator:** _____
Serial No.: _____ **Type:** _____	**Serial No.:** _____
Settings:	**Level:** _____ dB **Frequency:** _____ Hz
	Comments:
Mic. Location:	

Events and Incidents Log

Event No.	Start Time	Stop Time	Task/Event	Event Description and Comments

General Noise Exposure Monitoring Data Log Sheet

Federal Railroad Administration
Measurement Site Geometry and Meteorological Conditions Log Sheet

Page ___ of ___

Name(s): _____ **Date:** _____

Type of Measurement: **Start Time:**

Railroad Personnel and Measurement Site Information

Names: _____ **Railroad Equipment:** _____

Location: **Comments:**

Measurement Site Geometry ***(Plan View)***

N

Meteorological Conditions

Event No.	Time	Wind Speed	Wind Direction	Temperature	Relative Humidity	Comments

General Measurement Site Geometry and Meteorological Conditions Log Sheet

Federal Railroad Administration
Receiving Property Noise Measurement Data Log Sheet

Page ____ of ____

Name(s): _____ **Date:** _____

Type of Measurement: **Start Time:**

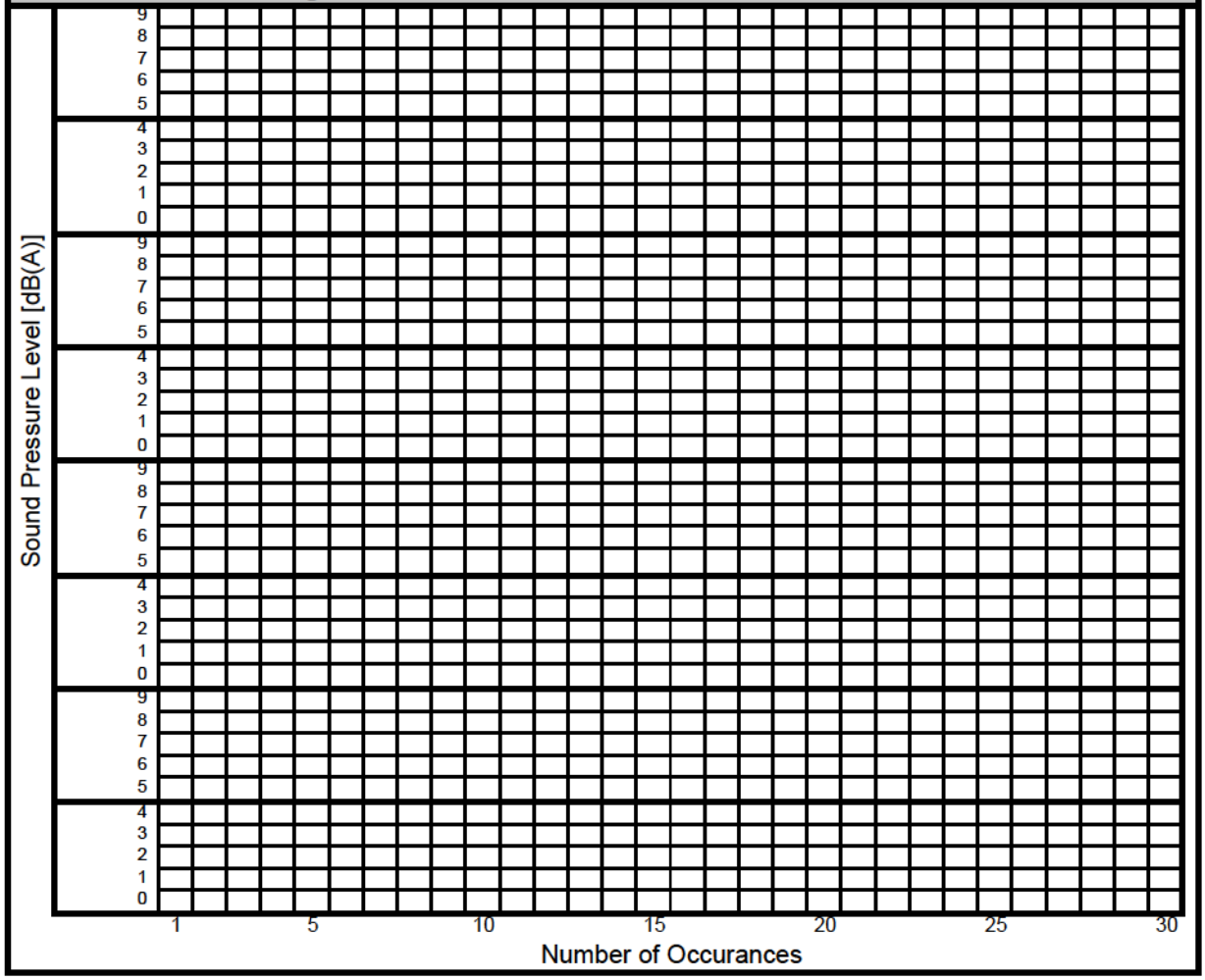
Railroad Personnel and Measurement Site Information

Names: _____	**Railroad Equipment:** _____
Location:	**Comments:**

Measurement Instrument Information

Meas. Device: _____	**Calibrator:** _____
Serial No.: _____ **Type:** _____	**Serial No.:** _____
Settings:	**Level:** _____ dB **Frequency:** _____ Hz
	Comments:

Events and Incidents Log



General Receiving Property Noise Measurement Log Sheet

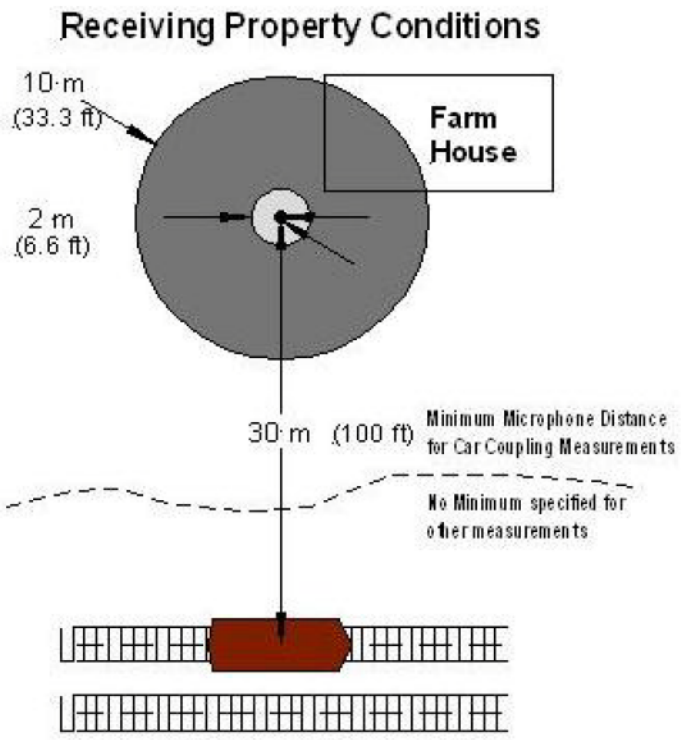
Receiving Property Measurement Site Criteria- Yard Operations

The microphone *must* be setup in a flat, open area, free of vertical surfaces larger than 1.2 m (4 ft) in height within 10 m (33.3 ft) of the microphone, as illustrated, EXCEPT

- Residential or commercial unit walls or facility noise barriers may be in closer proximity to the microphone, but still must be at least 2.0 m (6.6 ft) away from the microphone position.
- If the receiving property measurements are being made near a farm home, then one of the outer walls of the farm house *must* be within a 2.0 m to 10.0 m (6.6 ft to 33.3 ft) range of the microphone.

The microphone *must* be between 1.2 and 1.5 m (4 ft and 5 ft) above the ground.

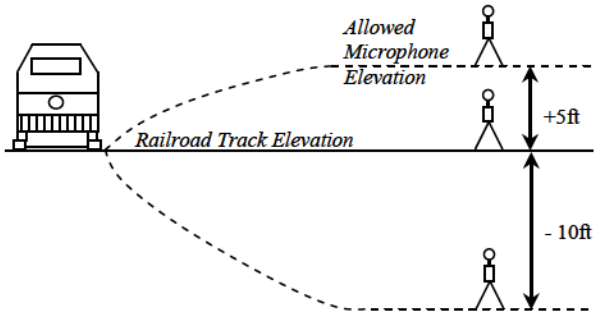
For car-coupling impact measurements only, the microphone *must* be *at least* 30 m (100 ft) from the nearest track where car-coupling occurs.



Sideline Measurement Site Criteria - Line Haul Pass-By (Locomotives and Rail Cars), Yard Operations and Locomotive Horns

Microphone Elevation at Measurement Site for Railroad Sideline Measurements

The ground must be relatively flat. That is, within +5 and -10 ft of the top of the test rail at the microphone.



Where possible, **avoid**:

- Measurements over water, wet ground, snow covered ground or high grass. Measurements over water will be higher than measurements over land due to reflection.
- Test sites less than ¼ mile from a grade crossings, to avoid noise contamination from the horn and crossing bells.
- Test sites close to antennas, power lines, generators and other sources of electromagnetic interference. Document the location of these sources if avoidance is not possible. Electromagnetic interference is discussed in more depth in Chapter 8 of this Handbook.

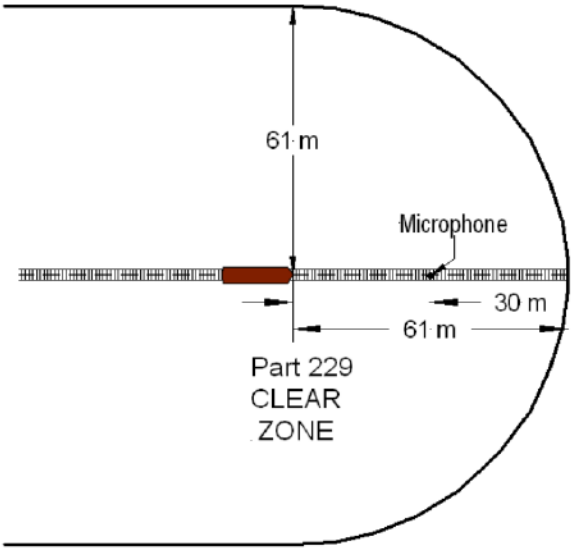
Measurement Site – Track visibility – all sites

For pass-by measurements, at least 80% of one rail along the test track must be visible from the microphone location, and no single obstruction should obscure more than 5% of the test track.

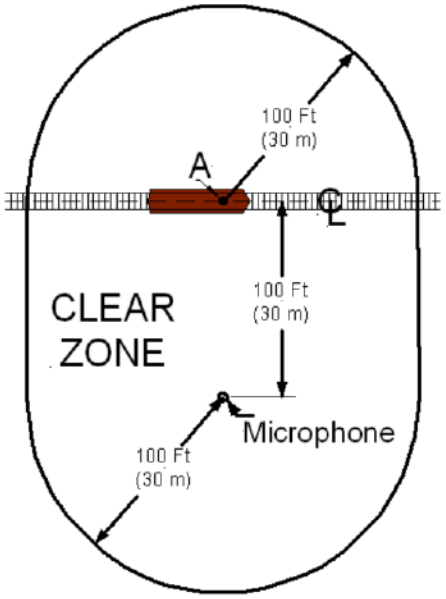
Measurement Site - Clear zone requirements – all sites

The measurement site must be free of large, reflecting objects such as buildings, hills, sign posts, bridges, parked vehicles, railroad cars and locomotives (other than the one being tested). Reflections off of these objects may increase the measured sound level.

Measurement Site Boundaries for Railroad Horn Measurements



Measurement Site Boundaries for Railroad Sideline Measurements



Checklist B-1. Measurement Equipment

Basic Noise Measurement Instruments

- ☐ Sound Level Meter (SLM), including:
  - ☐ Windscreen
  - ☐ Microphone
  - ☐ Preamplifier
  - ☐ Measurement Device (Sound Level Meter or Dosimeter)
- ☐ Calibrator (94 dB, A-weighted sound pressure level at 1 kHz)
- ☐ Batteries (lithium, nickel-cadmium gel cell, etc)
- ☐ Handheld anemometer to measure wind data

Additional Equipment

- ☐ Tape measure
- ☐ Camera
- ☐ Stopwatch or speed detection equipment
- ☐ Communication equipment (cell phone, walkie-talkie, etc.)
- ☐ Tripods
- ☐ Log sheets
- ☐ Backup equipment (measurement instrument, batteries, storage media, pens, etc.)

Checklist B-2. Noise Measurement Advance Planning

☐ Identify the type of test.

☐ Identify the railroad equipment or locations that will be the subject of the test, and determine their availability.

- Locomotive location for locomotive cab interior / railroad horn measurements,
- Crew boarding location for personal monitoring of occupational noise exposure,
- Track wayside, rail yard, or receiving property, or
- Sleeping quarter location.

☐ Determine the general location, time, and date of the measurements.

Address _____
City _____
County _____
State _____
Railroad/Milepost _____
Rail Yard _____

☐ Identify and review applicable standards and regulations.

CFR PART _____

☐ Review railroad safety rules and site-specific safety considerations.

☐ Identify and contact other participants who will assist.

☐ Select and prepare appropriate noise measurement and other instruments.

- Check batteries
- Reset / Confirm proper configuration of instruments. (Weighting, response rate, etc.).

Checklist B-3. Basic Procedure for Noise Measurements

Set up the Noise Measurement Instrument(s).

- ☐ Mount the noise measurement instrument on a tripod (or hold at arm's length) at the height specified in the regulations.
- ☐ Orient the microphone according to the sound source:
  - Normal incidence for stationary sources, or
  - Grazing incidence for moving sources.
- ☐ Verify the instrument condition and settings.
  - Calibration setting (Measure and document 10 seconds of the acoustic calibration signal. Adjust as necessary)
  - Full battery power
  - Frequency weighting filter (A or C)
  - Dynamic response (fast, slow)
  - Measurement metric (L_{AFmx}, L_{ASmx}, L_{AeqT})
- ☐ Verify time synchronization - or offset.
  - Instrument (SLM or Dosimeter)
  - Wrist watch (or cell phone)
  - Laptop
- ☐ Place a windscreen over the microphone.

☐ **Confirm clear noise measurement pathways.**
Position observers, operators and employees away from the microphone, rail equipment and out of the direct path of the noise source.

☐ **Measure and confirm that the environmental conditions are within the specified limits.**

- Wind speed: Sustained <12 mph, Gusts < 20 mph
- No Precipitation

Not required for indoor measurement (cab interior sleeping quarters)

- Temperature: 14°F to 122°F (36°F to 95°F preferred)
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

☐ **Measure and document the background noise level.** The specific procedure and metric is regulation-dependant.

☐ **Perform source noise measurements.**

- Document any noticeable environmental changes, including substantial changes in weather, background noise or contamination from other noise sources.
- Field calibrate the instrument at intervals not exceeding one hour for longer duration measurements. (Not required for all measurements)

☐ **Perform post-measurement checks.**

- Measure and record the background noise level.
- Measure and record a calibration tone.
- Document the environmental conditions.

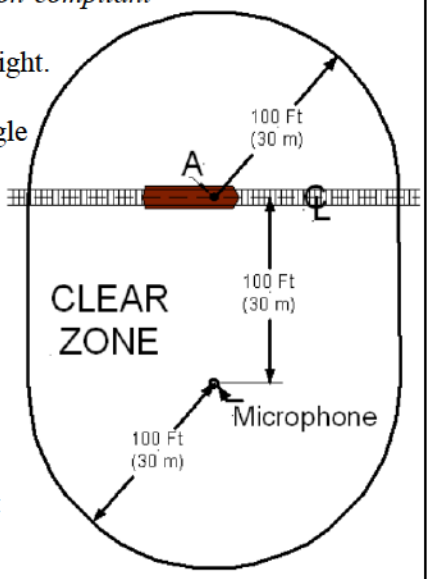
☐ **Backup data.**

- Save and/or download the data to memory or an external storage device.
- Make backup copies of the data and the corresponding log sheets at a convenient time.

Checklist B-4a. Procedure for Line-Haul Measurements (40CFR Part201.12. and 201.13)

Inspect the test site for regulatory compliance. *Document specific non-compliant conditions.*

- ☐ Ground at the microphone site is within +5 to -10 ft of track height.
- ☐ Free of large, reflecting objects.
- ☐ At least 80% of one rail is visible from the microphone; no single obstruction obscures more than 5% of the track.
- ☐ The track must have less than a 2 degree curve, free of rail corrugations and without rail joints.
- ☐ *Where possible*, avoid:
  - Measurement over water, snow covered ground, or high grass;
  - Sites less than ¼ mile from a grade crossing; and
  - Areas close to sources of electromagnetic interference.



Set up the Instruments.

- ☐ Mount the noise measurement instrument on a tripod (or hold at arm's length).
  - 30 m from the centerline of the track
  - 1.2 m above ground
  - Orient the microphone properly towards the pass-by location; usually grazing incidence.
- ☐ Verify the instrument settings.
  - A-weighting
  - Fast-response
  - Maximum sound level, L_{AFmx}, metric
- ☐ Calibrate the instrument (or verify calibration).
- ☐ Verify time synchronization - or document offset.
  - Instrument
  - Watch (or cell phone)
  - Laptop
- ☐ Place a windscreen over the microphone.
- ☐ *For rail car measurements only*, set-up a method of speed detection (locomotive speedometer, stopwatch, or radar gun).

☐ **Confirm clear noise measurement pathways.**

☐ **Confirm that the environmental conditions are within specified limits.**

- Wind speed: Sustained <12 mph, Gusts < 20 mph
- No Precipitation
- Temperature: 14°F to 122°F (36°F to 95°F preferred)
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

Perform noise measurements.

- ☐ Measure background noise for 30 seconds - document the maximum level.
- ☐ Measure and record the locomotive/rail car sound level, beginning as it starts its approach, continuing until it is well past the microphone.
- ☐ Document the maximum sound level (if possible), along with the time of pass-by.
- ☐ Make sure that the test subject locomotive or rail car was separated from other operating locomotives by 10 car lengths or 500 ft.
- ☐ *For rail cars,* document the speed and number of cars separating the test car from the operating locomotive.

Perform post-measurement checks.

- ☐ Measure and record the background noise level.
- ☐ Measure and record a calibration tone.
- ☐ Document the environmental conditions.

Checklist B-4b. Line-Haul Measurement Data Processing

(may be done on-site, if desired)

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the pass-by event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the maximum sound level** for each pass-by event and each background noise measurement.

- From log sheet, or
- Identify the timeframe of the pass-by event in the measured noise data and the maximum sound level within that measurement interval.

☐ **Verify that background noise did not contaminate the measurements.**

- ⊗ The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

☐ **Compare the maximum sound level for the event to the appropriate railroad noise level criteria.**

90 dB(A)	Locomotives
96 dB(A)	Locomotives manufactured before 12/31/1979
88 dB(A)	Rail cars at speeds ≤ 75 km/h
93 dB(A)	Rail cars at speeds > 75 km/h

To account for the effects of variations in instrument tolerances, site topography, atmospheric conditions, reflected sound from small objects, and the common practice of reporting sound levels to the nearest decibel, 2 dB(A) may be added to the compliance level.

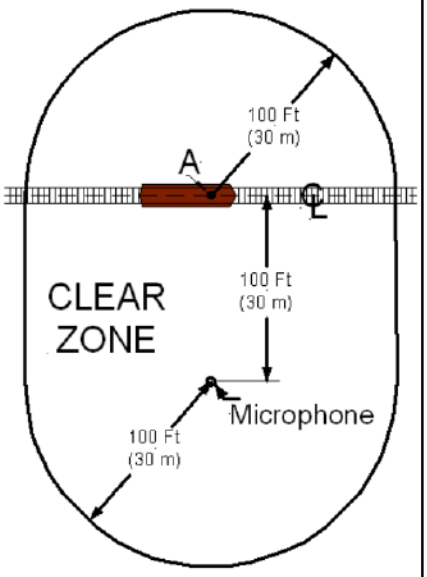
☐ **Evaluate Compliance.**

The regulations state that a non-compliant locomotive or rail car shall be subjected to another pass by test prior to return to service. However, no retest is required if the cause of the noise defect is readily apparent and is corrected.

Checklist B-5a. Procedure for Fixed-Site Sideline Measurements: Stationary Locomotives and Load Cell Test Stands (40CFR Part 201.11 and 201.16)

Inspect the test site for regulatory compliance. *Document specific non-compliant conditions.*

- ☐ Ground at the microphone site within +5 to -10 ft of track height.
- ☐ Free of large, reflecting objects.
- ☐ At least 80% of one rail is visible from the microphone; no single obstruction obscures more than 5% of the track.
- ☐ *Where possible*, avoid:
  - Measurement over water, snow covered ground, or high grass.
  - Sites less than ¼ mile from a grade crossing.
  - Areas close to sources of electromagnetic interference.



Set up the Noise Measurement Instrument(s).

- ☐ Mount the noise measurement instrument on a tripod (or hold at arm's length):
  - 30 m from the centerline of the track, at the geometric center of the locomotive,
  - 1.2 m above ground,
  - Orient the microphone properly towards the pass-by location; usually grazing incidence.
- ☐ Verify the instrument settings:
  - A-weighting • Slow-response • Maximum sound level, L_{ASmx}, metric
- ☐ Calibrate the instrument (or verify calibration).
- ☐ Verify time synchronization - or document offset.
  - Instrument • Watch (or cell phone) • Laptop
- ☐ Place a windscreen over the microphone.

☐ **Confirm clear noise measurement pathways.**

☐ **Confirm that the environmental conditions are within specified limits.**

- Wind speed: Sustained <12 mph, Gusts < 20 mph • No Precipitation
- Temperature: 14°F to 122°F (36°F to 95°F preferred)
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

Perform Noise Measurements

- ☐ Measure background noise for 30 seconds - document the maximum level.
- ☐ Warm-up the locomotive. The engine must reach the normal cooling water operating temperature.
- ☐ Set locomotive to desired throttle setting. Stabilize for 40 seconds.
- ☐ Measure and record the locomotive sound level for 30 seconds – document the maximum level.

Perform Post-measurement checks

- ☐ Measure the background noise for 30 seconds – document the maximum level.
- ☐ Measure and record a calibration tone.
- ☐ Document the environmental conditions.

Checklist B-5b. Data Processing for Fixed-Site Sideline Measurements: Stationary Locomotives and Load Cell Test Stands

(may be done on-site, if desired)

Backup Data

- ☐ Save and/or download the data to memory or an external storage device.
- ☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the maximum sound level** for each event and each background noise measurement.

- From log sheet, or
- Identify the timeframe of the event in the measured noise data, and the maximum sound level within that measurement interval.

☐ **Verify that background noise did not contaminate the measurements.**

- ⊗ The maximum sound level for the event must be 10 dB(A) above the background levels both before and after the event.

☐ **Compare the maximum sound level for the event to the appropriate railroad noise level criteria.**

$L_{ASmx} \leq 70$ dB(A)	Locomotives (including switchers), stationary, idle
$L_{ASmx} \leq 73$ dB(A)	Locomotives, stationary, idle, manufactured before 12/31/1979
$L_{ASmx} \leq 87$ dB(A)	Locomotives (including switchers) attached to load cell, any throttle
$L_{ASmx} \leq 93$ dB(A)	Locomotive attached to load cell, any throttle, manufactured before 12/31/1979
$L_{ASmx} \leq 78$ dB(A)	Load cell test stand, with stationary locomotive at maximum throttle.

To account for the effects of variations in instrument tolerances, site topography, atmospheric conditions, reflected sound from small objects, and the common practice of reporting sound levels to the nearest decibel, 2 dB(A) may be added to the compliance level.

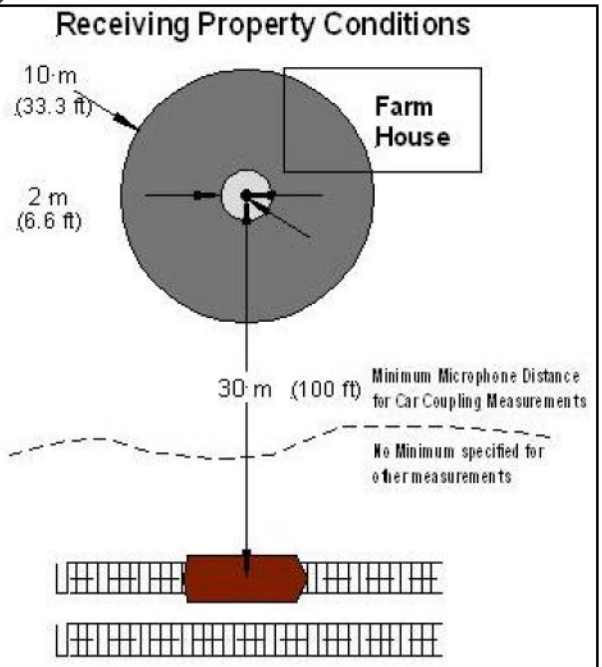
☐ **Evaluate Compliance.**

Checklist B-6a: Procedure for Receiving Property Measurements: Switcher Locomotives and Load Cell Test Stands (40CFR Part 201.11, 201.12, 201.16. and 201.27)

Inspect the Test Site for Regulatory Compliance

☐ The microphone is setup in a flat, open area, free of vertical surfaces over 1.2 m in height within 10 m of the microphone, as illustrated, EXCEPT:
- Residential or commercial unit walls, or facility noise barriers, may be in closer proximity to the microphone, but still must be at least 2.0 m away from the microphone position.
- If the receiving property measurements are near a farm home, then one of the outer walls of the farm house *must* be within 2.0 m to 10.0 m of the microphone.

☐ Document the measurement site layout (rail yard and receiving property); label the locations of the microphones, noise sources, and the approximate distance between each source and the microphone.



Setup the Noise Measurement Instrument.

☐ Mount the noise measurement instrument on a tripod (or hold at arm's length).
- 30 m from the centerline of the track
- 1.2 - 1.5 m above ground
- Orient the microphone properly towards the rail yard location; usually grazing incidence.

☐ Verify the instrument settings:
- A-weighting
- Fast response
- Exceedance Percentile Levels: L_{90}, L_{10}, L_{99}.

☐ Calibrate the instrument (or verify calibration).

☐ Verify time synchronization - or document offset.
- Instrument
- Watch (or cell phone)
- Laptop

☐ Place a windscreen over the microphone.

☐ **Confirm that the environmental conditions are within specified limits.**
- Wind speed: Sustained <12 mph, Gusts < 20 mph
- No Precipitation
- Temperature: 14°F to 122°F (36°F to 95°F preferred)
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

Perform Noise Measurements.

☐ Measure the background noise level at least once every 10 seconds for at least 15 minutes or until 100 measurements have been obtained.

☐ Warm up and stabilize the switcher locomotive or locomotive connected to the load cell. The switcher locomotive should be operating singly at maximum throttle.

☐ Measure and record the sound level of the switcher locomotive at a rate of at least once every 10 seconds until 100 measurements are obtained.

☐ Check for problems.
- If there was a change in load cell sound level greater than 10 dB(A), measurements must be repeated.

Perform post-measurement checks.

☐ Measure and record the background noise level.

☐ Measure and record a calibration tone.

☐ Document the environmental conditions.

Checklist B-6b: Data Processing for Receiving Property Measurements: Switcher Locomotives and Load Cell Test Stands

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment

☐ Compute the difference (ΔCal) in the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.

o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the exceedance percentile sound levels (L_{90}, L_{10}, L_{99})** for each event and each background noise measurement.

- From log sheets, instrument, or stored data.
- The L_{10} is the level exceeded by 10% of the measurements, equivalent to the statistical 90th percentile sound level or, out of 100 measurements, the 10th highest sound level.
- Similarly, the L90 is the level exceeded by 90% of the measurements, equivalent to the statistical 10th percentile sound level, or, out of 100 measurements, the 11th lowest sound level.
- The L99 is the level exceeded by 99% of the measurements, equivalent to the statistical 1st percentile sound level, or, out of 100 measurements, the 2nd lowest sound level.

☐ **Validate the noise source L_{90}.**

⊗ Calculate $L_{10} - L_{99}$. If this value is more than 4 dB(A), the measurement must not be used for compliance.

☐ **Verify that background noise did not contaminate the measurements.**

⊗ If L_{90} of the noise source is not at least 5 dB(A) more than the L_{90} of the background levels both before and after the event, the measurement must not be used for compliance.

☐ **Compare the maximum sound level for the event to the railroad noise level criteria:**

$L_{90} \leq 65$ dB(A) Switcher locomotive and load cell test stand

If two L_{90} measurements were collected due to a change in load cell sound level >10 dB(A), compare the L_{90} values:

- If the second value differs from the first by 10 dB(A) or more, then use the larger of the two measurements.
- If the second does not differ by at least 10 dB(A), then use the first.

2 dB(A) tolerance may be added to the compliance level.

☐ **Evaluate Compliance.**

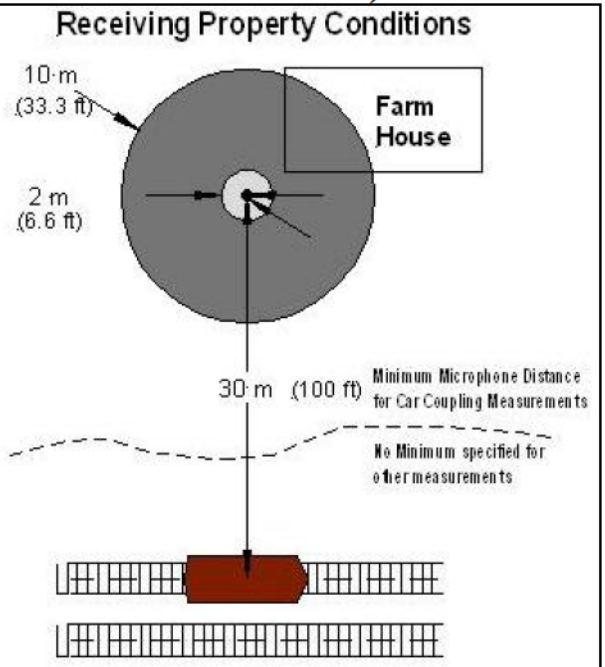
⊗ If the validated L_{90} is greater than 65 dB(A), then the sources are in violation.

o If a violation occurs, the following evaluation must take place:

1. Listen to the sound and attempt to determine the specific source and principal direction.
2. If the sound emanates from only stationary locomotives, including at least one switcher locomotive, then a violation of the 65 dB(A) criteria for these locomotives has occurred. As a result, fixed-site sideline measurements must be conducted for these locomotives.
3. If the sound emanates from only a locomotive load cell test stand and the locomotive being tested, then a violation of the 65 dB(A) criteria has occurred. The fixed-site sideline measurements must be attempted for this load cell and locomotive combination.
4. If the sound includes both a load cell test stand and at least one stationary switcher locomotive, then 3 dB(A) may be subtracted from the validated L_{90} before determining compliance with the 65 dB(A) criteria.

Checklist B-7a: Procedure for Receiving Property Measurements: Car Coupling and Retarders (40CFR Part 201.14 and 201.15)

Inspect the Test Site for Regulatory Compliance.



- ☐ The microphone must be at least 30 m from the nearest track where car-coupling occurs.
- ☐ The microphone is setup in a flat, open area, free of vertical surfaces over 1.2 m in height within 10 m of the microphone, as illustrated, EXCEPT:
  - Residential or commercial unit walls, or facility noise barriers, may be in closer proximity to the microphone, but still must be at least 2.0 m away from the microphone position.
  - If the receiving property measurements are near a farm home, then one of the outer walls of the farm house *must* be within 2.0 m to 10.0 m of the microphone.
- ☐ Document the measurement site layout (rail yard and receiving property); label the locations of the microphones, noise sources, and the approximate distance between each source and the microphone.

Setup the Noise Measurement Instrument.

- ☐ Mount the noise measurement instrument on a tripod (or hold at arm's length).
  - 30 m from the centerline of the track
  - 1.2 - 1.5 m above ground
  - Orient the microphone properly towards the rail yard location; usually grazing incidence.
- ☐ Verify the instrument settings:
  - A-weighting
  - Fast response
  - Maximum sound Level
- ☐ Calibrate the instrument (or verify calibration).
- ☐ Verify time synchronization - or document offset.
  - Instrument
  - Watch (or cell phone)
  - Laptop
- ☐ Place a windscreen over the microphone.

☐ **Confirm that the environmental conditions are within specified limits.**

- Wind speed: Sustained <12 mph, Gusts < 20 mph
- No Precipitation
- Temperature: 14°F to 122°F (36°F to 95°F preferred)
- Relative humidity: Follow manufacturers' instructions (generally 5% to 80%)

Perform Noise Measurements.

- ☐ Measure and record the maximum sound level of at least 30 consecutive car-coupling or retarder events over a period of at least 60 but not more than 240 minutes.
  - If it is not possible to measure 30 events in 240 minutes, repeat the measurement when events are expected to be more frequent. If this does not happen, then the rail yard is in compliance.

Perform Post-measurement checks.

- ☐ Measure and record a calibration tone.
- ☐ Document the environmental conditions.

Checklist B-7b: Data Processing Procedure for Receiving Property Measurements: Car Coupling and Retarders

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment.

☐ Compute the difference (ΔCal) in the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.

o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine maximum sound level** for each event.

- From log sheets, instrument, or stored data.

☐ **Calculate the $L_{adj\ ave\ max}$ from the individual noise measurements.**

$$L_{adj\ ave\ max} = L_{ave\ max} + C$$

L_{avemax} is the energy average of the individual L_{AFmx}.

$$L_{ave\,max} = 10\log_{10}\left(\frac{10^{L_{AFmx1}/10} + 10^{L_{AFmx2}/10} + \ldots + 10^{L_{AFmxn}/10}}{n}\right)$$

Where: $L_{AFmx1} \ldots L_{AFmxn}$ = the individual maximum sound levels and

n = total number of events.

C is the duration adjustment factor:

$$C = 10\log_{10}(n/T)$$

T = duration of the measurements [in minutes].

☐ **Compare the $L_{adj\ ave\ max}$ sound level for the events to the appropriate railroad noise level criteria.**

$L_{adj\ ave\ max} \leq 92$ dB(A)	Car Coupling
$L_{adj\ ave\ max} \leq 83$ dB(A)	Retarders

To account for the effects of variations in instrument tolerances, site topography, atmospheric conditions, reflected sound from small objects, and the common practice of reporting sound levels to the nearest decibel, 2 dB(A) tolerance may be added to the compliance level.

An additional 2 dB(A) tolerance may be added to the compliance level when using Type 2 Sound Measurement Instruments for car coupling events.

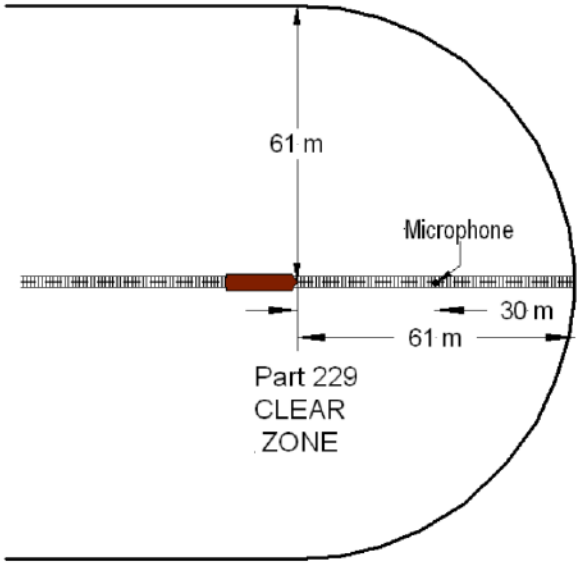
An additional 4 dB(A) tolerance may be added to the compliance level when using Type 2 Sound Measurement Instruments for retarder events.

☐ **Evaluate Compliance**

Checklist B-8a. Procedure for Audible Warning Device Measurements: Locomotive Horn and Wayside Horn (49CFR Part 229.129 and Part 222 Appendix E)

Inspect the test site for regulatory compliance.
Document specific non-compliant conditions.

- ☐ Free of large, reflecting objects in clear zone.
- ☐ *Where possible*, avoid:
  - measurement over water, snow covered ground, or high grass.
  - areas close to sources of electromagnetic interference.



Set up the Noise Measurement Instrument.

- ☐ Mount the noise measurement instrument on a tripod:
  - 30m from the front knuckle of the locomotive, at a position no greater than ±20º from the centerline of the track.
  - 1.2 m above ground for horns mounted on the front of the locomotive, or wayside horns.
  - 4.6 m above ground for horns mounted behind the locomotive cab.
  - Orient the microphone properly towards the horn.
- ☐ Verify the instrument settings:
  - A-weighting • Slow-response • Equivalent sound level, $L_{Aeq,}$ metric
- ☐ Calibrate the instrument (or verify calibration).
- ☐ Verify time synchronization - or document offset
  - Instrument • Watch (or cell phone) • Laptop
- ☐ Place a windscreen over the microphone.

☐ **Confirm clear noise measurement pathways.**

☐ **Wear hearing protection.**

☐ **Confirm that the environmental conditions are within specified limits.**

- Wind speed: Sustained <12 mph, Gusts < 20 mph • No Precipitation
- Temperature: 2°C to 35°C (36°F to 95°F)
- Relative humidity between 20% and 95%

Perform Noise Measurements.

- ☐ Measure background noise for 30 seconds - document the equivalent sound level (L_{Aeq}) if displayed by the instrument.
- ☐ Measure and record the horn sound level for 10 seconds.
- ☐ Document the equivalent sound level (L_{Aeq}), if displayed by the instrument, along with the time.
- ☐ Repeat for a total of 6 events.
  - *If a bi-directional horn is being tested, then the measurements must be conducted twice; once for each end of the locomotive.*

Perform Post-measurement checks

- ☐ Measure and record the background noise level – document the equivalent sound level (L_{Aeq}).
- ☐ Measure and record a calibration tone.
- ☐ Document the environmental conditions.

Checklist B-8b. Data Processing for Audible Warning Device Measurements

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment.

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

⊗ If ΔCal is more than ±0.5 dB, the measurements must not be used for compliance.

o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the equivalent sound level** for each event and each background noise measurement.

- From the log sheet, or
- Identify the timeframe of the event in the measured noise data and the sound levels within that 10-second measurement interval. Using a scientific calculator or spreadsheet, calculate the $L_{Aeq,\ 10s}$:

$$L_{AeqT} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

Where: N=number of 1-second samples (at least 10),

T= the duration of the measurement interval (in seconds),

and

L_{Ai}= the ith A=weighted sound pressure level (in dB(A)).

☐ **Calculate the algebraic average of the 6 horn measurements**.

☐ **Calculate the standard deviation of the 6 horn measurements,** using a spreadsheet or scientific calculator. (an example of this calculations can also be found in Appendix C).

☐ **Verify that background noise did not contaminate the measurements.**

⊗ The $L_{Aeq,\ 10s}$ for each event must be 10 dB(A) above the background L_{Aeq} measured both before and after the events.

☐ **Compare the average L_{Aeq} and standard deviation of the six events to the appropriate railroad noise level criteria.**

- Average locomotive horn L_{Aeq} greater than 96 dB(A) and less than 110 dB(A)
  Standard deviation ≤ 1.5 dB(A)
- Average wayside horn L_{Aeq} greater than 92 dB(A) and less than 110 dB(A)
  Standard deviation ≤ 1.5 dB(A)

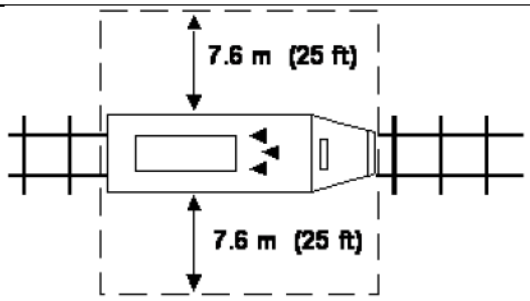
There is no tolerance allowance for these measurements in the regulations.

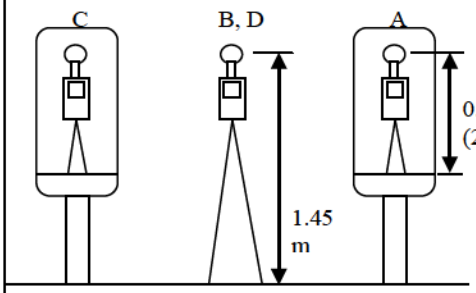
☐ **Evaluate Compliance.**

Checklist B-9a. Procedure for Locomotive Static In-Cab Measurements (49CFR Part 229.121)

☐ **Inspect the test site for regulatory compliance.**
Document specific non-compliant conditions.

- The site must be free of large, reflecting objects in the clear zone, 7.6 m to either side of the locomotive.
- The locomotive must not be on a site specifically designed to artificially lower in-cab noise levels, such as elevated track structures.
- Measurements may be conducted indoors, as long as the test area complies with the clear zone criteria.





Set up the Noise Measurement Instrument(s).

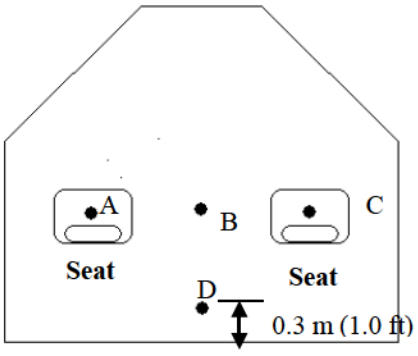
☐ Microphones must be positioned at four locations inside the locomotive cab. Measurements may be conducted by using four instruments simultaneously or one instrument moved from one location to the next.

Position A. 0.76 m (30 in) above the center of the left seat;

Position B. 1.45 m (56 in) above the floor in the center of the locomotive cab between the two seats;

Position C. 0.76 m (30 in) above the center of the right seat;

Position D. 1.45 m (56 in) above the floor, 0.3 m (12 in) from the center of the back interior wall of the locomotive cab.



Verify the instrument settings:

- A-weighting • Slow-response • $L_{Aeq,}$ metric

☐ Calibrate the instrument (or verify calibration).

☐ Verify time synchronization - or document offset.

- Instrument • Watch (or cell phone) • Laptop

☐ Place a windscreen over the microphone.

☐ Warm-up and stabilize locomotive at the highest horsepower or throttle setting.

☐ Clear all extra personnel out of the cab: only two people are permitted inside to operate the locomotive and measurement instruments.

☐ Close all windows, doors, and cabinet seals.

☐ Operate the HVAC system on high.

Perform Noise Measurements.

☐ Measure and record the sound level at each position for 30 seconds.

☐ Document the equivalent sound level (L_{Aeq}), if displayed by the instrument, along with the time.

☐ **Check for Problems**

- Extraneous noise from: adverse weather, other sources, locomotive operational problems.
- Measurements may be repeated after the problem has been resolved, but the failure and apparent reason for failure must be documented.

Perform Post-measurement checks

☐ Measure and record a calibration tone.

Checklist B-9b. Data Processing Locomotive Static In-Cab Measurements

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±0.5 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the equivalent sound level** for at each of the four microphone positions.

- From the log sheet, or
- Identify the timeframe of the event in the measured noise data and the sound levels within that 30-second measurement interval. Using a scientific calculator or spreadsheet, calculate the $L_{Aeq,\ 30s}$:

$$L_{AeqT} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

Where: N=number of 1-second samples (at least 30),
T= the duration of the measurement interval (in seconds), and
L_{Ai}= the ith A=weighted sound pressure level (in dB(A)).

☐ **Add a 3 dB(A) adjustment factor if the locomotive was not self-loading.**

☐ **For new locomotives, calculate the upper 99% confidence level across all locomotives tested:**

$$Upper\ 99\%\ CL = \left(\frac{1}{N}\sum_{i=1}^{N}L_i\right) + t\left(\sigma/\sqrt{N}\right)$$

Where: L_i = i-th sound level in the data set;
N = number of samples in a data set;
t = the critical value of the t-distribution for a 99% confidence interval (2.326 when the sample size is large); and
σ = standard deviation of the data set.

☐ **Compare the L_{Aeq} to the appropriate railroad noise level criteria.**

After maintenance or alterations:

- The highest of the four L_{Aeq} values must be:
  - < 82 dB(A) if the original (manufacturer-supplied) value was < 82 dB(A).
  - < 85 dB(A) if the original value was 82-85 dB(A).

New locomotives:

- The highest of the four LAeq values, averaged across all locomotives tested, must be <85 dB(A).
- The upper 99% confidence limit across all locomotives must be ≤ 87 dB(A).

There is no tolerance allowance for these measurements in the regulations.

☐ **Evaluate Compliance.**

If problems existed which cause a non compliant measurement, the measurements may be repeated under more desirable conditions.

Checklist B-10a. Procedure for Employee Sleeping Quarters Measurements: (49CFR Part 228)

Inspect and document the test site. *Document specific non-compliant conditions.*

☐ Noise levels in the railroad employee sleeping quarters should be measured only during the hours they are normally used (e.g., 10:00 PM to 6:00 AM).
- If the railroad employee sleeping quarters are used more than 8 hours a day, then multiple $L_{Aeq\ (8)}$ measurements should be performed to cover all hours of use.

☐ All windows must be closed.

☐ If possible, perform measurements while HVAC systems are both off and on.

Set up the Noise Measurement Instrument(s).

☐ The instrument(s) should be set up at the expected noisiest sleeping location inside the sleeping quarters.

☐ Mount the instrument on a tripod or other type of instrument stand, at a height that approximates the hearing zone of an off-duty employee at rest.

☐ Verify the instrument settings:
- A-weighting
- Slow-response
- Equivalent sound level, $L_{Aeq,}$ metric

☐ Calibrate the instrument (or verify calibration).

☐ Verify time synchronization - or document offset.
- Instrument
- Watch (or cell phone)
- Laptop

☐ Place a windscreen over the microphone.

Perform Noise Measurements.

☐ Measure at least 8 hours of representative noise in the employee sleeping quarters.

☐ If possible, observe measurements to document noise source information, specifically whether or not the source is under the railroad's control.

Perform Post-measurement checks.

☐ Measure and record a calibration tone.

Checklist B-10b. Employee Sleeping Quarters Measurements Data Processing

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) and after (Cal_{Final}) the event(s).

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ **Determine the equivalent sound level** for the 8-hour period.

- From the instrument display, or;
- Download the 1-second sound levels to a spreadsheet and calculate the $L_{Aeq(8)}$:

$$L_{AeqT} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N}10^{L_{Ai}/10}\right)$$

Where: N=number of 1-second samples,

T= the duration of the measurement interval (in seconds),

and

L_{Ai}= the ith A=weighted sound pressure level (in dB(A)).

- Remove any high-level, non-railroad sounds (horns, sirens, etc.) from the data in the spreadsheet before calculation.

☐ **Compare the $L_{Aeq(8)}$ to the appropriate railroad noise level criteria.**

$L_{Aeq(8)}$ must not exceed 55 dB(A) from sources under the railroad's control, exclusive of cooling, heating and ventilating equipment.

☐ **Evaluate Compliance.**

Checklist B-11a. Procedure for Personal Monitoring for Determining Occupational Exposure (49CFR Part 227)

☐ **Document the test location and conditions. (Locomotive number, location, windows open/closed, etc.)**

Set up the Noise Measurement Instrument.

☐ Verify the instrument settings:

- A-weighting
- Slow-response
- 8-hour Time Weighted Average, $L_{TWA(8)}$, metric
- 80 dB(A) threshold level
- 90 dB(A) criterion level
- 1-second sampling rate

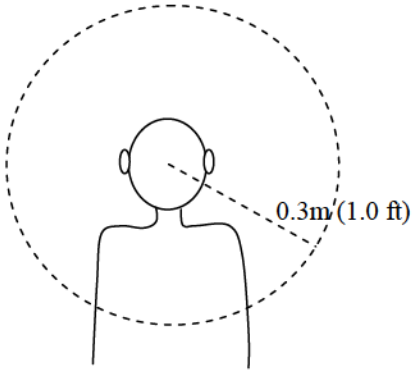
☐ Calibrate the instrument (or verify calibration). Record 10 seconds of the calibration tone.

☐ Verify time synchronization - or document offset.

- Instrument
- Watch (or cell phone)
- Laptop

☐ Place a windscreen over the microphone.

☐ Position the microphone in the employee's hearing zone, a sphere 2 ft in diameter around the employee's head.



☐ Ensure that the cable connecting the dosimeter body and microphone do not interfere with the employee's safety or performance.

Perform Noise Measurements.

☐ Monitor for the duration of the work shift.

☐ Document the source of sound levels over 115 dB(A), or instances where artifacts, such as brushing against the microphone or coughing, may cause readings over 115 dB(A). *(a second, handheld, noise measurement instrument may be helpful)*

☐ Periodically check the instrument over the course of the noise exposure monitoring to ensure that it is oriented and positioned properly.

Perform Post-measurement checks.

☐ Measure and record a calibration tone.

Checklist B-11b. Data Processing for Personal Monitoring to Determine Occupational Noise Exposure

Backup Data

☐ Save and/or download the data to memory or an external storage device.

☐ Make backup copies of the data and the corresponding log sheets at a convenient time.

Compute Calibration Adjustment.

☐ Compute the difference (ΔCal) between the sound level of the calibrations before ($Cal_{Initial}$) during, and after (Cal_{Final}) the monitoring.

$$\Delta Cal = Cal_{Final} - Cal_{Initial}$$

- ⊗ If ΔCal between any two consecutive calibrations is more than ±1.0 dB, the measurements must not be used for compliance.
- o If ΔCal is more than ±0.3 dB but less than or equal to ±1.0 dB, then the difference should be halved and subtracted from all the measured noise level(s) between these calibrations.

☐ Calculate the $L_{TWA(8)}$ metric. The instrument may have been setup ahead of time to automatically calculate either Dose (D) or $L_{TWA\ (8)}$.

- If necessary, convert dose measurements to $L_{TWA\ (8)}$.

$$\mathbf{L_{TWA(8)} = 16.61*\log_{10}(D/100) + 90}$$

Check for Problems

☐ Download the 1-second sound level data to a spreadsheet.

☐ Identify any instances in the data where the 1-second sound levels have exceed 115 dB(A), and identify probable causes based on log sheets.

- If the readings are caused by coughing, brushing against the microphone, etc., or if no cause can be identified, then these artifacts may be removed from the data, and the $L_{TWA(8)}$ may be re-calculated.
- Determine the number of 1-second samples where the sound level exceed 115 dB(A), not including the artifacts described above.

☐ **Compare the $L_{Aeq(8)}$ to the appropriate railroad noise level criteria.**

- $L_{Aeq(8)}$ must be < 90 dB(A)
- If $L_{Aeq(8)}$ is ≥85 dB(A), the employee must be included in the railroad's hearing conservation program.

☐ **Compare 1-second samples over 115 dB(A) to the criteria.**

- ⊗ 1-second sound levels over 120 dB(A) are not permitted
- ⊗ 1-second sound levels between 115 dB(A) and 120 dB(A) are not permitted for more than 5 seconds.

☐ **Evaluate Compliance.**

Appendix C: Data Analysis Calculations and Examples

This Appendix presents a series of step-by-step examples for performing the calculations discussed in this Handbook. First, examples are provided for calculating the various mathematical operations and noise metrics presented in Chapters 2 through 6 of this Handbook. Second, the calculations associated with the preliminary data processing procedures from are demonstrated. Third, examples of the regulation-specific data processing and analysis calculations are presented.

C.1. Mathematical Operations and Noise Metrics Examples

Calculating Sound Pressure Levels

First, the p_{rms} is calculated for a sound wave with known sound pressure amplitude of A = 10 Pa, using:

$$p_{rms} = {}^{A}/_{\sqrt{2}} = {}^{10}/_{\sqrt{2}}$$
$$= 7.071\ Pa$$

Next, the L is calculated using p_{ref} = 20 micro-Pa;

$$L = 10\log_{10}\left(\frac{p_{rms}^2}{p_{ref}^2}\right) = 10\log_{10}\left(\frac{7.071^2}{0.00002^2}\right)$$
$$= 10\log_{10}\left(\frac{50}{4\times10^{-10}}\right)$$
$$= 10\log_{10}\left(1.25\times10^{11}\right)$$
$$= 111\ dB$$

Adding Sound Levels - Logarithmic Addition

Example 1: Given two sound pressure levels each at 60 dB, they are added together using:

$$L_{total} = 10\log_{10}\left(\frac{p_{total}^2}{p_{ref}^2}\right) = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10}\right)$$
$$= 10\log_{10}\left(10^{60/10} + 10^{60/10}\right)$$
$$= 10\log_{10}\left(2\times10^{6}\right)$$
$$= 63\ dB$$

Example 2: Given L_1 = 40 dB, L_2 = 50 dB, L_3 = 60 dB, L_4 = 70 dB, L_5 = 80 dB, L_{total} is calculated using:

$$L_{total} = 10\log_{10}\left(\frac{p_{total}^2}{p_{ref}^2}\right) = 10\log_{10}\left(10^{L_1/10} + 10^{L_2/10} + 10^{L_3/10} + 10^{L_4/10} + 10^{L_5/10}\right)$$
$$= 10\log_{10}\left(10^{40/10} + 10^{50/10} + 10^{60/10} + 10^{70/10} + 10^{80/10}\right)$$
$$= 10\log_{10}\left(111.11 \times 10^6\right)$$
$$= 80.5\ dB$$

Subtracting Sound Levels - Logarithmic Subtraction

Given L_1 = 63 dB(A)and L_2 = 60 dB, the two levels can be logarithmically subtracted:

$$L_{total} = 10\log_{10}\left(\frac{p_{total}^2}{p_{ref}^2}\right) = 10\log_{10}\left(10^{L_1/10} - 10^{L_2/10}\right)$$
$$= 10\log_{10}\left(10^{63/10} - 10^{60/10}\right)$$
$$= 10\log_{10}\left(0.995 \times 10^6\right)$$
$$= 60\ dB$$

Algebraic Averaging of Sound Levels

The algebraic average of three sound pressure levels (L_1 = 50 dB, L_2 = 60 dB, and L_3 = 70 dB) is calculated using:

$$L_{ave} = \frac{L_1 + L_2 + L_3}{3} = \frac{50 + 60 + 70}{3}$$
$$= 60\ dB$$

Energy Averaging of Sound Levels

The energy average of three sound pressure levels (L_1 = 50 dB, L_2 = 60 dB, and L_3 = 70 dB) is calculated using:

$$L_{ave} = 10\log_{10}\left(\frac{p_{ave}^2}{p_{ref}^2}\right) = 10\log_{10}\left(\frac{10^{L_1/10} + 10^{L_2/10} + 10^{L_3/10}}{3}\right)$$
$$= 10\log_{10}\left(\frac{10^{50/10} + 10^{60/10} + 10^{70/10}}{3}\right)$$
$$= 10\log_{10}\left(\frac{11.1 \times 10^6}{3}\right)$$
$$= 65.7\ dB$$

Calculating A-weighted Sound Pressure Levels from Un-weighted Spectral Data

First, the corresponding A-weighting adjustment factor from Table 19 should be arithmetically added to each un-weighted, octave frequency band pressure level [in dB], to produce the A-weighted band pressure level [in dB(A)] (see Table 22).

Table 22. Application of A-Weighting to Un-Weighted Octave Noise Data

Frequency [Hz]	Un-Weighted Band Pressure Level [dB]	+	A-Weighting Adjustment Factor [dB]	=	A-Weighted Band Pressure Level [dB(A)]
16	80	+	-56.7	=	23.3
31.5	80	+	-39.4	=	40.6
63	80	+	-26.2	=	53.8
125	80	+	-16.1	=	63.9
250	80	+	-8.6	=	71.4
500	80	+	-3.2	=	76.8
1000	80	+	0	=	80
2000	80	+	1.2	=	81.2
4000	80	+	1	=	81
8000	80	+	-1.1	=	78.9
16000	80	+	-6.6	=	73.4

The A-weighted, octave-band pressure levels are then used to calculate the A-weighted sound pressure level using logarithmic addition:

$$L_A = 10\log_{10}\left(\sum_{i=0}^{N-1} 10^{L_{Af\,(12+3i)}/10}\right)$$

$$= 10\log_{10}\left(\begin{array}{l} 10^{23.3/10} + 10^{40.6/10} + 10^{53.8/10} + 10^{63.9/10} + 10^{71.4/10} + \ldots \\ \ldots + 10^{76.8/10} + 10^{80/10} + 10^{81.2/10} + 10^{81/10} + 10^{78.9/10} + 10^{73.4/10} \end{array}\right)$$

$$= 10\log_{10}\left(5.2 \times 10^{8}\right)$$

$$= 87.2\ dB(A)$$

This process can also be applied to one-third octave-band data.

Calculating L_{Aeq} (A-Weighted Equivalent Sound Pressure Level)

Given A-weighted sound pressure levels collected once a second for thirty seconds resulting in:

1 second at 95 dB(A),

4 seconds at 87 dB(A),

10 seconds at 75 dB(A),

13 seconds at 62 dB(A), and

2 seconds at 55 dB(A),

The $L_{Aeq,30s}$ may be calculated using:

$$L_{Aeq\ 30s} = 10\log_{10}\left(\frac{1}{T}\sum_{i=1}^{N} t_i \times 10^{L_{Ai}/10}\right)$$
$$= 10\log_{10}\left(\frac{1}{30}\left[10^{95/10} + \left(4\times 10^{87/10}\right) + \left(10\times 10^{75/10}\right) + \left(13\times 10^{62/10}\right) + \left(2\times 10^{55/10}\right)\right]\right)$$
$$= 10\log_{10}\left(\frac{1}{30}\left[5.505\times 10^{9}\right]\right)$$
$$= 82.6\ dB(A)$$

Calculating $L_{TWA(8)}$ (Eight-Hour Time-Weighted Average)

A known percentage noise dose (D = 95%) may be converted to $L_{TWA\ (8)}$.

$$L_{TWA(8)} = 16.61\times\log_{10}(D/100) + 90$$
$$= 16.61\times\log_{10}(95/100) + 90$$
$$= 16.61\times(-0.0223) + 90$$
$$= 89.6 \quad \text{dB(A)}$$

C.2. Preliminary Data Processing Examples

Performing Calibration Adjustments

In Chapter 3, the adjustment of the measured noise data for change calibration levels between the initial and final calibration is discussed. If the change in calibration level over the course of the measurements is less than 0.3 dB, then no calibration adjustment is needed, and if that change is greater than 1.0 dB, then the noise measurement data affected by the calibration is invalid. However, if the calibration drift is between 0.3 dB(A)and 1.0 dB(A), then the measured sound pressure levels should be adjusted for this difference. Given the following measured sound pressure levels:

Railroad Event Sound Pressure Levels, L_1 = 80 dB(A) for 15 seconds, and
L_2 = 75 dB(A) for 15 seconds,

Initial Calibration Level, $Cal_{initial}$ = 114.0 dB(A), and

Finial Calibration Level, Cal_{final} = 114.6 dB(A),

the calibration adjustment may be applied to the railroad sound pressure levels using:

$$L_{i\_adj.} = L_i - \left(\frac{CAL_{initial} - CAL_{final}}{2}\right)$$

$$L_{1\_adj.} = 80 - \left(\frac{114.0 - 114.6}{2}\right) \qquad L_{2\_adj.} = 75 - \left(\frac{114.0 - 114.6}{2}\right)$$

$$L_{1\_adj.} = 80.3\text{dB(A)} \qquad L_{2\_adj.} = 75.3\text{dB(A)}$$

After the calibration adjustment has been applied to the measured noise data, then the adjusted data may be used to calculate the appropriate regulation-specific noise metric.

C.3. Regulation Specific Data Processing Examples

This section of Appendix C deals with data processing examples for specific FRA noise regulations. In several instances, the data processing and analysis procedures and examples are sufficiently covered in Chapters 3-6 and in Section C.2. of this Appendix, and do not require further explanation or examples here. However, detailed examples will be presented for the remainder of the analysis procedures.

Processing Receiving Property Noise Data for Stationary Switcher Locomotives and Load Cell Test Stands

Assuming that L_{10}, L_{90}, and L_{99} values are either calculated automatically by the acoustic instrumentation, are determined using spread-sheet sorting techniques, or are manually determined using the log sheets (Figure 16), the following information is given:

Switcher Locomotive Noise

L_{10} = 66 dB(A),

L_{90} = 64 dB(A), and

L_{99} = 63 dB(A)

Background Noise

Initial $L_{90,\ background\ i}$ = 42 dB(A), and

Final $L_{90,\ background\ f}$ = 43 dB(A).

The L_{90} for the switcher noise is "validated":

Is L_{10}-L_{99}<=4 dB(A)?

{66-63=3dB(A)} – Yes.

Therefore, the L_{90} for the switcher locomotive receiving property measurements is considered "validated". Next, this "validated" L_{90} must be compared to $L_{90,\ background\ i}$ and $L_{90,\ background\ f}$:

Is "validated" $L_{90} - L_{90,background\ I} > 5$dB

And "validated" $L_{90} - L_{90,background\ f} > 5$dB?

64-42=22 – Yes.

64-43=21 – Yes.

In this case, the "validated" L_{90} meets the background noise criteria, and this metric may now be used to evaluate compliance with 40 CFR Part 201.11 and Part 201.12.

Load cell test stand noise processing procedures present a variation to the normal processing procedure, for instances when the noise generated by the load cell test stand is observed to change by 10 dB(A)or more during the noise measurements. For example:

A measurement of $L_{90,\ 1}$ = 52 dB(A) was made for a locomotive load cell test stand, but a large change in sound pressure levels (more than 10 dB) was observed during the measurements and attributed to the load cell test stand. Therefore, a second a second set of noise data was collected, resulting in $L_{90,\ 2}$ = 66 dB(A). Therefore, the data set containing the larger of the two values (the second data set containing $L_{90,\ 2}$ in this example) will be used for the remainder of the data processing.

Processing Receiving Property Noise Data for Car Coupling Impacts*

Car-coupling impact noise measurements require collected L_{AFmx} noise data for a minimum of 30 consecutive car-coupling events, so for the purpose of this example, it is given that 30 car-coupling events (N) took place within 75 minutes (T) and resulted in;

$L_{AFmx\ 1}$ through $L_{AFmx\ 10}$ = 85 dB(A),

$L_{AFmx\ 11}$ through $L_{AFmx\ 20}$ = 80 dB(A),

$L_{AFmx\ 21}$ through $L_{AFmx\ 23}$ = 97 dB(A), and

$L_{AFmx\ 24}$ through $L_{AFmx\ 30}$ = 75 dB(A).

First, the noise data is energy averaged to yield $L_{ave\ max}$;

$$L_{ave\ \max} = 10\log_{10}\left(\frac{p_{ave}^2}{p_{ref}^2}\right) = 10\log_{10}\left(\frac{1}{N}\sum_{i=1}^{N}10^{L_{AFmx\,i}/10}\right)$$

$$= 10\log_{10}\left(\frac{\left(10\times10^{85/10}\right)+\left(10\times10^{80/10}\right)+\left(3\times10^{97/10}\right)+\left(7\times10^{75/10}\right)}{30}\right)$$

$$= 10\log_{10}\left(\frac{1.94\times10^{10}}{30}\right)$$

$$= 88.1\ dB(A)$$

Since 30 car-coupling events took place in 75 minutes, n/T = 30/75 = 0.4, which is used to calculate the car-coupling adjustment factor, C:

$$C = 10\log_{10}\left(\frac{n}{T}\right) = 10\log_{10}(0.4)$$

$$= -4.0\ dB$$

This adjustment factor is added to $L_{ave\ max}$ to calculate $L_{adj\ ave\ max}$;

$$L_{adj\ ave\ max} = L_{ave\ max} + C$$

$$= 88.1 - 4.0$$

$$= 84.1\ dB(A)$$

This $L_{adj\ ave\ max}$ is used for determining compliance with 40 CFR Part 201.15.

Processing Locomotive Horn Noise Data†

The six data sets of locomotive horn noise collected using the measurement procedure presented in Section 1 should be used to compute a separate $L_{Aeq,\ 10s}$ value, if it was not calculated automatically by the acoustic instrumentation. For this example, assume this procedure generated the following six $L_{Aeq,\ 10s}$ values;

* This example is also valid for evaluating retarder noise measured at receiving property locations.
† This example is also valid for evaluating wayside horn noise.

$L_{Aeq,\ 10s\ 1}$ = 111 dB(A),

$L_{Aeq,\ 10s\ 2}$ = 114 dB(A),

$L_{Aeq,\ 10s\ 3}$ = 108 dB(A),

$L_{Aeq,\ 10s\ 4}$ = 98 dB(A),

$L_{Aeq,\ 10s\ 5}$ = 94 dB(A), and

$L_{Aeq,\ 10s\ 6}$ = 103 dB(A).

These six values are algebraically averaged:

$$\text{Average } L_{Aeq,\ 10s} = (111+114+108+98+94+103)/6$$
$$= 104.7 \text{ dB(A)}$$

The data should then be used to calculate the standard deviation (σ) of the horn noise data;

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} L_i - \left(\frac{1}{N}\sum_{i=1}^{N} L_i\right)}{N-1}}$$
$$= \sqrt{\frac{\sum_{i=1}^{6} L_{Aeq,10si} - \left(\frac{1}{6}\sum_{i=1}^{6} L_{Aeq10si}\right)}{6-1}}$$
$$= \sqrt{\frac{628-104.7}{5}}$$
$$= 10.2\ dB$$

Although the average $L_{Aeq,\ 10s}$ was within the desired operational range specified by 49 CFR Part 229.129, the standard deviation was too large (maximum σ = 1.5 dB). Therefore, the locomotive horn was not in compliance with the FRA regulation, and the performance should be investigated before it is retested.

Processing Railroad Employee Personal Noise Exposure Data

For a locomotive employee, the following noise exposure levels and corresponding durations are given for an 8 hour work shift;

L_1 = 88 dB(A) for 2 hours,

L_2 = 65 dB(A) for 4 hours,

L_3 = 95 dB(A) for 1 hour,

L_4 = 104 dB(A) for 59 minutes and 56 seconds (0.99889 hours), and

L_5 = 118 dB(A) for 4 seconds (0.00111 hours),

$L_{TWA(8)}$ can be calculated from the collected noise exposure data, using Equation 23.

$$L_{TWA(8)} = 16.61 \times \log_{10}\left(\frac{1}{T_c}\sum_{i=1}^{N} T_i \times 2^{L_i/\ 5}\right)$$

Equation 1

where N = number of samples/tasks;

T_i = measurement duration which corresponds to the measurement resulting in L_i [in hours];

T_c = criterion duration [in hours] (i.e.: 8 hours); and

L_i = A-weighted sound pressure level (above the 80 dB(A) threshold level only).

$$L_{TWA(8)} = 16.61 \times \log_{10}\left(\frac{1}{8}\left[\begin{matrix}\left(2X2^{88/5}\right)+\left(4X2^{65/5}\right)+\left(1X2^{95/5}\right)\\ +\left(0.99889X2^{104/5}\right)+\left(0.00111X2^{118/5}\right)\end{matrix}\right]\right)$$

$$= 16.61 \times \log_{10}\left(\frac{1}{8}\left[2.79 \times 10^{6}\right]\right)$$

$$= 92.1 \quad dB(A)$$

Even though there was less than 5 seconds of exposure to noises between 115 dB(A) and 120 dB(A), the overall noise exposure was larger than 90 dB(A). Therefore, this monitored employee was not in compliance with 49 CFR Part 227.

Processing Railroad Employee Sleeping Quarters Noise Data

Given the following data set:

L_1 = 48 dB(A) for 2 hours,

L_2 = 56 dB(A) for 4 hours, and

L_3 = 45 dB(A) for 2 hours.

$L_{Aeq\,(8)}$ is calculated:

$$L_{Aeq\,(8)} = 10\log_{10}\left(\frac{1}{8}\sum_{i=1}^{N} t_i \times 10^{L_{Ai}/10}\right)$$

$$= 10\log_{10}\left(\frac{1}{8}\left[\left(2 \times 10^{48/10}\right)+\left(4 \times 10^{56/10}\right)+\left(2 \times 10^{45/10}\right)\right]\right)$$

$$= 10\log_{10}\left(\frac{1.78 \times 10^{6}}{8}\right)$$

$$= 53.5\ dB(A)$$

$L_{Aeq\,(8)}$ may be used for determining compliance with 49 CFR Part 228.

Processing Locomotive Cab Noise Data

Example 1, Single locomotive: A locomotive, who's original manufacturer's average level was 80 dB(A), is now having its in-cab noise levels retested after some repairs. The noise measurements produced the following sound pressure levels for the data set at measurement position A under no-load conditions;

$L_{Aeq,\,A}$ = 81.4 dB(A) for 10 seconds,

$L_{Aeq\,B}$ = 81.7 dB(A),

$L_{Aeq\,C}$ = 80.9 dB(A), and

$L_{Aeq\,D}$ = 82.9 dB(A).

Since $L_{Aeq\,D}$ is the maximum of these four values, it is used for compliance with 49 CFR Part 229.121 (b). Although $L_{Aeq\,D}$ is less than 85 dB(A), the original manufacturer's average locomotive cab noise level was 80 dB(A), which requires L_{Aeq} to be less than 82 dB(A). Therefore, the locomotive is not in compliance with the FRA regulation, and the source of that noise problem needs to be investigated.

Example 2, multiple locomotives from a new model line: Given 250 newly constructed locomotives, the maximum L_{Aeq} values for each locomotive in the line are listed below;

$L_{Aeq\,1}$ through $L_{Aeq\,100}$ = 75 dB(A),

$L_{Aeq\,101}$ through $L_{Aeq\,175}$ = 83 dB(A),

$L_{Aeq\,176}$ through $L_{Aeq\,198}$ = 87 dB(A),

$L_{Aeq\,199}$ through $L_{Aeq\,200}$ = 89 dB(A),

$L_{Aeq\,201}$ through $L_{Aeq\,240}$ = 85 dB(A), and

$L_{Aeq\,241}$ through $L_{Aeq\,250}$ = 77 dB(A).

The average L_{av} for the entire line is calculated using algebraic averaging;

Average <LAeq = (100*75 + 75*83 + 22*87 + 2*89 + 40*85 + 10*77)/250

= 80.0 dB(A)

Next, the standard deviation (σ) of the L_{Aeq} values should be calculated;

$$\sigma = \sqrt{\frac{\left(\sum_{i=1}^{N} L_i\right) - \left(\frac{1}{N}\sum_{i=1}^{N} L_i\right)}{N-1}}$$

$$= \sqrt{\frac{\left(\sum_{i=1}^{250} L_{av\,i}\right) - \left(\frac{1}{250}\sum_{i=1}^{250} L_{av\,i}\right)}{250-1}}$$

$$= \sqrt{\frac{(19987) - (80)}{249}}$$

$$= 8.9\ dB$$

Once the standard deviation has been determined, the upper 99% confidence interval is calculated, where t, the critical value of the t-distribution for a 99% confidence level and N=250 is 2.326;

$$\boldsymbol{Upper99\%CL = t\left(\frac{\sigma}{\sqrt{N}}\right)}$$

$$\boldsymbol{= 2.326\left(\frac{8.9}{\sqrt{250}}\right)}$$

$$\boldsymbol{= 1.32\ dB}$$

From here, the upper 99% confidence limit is calculated;

$$\begin{aligned} {}_{Upper}\ 99\%\ CL &= L + {}_{Upper}\ 99\%\ CI \\ &= 80.0 + 1.32 \\ &= 81.32\ dB(A) \end{aligned}$$

Therefore, the locomotive model line is in compliance with 49 CFR Part 229.121 (a), because the average in-cab L_{Aeq} for the line is less than 85 dB(A) with an upper 99% confidence limit less than 87 dB(A).

Calculating Estimated Noise Exposure with Hearing Protection

Given the sound pressure level in the workplace of 108 dB(A), the estimated noise exposure of a railroad employee utilizing hearing protection with a noise reduction rating of 15 is calculated as follows:

LHP = LA – (NRR – 7 dB)

=108-(15-7)

=100 dB(A)

If the hearing protection was being used as part of a hearing conservation program to reduce a railroad employee's personal noise exposure to 90 dB(A) over an eight hour long workday, then these hearing protectors are insufficient. The hearing protectors would need to have a NNR value greater than or equal to 25, in order to satisfy the conditions in 49 CFR Part 227 in this specific work environment.

Appendix D: Railroad Noise Regulations

This Appendix presents all of the railroad noise regulations referenced in this Handbook in their entirety. The regulations are updated on a regular basis; the regulations and any updates can be found in most libraries and online at www.gpoaccess.gov. The following noise regulations are presented in this Appendix:

(1) 40 CFR Part 201 - Noise Emission Standards for Transportation Equipment; Interstate Rail Carriers;

(2) 49 CFR Part 210 - Railroad Noise Emission Compliance Regulations;

(3) 49 CFR Parts 222 and 229.129 - Use of Locomotive Horns at Highway-Rail Grade Crossings;

(4) 49 CFR Part 227 - Occupational Noise Exposure for Railroad Operating Employees; and

(5) 49 CFR Part 228 - Hours of Service of Railroad Employees.

SUBCHAPTER G—NOISE ABATEMENT PROGRAMS

PART 201—NOISE EMISSION STANDARDS FOR TRANSPORTATION EQUIPMENT; INTERSTATE RAIL CARRIERS

Subpart A—General Provisions

Subpart B—Interstate Rail Carrier Operations Standards

Subpart C—Measurement Criteria

AUTHORITY: Noise Control Act of 1972, sec. 17(a), 86 Stat. 1234 (42 U.S.C. 4916(a)).

SOURCE: 45 FR 1263, Jan. 4, 1980, unless otherwise noted.

Subpart A—General Provisions

§ 201.1 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them in the Act:

(a) *Act* means the Noise Control Act of 1972 (Pub. L. 92–574, 86 Stat. 1234).

(b) *Car Coupling Sound* means a sound which is heard and identified by the observer as that of car coupling impact, and that causes a sound level meter indicator (FAST) to register an increase of at least ten decibels above the level observed immediately before hearing the sound.

(c) *Carrier* means a common carrier by railroad, or partly by railroad and partly by water, within the continental United States, subject to the Interstate Commerce Act, as amended, excluding street, suburban, and interurban electric railways unless operated as a part of a general railroad system of transportation.

(d) *Classification of Railroads* means the division of railroad industry operating companies by the Interstate Commerce Commission into three categories. As of 1978, Class I railroads must have annual revenues of $50 million or greater, Class II railroads must have annual revenues of between $10 and $50 million, and Class III railroads must have less than $10 million in annual revenues.

(e) *Commercial Property* means any property that is normally accessible to the public and that is used for any of the purposes described in the following standard land use codes (reference *Standard Land Use Coding Manual*. U.S. DOT/FHWA, reprinted March 1977): 53–59, Retail Trade; 61–64, Finance, Insurance, Real Estate, Personal, Business and Repair Services; 652–659, Legal and other professional services; 671, 672, and 673 Governmental Services; 692 and 699, Welfare, Charitable and Other Miscellaneous Services; 712 and 719, Nature exhibitions and other Cultural Activities; 721, 723, and 729, Entertainment, Public and other Public Assembly; and

74–79, Recreational, Resort, Park and other Cultural Activities.

(f) *dB(A)* is an abbreviation meaning A-weighted sound level in decibels, reference: 20 micropascals.

(g) *Day-night Sound Level* means the 24-hour time of day weighted equivalent sound level, in decibels, for any continuous 24-hour period, obtained after addition of ten decibels to sound levels produced in the hours from 10 p.m. to 7 a.m. (2200–0700). It is abbreviated as L_{dn}.

(h) *Decibel* means the unit measure of sound level, abbreviated as dB.

(i) *Energy Average Level* means a quantity calculated by taking ten times the common logarithm of the arithmetic average of the antilogs of one-tenth of each of the levels being averaged. The levels may be of any consistent type, e.g. maximum sound levels, sound exposure levels, and day-night sound levels.

(j) *Energy Summation of Levels* means a quantity calculated by taking ten times the common logarithm of the sum of the antilogs of one-tenth of each of the levels being summed. The levels may be of any consistent type, e.g., day-night sound level or equivalent sound level.

(k) *Equivalent Sound Level* means the level, in decibels, of the mean-square A-weighted sound pressure during a stated time period, with reference to the square of the standard reference sound pressure of 20 micropascals. It is the level of the sound exposure divided by the time period and is abbreviated as L_{eq}.

(l) *Fast Meter Response* means that the ''fast'' response of the sound level meter shall be used. The fast dynamic response shall comply with the meter dynamic characteristics in paragraph 5.3 of the American National Standard Specification for Sound Level Meters. ANSI S1.4–1971. This publication is available from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

(m) *Idle* means that condition where all engines capable of providing motive power to the locomotive are set at the lowest operating throttle position; and where all auxiliary non-motive power engines are not operating.

(n) *Interstate Commerce* means the commerce between any place in a State and any place in another State, or between places in the same State through another State, whether such commerce moves wholly by rail or partly by rail and partly by motor vehicle, express, or water. This definition of ''interstate commerce'' for purposes of this regulation is similar to the definition of ''interstate commerce'' in section 203(a) of the Interstate Commerce Act (49 U.S.C. 303(a)).

(o) *Load Cell* means a device external to the locomotive, of high electrical resistance, used in locomotive testing to simulate engine loading while the locomotive is stationary. (Electrical energy produced by the diesel generator is dissipated in the load cell resistors instead of the traction motors).

(p) *Locomotive* means for the purpose of this regulation, a self-propelled vehicle designed for and used on railroad tracks in the transport or rail cars, including self-propelled rail passenger vehicles.

(q) *Locomotive Load Cell Test Stand* means the load cell §201.1(o) and associated structure, equipment, trackage and locomotive being tested.

(r) *Maximum Sound Level* means the greatest A-weighted sound level in decibels measured during the designated time interval or during the event, with either fast meter response §201.1(l) or slow meter response §201.1(ii) as specified. It is abbreviated as L_{max}.

(s) *Measurement Period* means a continuous period of time during which noise of railroad yard operations is assessed, the beginning and finishing times of which may be selected after completion of the measurements.

(t) *Rail Car* means a non-self-propelled vehicle designed for and used on railroad tracks.

(u) *Railroad* means all the roads in use by any common carrier operating a railroad, whether owned or operated under a contract, agreement, or lease.

(v) *Receiving Property Measurement Location* means a location on receiving property that is on or beyond the railroad facility boundary and that meets the receiving property measurement location criteria of subpart C.

(w) *Receiving Property* means any residential or commercial property that receives the sound from railroad facility operations, but that is not owned or operated by a railroad; except that occupied residences located on property owned or controlled by the railroad are included in the definition of ''receiving property.'' For purposes of this definition railroad crew sleeping quarters located on property owned or controlled by the railroad are not considered as residences. If, subsequent to the publication date of these regulations, the use of any property that is currently not applicable to this regulation changes, and it is newly classified as either residential or commercial, it is not receiving property until four years have elapsed from the date of the actual change in use.

(x) *Residential Property* means any property that is used for any of the purposes described in the following standard land use codes (ref. *Standard Land Use Coding Manual*. U.S. DOT/FHWA Washington, DC, reprinted March 1977): 1, Residential: 651, Medical and other Health Services; 68, Educational Services; 691, Religious Activities; and 711, Cultural Activities.

(y) *Retarder (Active)* means a device or system for decelerating rolling rail cars and controlling the degree of deceleration on a car by car basis.

(z) *Retarder Sound* means a sound which is heard and identified by the observer as that of a retarder, and that causes a sound level meter indicator at fast meter response §201.1(l) to register an increase of at least ten decibels above the level observed immediately before hearing the sound.

(aa) *Sound Level* means the level, in decibels, measured by instrumentation which satisfies the requirements of American National Standard Specification for Sound Level Meters S1.4–1971 Type 1 (or S1A) or Type 2 if adjusted as shown in Table 1. This publication is available from the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018. For the purpose of these procedures the sound level is to be measured using the Aweighting of spectrum and either the FAST or SLOW dynamic averaging characteristics, as designated. It is abbreviated as L_A.

(bb) *Sound Exposure Level* means the level in decibels calculated as ten times the common logarithm of time integral of squared A-weighted sound pressure over a given time period or event divided by the square of the standard reference sound pressure of 20 micropascals and a reference duration of one second.

(cc) *Sound Pressure Level* (in stated frequency band) means the level, in decibels, calculated as 20 times the common logarithm of the ratio of a sound pressure to the reference sound pressure of 20 micropascals.

(dd) *Special Purpose Equipment* means maintenance-of-way equipment which may be located on or operated from rail cars including: Ballast cribbing machines, ballast regulators, conditioners and scarifiers, bolt machines, brush cutters, compactors, concrete mixers, cranes and derricks, earth boring machines, electric welding machines, grinders, grouters, pile drivers, rail heaters, rail layers, sandblasters, snow plows, spike drivers, sprayers and other types of such maintenance-of-way equipment.

(ee) *Special Track Work* means track other than normal tie and ballast bolted or welded rail or containing devices such as retarders or switching mechanisms.

(ff) *Statistical Sound Level* means the level in decibels that is exceeded in a stated percentage (x) of the duration of the measurement period. It is abbreviated as L_x.

(gg) *Switcher Locomotive* means any locomotive designated as a switcher by the builder or reported to the ICC as a switcher by the operator-owning-railroad and including, but not limited to, all locomotives of the builder/model designations listed in Appendix A to this subpart.

(hh) *Warning Device* means a sound emitting device used to alert and warn people of the presence of railroad equipment.

(ii) *Slow Meter Response* means that the slow response of the sound level meter shall be used. The slow dynamic response shall comply with the meter dynamic characteristics in paragraph 5.4 of the American National Standard Specification for Sound Level Meters. ANSI S1.4–1971. This publication is

available from the American National Standards Institute Inc., 1430 Broadway, New York, New York 10018.

[45 FR 1263, Jan. 4, 1980, as amended at 47 FR 14709, Apr. 6, 1982]

APPENDIX A TO SUBPART A OF PART 201—SWITCHER LOCOMOTIVES

[The following locomotives are considered to be "switcher locomotives" under the general definition of this regulation]

Type	Engine
General Electric Co.	
44 ton	8–D17000(2).
70 ton	6–CBFWL–6T.
95 ton	6–CBFWL–6T.
Electromotive Division (GMC)	
SC	8–201A.
NC	12–201A.
NC1	12–201A.
NC2	12–201A.
NW	12–201A.
NW1	12–201A.
NW1A	12–201A.
NW2	12–567.
NW2	12–567A.
NW3	12–567.
NW4	12–201A.
NW5	12–567B.
SW	8–201A/6–567.
SW1	6–567A/AC.
SW2	6–567.
SW3	6–567.
SW600	6–567C.
SW7	12–567A.
SW8	8–567B/BC.
SW900	8–567B.
SW9	12–567B/BC/C.
SW1200	12–567C.
SW1000	8–645E.
SW1001	8–645E.
SW1500	12–645E.
MP15	12–645E.
MP15AC	12–645E.
GMD1	12–567C.
RS1325	12–567C.
Transfer Switcher including "Cow and Calf"	
T	12–201A(2)
TR	12–567(2)
TR1	16–567(2)
TR2	12–567A(2)
TR3	12–567(3)
TR4	12–567A(2)
TR5	12–567B(2)
TR6	8–567B(2)
Baldwin	
VO–660	6–VO.
DS–446	6–606NA.
DS4475	6–750.
S–8	6–606.
VO–1000	8–VO.
DS–4410	8–608NA.
DS–4410	6–606SC.
S–12	6–606A.
DRS–4410 [1]	6–606SC.
DRS–12 [1]	6–606A.

[The following locomotives are considered to be "switcher locomotives" under the general definition of this regulation]

Type	Engine
Fairbanks Morse	
H–10–44	6–OP.
H–12–44	6–OP.
H–12–44TS	6–OP.
H–12–46 [1]	6–OP.
Lima	
750 hp.	6–Hamilton.
800 hp.	6–Hamilton.
1000 hp.	8–Hamilton.
1200 hp.	8–Hamilton.
LRS [1]	8–Hamilton.
TL [1]	8–Hamilton (2).
ALCO and MLW	
S1	6–539NA.
S2	6–539T.
S3	6–539NA.
S4	6–539T.
S5	6–251.
S6	6–251A,B.
S7	6–539.
S10	6–539.
S11	6–539.
S12	6–539T.
S13	6–251C.
RSD–1	6–539.
RSC–13	6–539.
RSC–24	12–244
RS1	6–539T.
RS2 [1]	12–244.
RS3 [1]	12–244.
RS10 [1]	12–244.
RSC–2 [1]	12–244.
RS3 [1]	12–244.
RSD–4 [1]	12–244.
RSD–5 [1]	12–244.
T6	6–251B.
C–415 [1]	8–251F.
M–420TR	12–251.

[1] These models may be found assigned to road service as well as switcher service, but are considered switcher locomotives for the purpose of this regulation.

Subpart B—Interstate Rail Carrier Operations Standards

§ 201.10 Applicability.

The provisions of this subpart apply to all rail cars and all locomotives, except steam locomotives, operated or controlled by carriers as defined in subpart A of this part, except that § 201.11 (a), (b), and (c) do not apply to gas turbine-powered locomotives and to any locomotive type which cannot be connected by any standard method to a load cell. They apply to the total sound level emitted by rail cars and locomotives operated under the conditions specified, including the sound produced by refrigeration and air conditioning

units which are an integral element of such equipment. The provisions of this subpart apply to all active retarders, all car coupling operations, all switcher locomotives, and all load cell test stands. These provisions do not apply to the sound emitted by a warning device, such as a horn, whistle or bell when operated for the purpose of safety. They do not apply to special purpose equipment which may be located on or operated from railcars; they do not apply to street, suburban or interurban electric railways unless operated as a part of a general railroad system of transportation. When land use changes after the publication date of this regulation from some other use to residential or commercial land use around a specific railyard facility, this regulation will become effective four (4) years from the date of that land use change.

§ 201.11 Standard for locomotive operation under stationary conditions.

(a) Commencing December 31, 1976, no carrier subject to this regulation shall operate any locomotive to which this regulation is applicable, and of which manufacture is completed on or before December 31, 1979, which produces A-weighted sound levels in excess of 93 dB at any throttle setting except idle, when operated singly and when connected to a load cell, or in excess of 73 dB at idle when operated singly, and when measured in accordance with the criteria specified in Subpart C of this part with slow meter response at a point 30 meters (100 feet) from the geometric center of the locomotive along a line that is both perpendicular to the centerline of the track and originates at the locomotive geometric center.

(b) No carrier subject to this regulation shall operate any locomotive to which this regulation is applicable, and of which manufacture is completed after December 31, 1979, which produces A-weighted sound levels in excess of 87 dB at any throttle setting except idle, when operated singly and when connected to a load cell, or in excess of 70 dB at idle when operated singly, and when measured in accordance with the criteria specified in Subpart C of this part with slow meter response at a point 30 meters (100 feet) from the geometric center of the locomotive along a line that is both perpendicular to the centerline of the track and originates at the locomotive geometric center.

(c) Commencing January 15, 1984, no carrier subject to this regulation may operate any switcher locomotive to which this regulation is applicable, and of which manufacture is completed on or before December 31, 1979, which produces A-weighted sound levels in excess of 87 dB at any throttle setting except idle, when operated singly and when connected to a load cell, or in excess of 70 dB at idle, and when measured in accordance with the criteria specified in Subpart C of this part with slow meter response at a point 30 meters (100 feet) from the geometric center of the locomotive along a line that is both perpendicular to the centerline of the track and originates at the locomotive geometric center. All switcher locomotives that operate in a particular railroad facility are deemed to be in compliance with this standard if the A-weighted sound level from stationary switcher locomotives, singly or in combination with other stationary locomotives, does not exceed 65 dB when measured with fast meter response at any receiving property measurement location near that particular railyard facility and when measured in accordance wtih Subpart C of this regulation.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.12 Standard for locomotive operation under moving conditions.

(a) Commencing December 31, 1976, no carrier subject to this regulation may operate any locomotive or combination of locomotives to which this regulation is applicable, and of which manufacture is completed on or before December 31, 1979, which produces A-weighted sound levels in excess of 96 dB when moving at any time or under any condition of grade, load, acceleration, or deceleration, when measured in accordance with the criteria specified in Subpart C of this regulation with fast meter response at 30 meters (100 feet) from the centerline of any section of track having less than a two (2) degree curve (or a radius of curvature greater than 873 meters (2865 feet)).

(b) No carrier subject to this regulation may operate any locomotive or combination of locomotives to which this regulation is applicable, and of which manufacture is completed after December 31, 1979, which produce A-weighted sound levels in excess of 90 dB when moving at any time or under any condition of grade, load, acceleration, or deceleration, when measured in accordance with the criteria specified in Subpart C of this part with fast meter response at 30 meters (100 feet) from the centerline of any section of track having less than a two (2) degree curve (or a radius of curvature greater than 873 meters (2,865 feet)).

(c) Commencing January 15, 1984, no carrier subject to this regulation may operate any switcher locomotive or a combination of switcher locomotives to which this regulation is applicable, and of which manufacture is completed on or before December 31, 1979 which produce A-weighted sound levels in excess of 90 dB when moving at any time or under any condition of grade, load, acceleration or deceleration, and when measured in accordance with the criteria in Subpart C of this part with fast meter response at 30 meters (100 feet) from the centerline of any section of track having less than a two (2) degree curve (or a radius of curvature greater than 873 meters (2,865 feet)). All switcher locomotives that operate in a particular railroad facility are deemed to be in compliance with this standard if the A-weighted sound level from stationary switcher locomotives, singly or in combination with other stationary locomotives, does not exceed 65 dB when measured with fast meter response at any receiving property measurement location near that particular railyard facility and when measured in accordance with Subpart C of this regulation.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.13 Standard for rail car operations.

Effective December 31, 1976, no carrier subject to this regulation shall operate any rail car or combination of rail cars which while in motion produce sound levels in excess of (1) 88 dB(A) at rail car speeds up to and including 75 km/hr (45 mph); or (2) 93 dB(A) at rail car speeds greater than 72 km/hr (45 mph); when measured in accordance with the criteria specified in Subpart C of this part with fast meter response at 30 meters (100) feet from the centerline of any section of track which is free of special track work or bridges or trestles and which exhibits less than a two (2) degree curve (or a radius of curvature greater than 873 meters (2,865 feet)).

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.14 Standard for retarders.

Effective January 15, 1984, no carrier subject to this regulation shall operate retarders that exceed an adjusted average maximum A-weighted sound level of 83 dB at any receiving property measurement location, when measured with fast meter response in accordance with Subpart C of this part.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.15 Standard for car coupling operations.

Effective January 15, 1984, no carrier subject to this regulation shall conduct car coupling operations that exceed an adjusted average maximum A-weighted sound level of 92 dB at any receiving property measurement location, when measured with fast meter response in accordance with Subpart C of this part, except, such coupling will be found in compliance with this standard and the carrier will be considered in compliance, if the railroad demonstrates that the standard is exceeded at the receiving property measurement locations (where the standard was previously exceeded) when cars representative of those found to exceed the standard are coupled at similar locations at coupling speeds of eight miles per hour or less.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.16 Standard for locomotive load cell test stands.

(a) Effective January 15, 1984, no carrier subject to this reguation shall operate locomotive load cell test stands that exceed an A-weighted sound level

of 78 dB when measured with slow meter response in accordance with Subpart C of this part excluding § 201.23 (b) and (c), at a point 30 meters (100 feet) from the geometric center of the locomotive undergoing test, along a line that is both perpendicular to the centerline of the track and originates at the locomotive geometric center, and in the direction most nearly towards the closest receiving property measurement location. All locomotive load cell test stands in a particular railroad facility are in compliance with this standard if the A-weighted sound level from the load cell does not exceed 65 dB at any receiving property measurement location near that particular railyard facility and when measured with fast meter response in accordance with Subpart C of this regulation.

(b) If the conditions of any part of § 201.23(a) cannot be met at a specific load cell test stand site, then the A-weighted sound level from that specific load cell test stand must not exceed 65 dB when measured with fast meter response at a receiving property measurement location more than 120 meters (400 feet) from the geometric center of the locomotive being tested and in accordance with Subpart C of this regulation.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

Subpart C—Measurement Criteria

§ 201.20 Applicability and purpose.

The following criteria are applicable to and contain the necessary parameters and procedures for the measurement of the noise emission levels prescribed in the standards of Subpart B of this part. These criteria are specified in order to further clarify and define such standards. Equivalent measurement procedures may be used for establishing compliance with these regulations. Any equivalent measurement procedure, under any circumstance, shall not result in a more stringent noise control requirement than those specified in this regulation using the measurement procedures in Subpart C.

§ 201.21 Quantities measured.

The quantities to be measured under the test conditions described below, are the A-weighted sound levels for ''fast'' or ''slow'' meter response as defined in the American National Standard S1.4–1971.

§ 201.22 Measurement instrumentation.

(a) A sound level meter or alternate sound level measurement system that meets, as a minimum, all the requirements of American National Standard S1.4–1971[1] for a Type 1 (or S1A) instrument must be used with the ''fast'' or ''slow'' meter response chacteristic as specified in Subpart B. To insure Type 1 response, the manufacturer's instructions regarding mounting or orienting of the microphone, and positioning of the observer must be observed. In the event that a Type 1 (or S1A) instrument is not available for determining non-compliance with this regulation, the measurements may be made with a Type 2 (or S2A), but with the measured levels reduced by the following amount to account for possible measurement instrument errors pertaining to specific measurements and sources:

TABLE 1—SOUND LEVEL CORRECTIONS WHEN USING A TYPE 2 (OR S2A) INSTRUMENT

Measurement section	Source	Decibels[1]
201.24	Locomotives	0
	Rail cars	0
	Locomotive load cell test stand	0
201.26	Retarder	4
	Car coupling	2
201.27	Locomotive load cell test stand	0
	Stationary locomotive	0

[1] Amount of correction to be subtracted from measured level (dB).

(b) A microphone windscreen and an acoustic calibrator of the coupler type must be used as recommended by: (1) the manufacturer of the sound level meter or (2) the manufacturer of the microphone. The choice of both devices must be based on ensuring that Type 1 or 2 performance, as appropriate, is maintained for frequencies below 10,000 Hz.

[1] American National Standards are available from the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

§ 201.23 Test site, weather conditions and background noise criteria for measurement at a 30 meter (100 feet) distance of the noise from locomotive and rail car operations and locomotive load cell test stands.

(a) The standard test site shall be such that the locomotive or train radiates sound into a free field over the ground plane. This condition may be considered fulfilled if the test site consists of an open space free of large, sound reflecting objects, such as barriers, hills, signboards, parked vehicles, locomotives or rail cars on adjacent tracks, bridges or buildings within the boundaries described by Figure 1, as well as conforms to the other requirements of this § 201.23.

(b) Within the complete test site, the top of at least one rail upon which the locomotive or train is located shall be visible (line of sight) from a position 1.2 meters (4 feet) above the ground at the microphone location, except as provided in paragraph (c) of this section.

(c) Ground cover such as vegetation, fenceposts, small trees, telephone poles, etc., shall be limited within the area in the test site between the vehicle under test and the measuring microphone such that 80 percent of the top of at least one rail along the entire test section of track be visible from a position 1.2 meters (4 feet) above the ground at the microphone location; except that no single obstruction shall account for more than 5 percent of the total allowable obstruction.

(d) The ground elevation at the microphone location shall be within plus 1.5 meters (5 feet) or minus 3.0 meters (10 feet) of the elevation of the top of the rail at the location in-line with the microphone.

(e) Within the test site, the track shall exhibit less than a 2 degree curve or a radius of curvature greater than 873 meters (2,865 feet). This paragraph shall not apply during a stationary test. The track shall be tie and ballast, free of special track work and bridges or trestles.

(f) Measurements shall not be made during precipitation.

(g) The maximum A-weighted fast response sound level observed at the test site immediately before and after the test shall be at least 10 dB(A) below the level measured during the test. For the locomotive and rail car pass-by tests this requirement applies before and after the train containing the rolling stock to be tested has passed. This background sound level measurement shall include the contribution from the operation of the load cell, if any, including load cell contribution during test.

(h) Noise measurements may only be made if the measured wind velocity is 19.3 km/hr (12 mph) or less. Gust wind measurements of up to 33.2 km/hr (20 mph) are allowed.

§ 201.24 Procedures for measurement at a 30 meter (100 feet) distance of the noise from locomotive and rail car operations and locomotive load cell test stands.

(a) *Microphone positions.* (1) The microphone shall be located within the test site according to the specifications given in the test procedures of paragraphs (b), (c) and (d) of this section, and shall be positioned 1.2 meters (4 feet) above the ground. It shall be oriented with respect to the source in accordance with the manufacturer's recommendations.

(2) The observer shall not stand between the microphone and the source whose sound level is being measured.

(b) *Stationary locomotive and locomotive load cell test stand tests.* (1) For stationary locomotive and locomotive load cell test stand tests, the microphone shall be positioned on a line perpendicular to the track at a point 30 meters (100 feet) from the track centerline at the longitudinal midpoint of the locomotive.

(2) The sound level meter shall be observed for thirty seconds after the test throttle setting is established to assure operating stability. The maximum sound level observed during that time shall be utilized for compliance purposes.

(3) Measurement of stationary locomotive and locomotive load cell test stand noise shall be made with all cooling fans operating.

(c) *Rail car pass-by test.* (1) For rail car pass-by tests, the microphone shall be positioned on a line perpendicular to the track 30 meters (100 feet) from the track centerline.

(2) Rail car noise measurements shall be made when the locomotives have passed a distance 152.4 meters (500 feet) or 10 rail cars beyond the point at the intersection of the track and the line which extends perpendicularly from the track to the microphone location, providing any other locomotives are also at least 152.4 meters (500 feet) or 10 rail car lengths away from the measuring point. The maximum sound level observed in this manner which exceeds the noise levels specified in §201.13 shall be utilized for compliance purposes.

(3) Measurements shall be taken on reasonably well maintained tracks.

(4) Noise levels shall not be recorded if brake squeal is present during the test measurement.

(d) *Locomotive pass-by test.* (1) For locomotive pass-by tests, the microphone shall be positioned on a line perpendicular to the track at a point 30 meters (100 feet) from the track centerline.

(2) The noise level shall be measured as the locomotive approaches and passes by the microphone location. The maximum noise level observed during this period shall be utilized for compliance purposes.

(3) Measurements shall be taken on reasonably well maintained tracks.

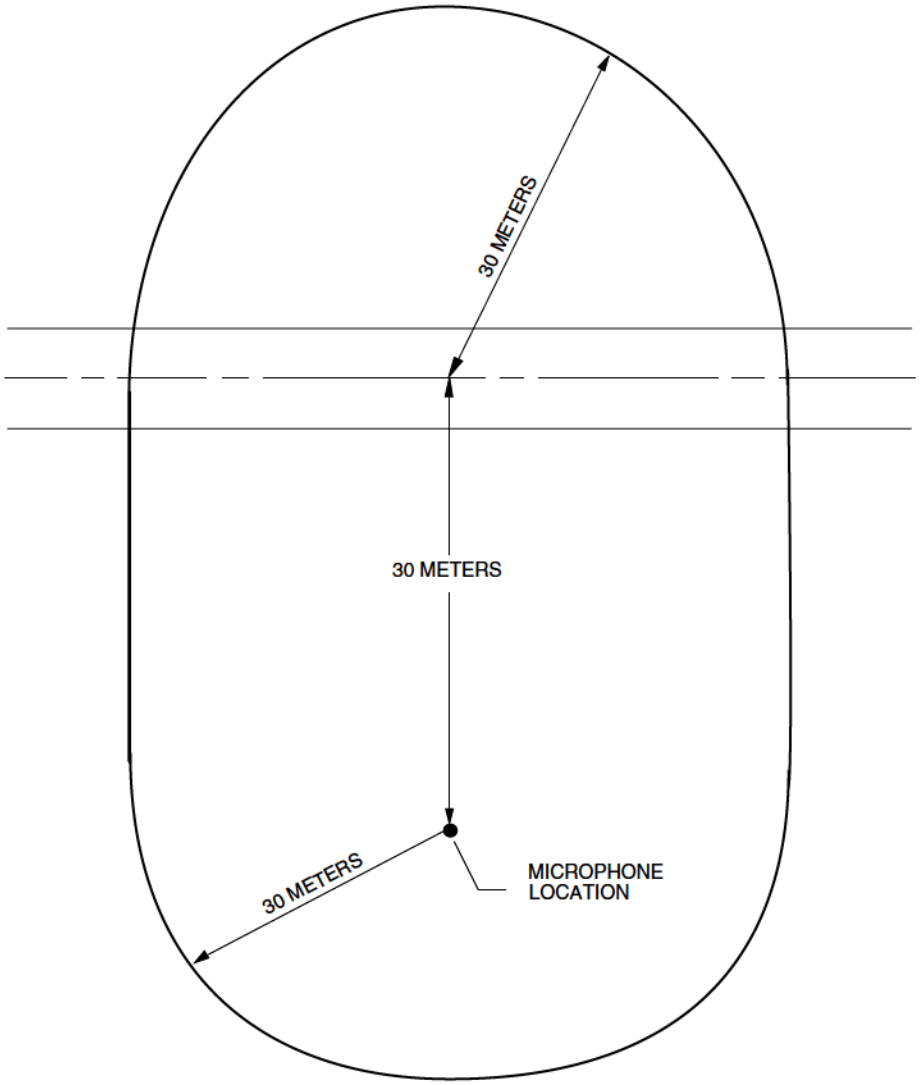


Figure 1. Test Site Clearance Requirement for Stationary Locomotive, Locomotive Pass-by, Rail Car Pass-by, and Locomotive Load Cell Test Stand Tests.

§ 201.25 Measurement location and weather conditions for measurement on receiving property of the noise of retarders, car coupling, locomotive load cell test stands, and stationary locomotives.

(a) Measurements must be conducted only at receiving property measurement locations.

(b) Measurement locations on receiving property must be selected such that no substantially vertical plane surface, other than a residential or commercial unit wall or facility boundary noise barrier, that exceeds 1.2 meters (4 feet) in height is located within 10 meters (33.3 feet) of the microphone and that no exterior wall of a residential or commercial structure is located within 2.0 meters (6.6 feet) of the microphone. If the residential structure is a farm home, measurements must be made 2.0 to 10.0 meters (6.6 to 33.3 feet) from any exterior wall.

(c) No measurement may be made when the average wind velocity during the period of measurement exceeds 19.3 km/hr (12 mph) or when the maximum wind gust velocity exceeds 32.2 km/hr (20 mph).

(d) No measurement may be taken when precipitation, e.g., rain, snow, sleet, or hail, is occurring.

§ 201.26 Procedures for the measurement on receiving property of retarder and car coupling noise.

(a) *Retarders*—(1) *Microphone.* The microphone must be located on the receiving property and positioned at a height between 1.2 and 1.5 meters (4 to 5 feet) above the ground. The microphone must be positioned with respect to the equipment in accordance with the manufacturers' recommendations for Type 1 or 2 performance as appropriate. No person may stand between the microphone and the equipment being measured or be otherwise positioned relative to the microphone at variance with the manufacturers' recommendations for Type 1 or 2 performance as appropriate.

(2) *Data.* The maximum A-weighted sound levels (FAST) for every retarder sound observed during the measurement period must be read from the indicator and recorded. At least 30 consecutive retarder sounds must be measured. The measurement period must be at least 60 minutes and not more than 240 minutes.

(3) *Adjusted average maximum A-weighted sound level.* The energy average level for the measured retarder sounds must be calculated to determine the value of the average maximum A-weighted sound level ($L_{ave\ max}$). This value is then adjusted by adding the adjustment (C) from Table 2 appropriate to the number of measurements divided by the duration of the measurement period (n/T), to obtain the adjusted average maximum A-weighted sound level ($L_{adj\ ave\ max}$) for retarders.

(b) *Car coupling impact*—(1) *Microphone.* The microphone must be located on the receiving property and at a distance of at least 30 meters (100 feet) from the centerline of the nearest track on which car coupling occurs and its sound is measured (that is, either the microphone is located 30 meters (100 feet) from the nearest track on which couplings occur, or all sounds resulting from car coupling impacts that occur on tracks with centerlines located less than 30 meters (100 feet) from the microphone are disregarded). The microphone shall be positioned at a height between 1.2 and 1.5 meters (4 and 5 feet) above the ground, and it must be positioned with respect to the equipment in accordance with the manufacturers' recommendations for Type 1 or 2 performance as appropriate. No person may stand between the microphone and the equipment being measured or be otherwise positioned relative to the microphone at variance with the manufacturers' recommendations for Type 1 or 2 performance as appropriate.

(2) *Data.* The maximum A-weighted sound levels (FAST) for every car coupling impact sound observed during the measurement period must be read from the indicator and recorded. At least 30 consecutive car coupling impact sounds must be measured. The measurement period must be at least 60 minutes and not more than 240 minutes, and must be reported.

TABLE 2—ADJUSTMENT TO $L_{ave\ max}$ TO OBTAIN $L_{adj\ ave\ max}$ FOR RETARDERS AND CAR COUPLING IMPACTS [1]

[n/T=number of measurements/measurement duration (min)
C=Adjustment in dB]

0.111 to 0.141	−9
0.142 to 0.178	−8
0.179 to 0.224	−7
0.225 to 0.282	−6
0.283 to 0.355	−5
0.356 to 0.447	−4
0.448 to 0.562	−3
0.563 to 0.708	−2
0.709 to 0.891	−1
0.892 to 1.122	0
1.123 to 1.413	+1
1.414 to 1.778	+2
1.779 to 2.239	+3
2.240 to 2.818	+4
2.819 to 3.548	+5
3.549 to 4.467	+6

[1] $L_{adj\ ave\ max}=L_{ave\ max}$ +C in dB.
Values in Table 2 were calculated from [C=10 log n/T] with intervals selected to round off values to the nearest whole decibel. The table may be extended or interpolated to finer interval gradations by using this defining equation.

(3) *Adjusted average maximum A-weighted sound level.* The energy average level for the measured car coupling sounds is calculated to determine the average maximum sound level ($L_{ave\ max}$). It is then adjusted by adding the adjustment (C) from Table 2 appropriate to the number of measurements divided by the duration of the measurement period (n/T), to obtain the adjusted average maximum A-weighted sound level ($L_{adj\ ave\ max}$) for car coupling impacts.

§ 201.27 Procedures for: (1) Determining applicability of the locomotive load cell test stand standard and switcher locomotive standard by noise measurement on a receiving property; (2) measurement of locomotive load cell test stands more than 120 meters (400 feet) on a receiving property.

(a) *Microphone.* The microphone must be located at a receiving property measurement location and must be positioned at a height between 1.2 and 1.5 meters (4 and 5 feet) above the ground. Its position with respect to the equipment must be in accordance with the manufacturers' recommendations for Type 1 or 2 performance as appropriate. No person may stand between the microphone and the equipment being measured or be otherwise positioned relative to the microphone at variance to the manufacturers' recommendations for Type 1 or Type 2 performance as appropriate.

(b) *Data.* (1) When there is evidence that at least one of these two types of nearly steady state sound sources is affecting the noise environment, the following measurements must be made. The purpose of these measurements is to determine the A-weighted L_{90} statistical sound level, which is to be used as described in subparagraph (c) below to determine the applicability of the source standards. Before this determination can be made, the measured L_{90} is to be ''validated'' by comparing the measured L_{10} and L_{99} statistical sound levels. If the difference between these levels is sufficiently small (4 dB or less), the source(s) being measured is considered to be a nearly steady state source.

(2) Data shall be collected by measuring the instantaneous A-weighted sound level (FAST) at a rate of at least once each 10 seconds for a measurement period of at least 15 minutes and until 100 measurements are obtained. The data may be taken manually by direct reading of the indicator at 10 second intervals (±1 second), or by attaching a statistical analyzer, graphic level recorder, or other equivalent device to the sound level meter for a more continuous recording of the instantaneous sound level.

(3) The data shall be analyzed to determine the levels exceeded 99%, 90%, and 10% of the time, i.e., L_{99}, L_{90}, and L_{10}, respectively. The value of L_{90} is considered a valid measure of the A-weighted sound level for the standards in § 201.16 only if the difference between L_{10} and L_{99} has a value of 4 dB or less. If a measured value of L_{90} is not valid for this purpose, measurements may be taken over a longer period to attempt to improve the certainty of the measurement and to validate L_{90}. If L_{90} is valid and is less than the level in applicable standards for these source types, the sources are in compliance. If the measured value of L_{90} is valid and exceeds the initial 65 dB requirement for any of the source types that appear to be affecting the noise environments, the evaluation according to the following paragraph (c) is required.

(c) *Determination of applicability of the standard when L_{90} is validated and is in excess of one or more of the source standards.* The following procedures must be

used to determine the compliance of the various source types when L_{90} is validated and in excess of one or more of the applicable standards.

(1) The principal direction of the nearly steady-state sound at the measurement location must be determined, if possible, by listening to the sound and localizing its apparent source(s). If the observer is clearly convinced by this localization process that the sound emanates only from one or both of these two sources, then:

(i) If only stationary locomotive(s), including at least one switcher locomotive, are present, the value of L_{90} is the value of the A-weighted sound level to be used in determining if the 65 dB requirement is exceeded and compliance with the standards in §§ 201.11(c) and 201.12(c) is necessary.

(ii) If only a locomotive load cell test stand and the locomotive being tested are present and operating, the value of L_{90} is the value of the A-weighted sound level to be used in determining applicability of the standard in § 201.16.

(iii) If a locomotive load cell test stand(s) and the locomotive being tested are present and operating with stationary locomotive(s), including at least one switcher locomotive, the value L_{90} minus 3 dB is the value of the A-weighted sound level to be used in determining applicability of the standards in §§ 201.11(c), 201.12(c) and 201.16.

(iv) If a locomotive load cell test stand(s) and the locomotive being tested are present and operating, and a stationary locomotive(s) is present, and if the nearly steady-state sound level is observed to change by 10 dB, coincident with evidence of a change in operation of the locomotive load cell test stand but without apparent change in the location of stationary locomotives, another measurement of L_{90} must be made in accordance with paragraph (b) of this section. If this additional measure of L_{90} is validated and differs from the initial measure of L_{90} by an absolute value of 10 dB or more, then the higher value of L_{90} is the value of the A-weighted sound level to be used in determining applicability of the standard in § 201.16.

(2) In order to accomplish the comparison demonstration of paragraph (c)(3) of this section, when one or more source types is found not to be in compliance with the applicable standard(s), documentation of noise source information shall be necessary. This will include, but not be limited to, the approximate location of all sources of each source type present and the microphone position on a diagram of the particular railroad facility, and the distances between the microphone location and each of the sources must be estimated and reported. Additionally, if other rail or non-rail noise sources are detected, they must be identified and similarly reported.

(3) If it can be demonstrated that the validated L_{90} is less than 5 dB greater than any L_{90} measured at the same receiving property location when the source types that were operating during the initial measurement(s) are either turned off or moved, such that they can no longer be detected, the initial value(s) of L_{90} must not be used for determining applicability to the standards. This demonstration must be made at a time of day comparable to that of the initial measurements and when all other conditions are acoustically similar to those reported in paragraph (c)(2) of this section.

[45 FR 1263, Jan. 4, 1980; 47 FR 14709, Apr. 6, 1982]

§ 201.28 Testing by railroad to determine probable compliance with the standard.

(a) To determine whether it is probably complying with the regulation, and therefore whether it should institute noise abatement, a railroad may take measurements on its own property at locations that:

(1) Are between the source and receiving property

(2) Derive no greater benefit from shielding and other noise reduction features that does the receiving property; and

(3) Otherwise meet the requirements of § 201.25.

(b) Measurements made for this purpose should be in accordance with the appropriate procedures in § 201.26 or § 201.27. If the resulting level is less than the level stated in the standard, then there is probably compliance with the standard.

(c) This procedure is set forth to assist the railroad in devising its compliance plan, not as a substantive requirement of the regulation.

PART 202—MOTOR CARRIERS ENGAGED IN INTERSTATE COMMERCE

Subpart A—General Provisions

Sec.
202.10 Definitions.
202.11 Effective date.
202.12 Applicability.

Subpart B—Interstate Motor Carrier Operations Standards

202.20 Standards for highway operations.
202.21 Standard for operation under stationary test.
202.22 Visual exhaust system inspection.
202.23 Visual tire inspection.

AUTHORITY: Sec. 18, 36 Stat. 1249, 42 U.S.C. 4917(a).

Subpart A—General Provisions

§ 202.10 Definitions.

As used in this part, all terms not defined herein shall have the meaning given them in the Act:

(a) *Act* means the Noise Control Act of 1972 (Pub. L. 92–574, 86 Stat. 1234).

(b) *Common carrier by motor vehicle* means any person who holds himself out to the general public to engage in the transportation by motor vehicle in interstate or foreign commerce of passengers or property or any class or classes thereof for compensation, whether over regular or irregular routes.

(c) *Contract carrier by motor vehicle* means any person who engages in transportation by motor vehicle of passengers or property in interstate or foreign commerce for compensation (other than transportation referred to in paragraph (b) of this section) under continuing contracts with one person or a limited number of persons either (1) for the furnishing of transportation services through the assignment of motor vehicles for a continuing period of time to the exclusive use of each person served or (2) for the furnishing of transportation services designed to meet the distinct need of each individual customer.

(d) *Cutout or by-pass or similar devices* means devices which vary the exhaust system gas flow so as to discharge the exhaust gas and acoustic energy to the atmosphere without passing through the entire length of the exhaust system, including all exhaust system sound attenuation components.

(e) *dB(A)* means the standard abbreviation for A-weighted sound level in decibels.

(f) *Exhaust system* means the system comprised of a combination of components which provides for enclosed flow of exhaust gas from engine parts to the atmosphere.

(g) *Fast meter response* means that the fast dynamic response of the sound level meter shall be used. The fast dynamic response shall comply with the meter dynamic characteristics in paragraph 5.3 of the American National Standard Specification for Sound Level Meters, ANSI S1. 4–1971. This publication is available from the American National Standards Institute, Inc., 1420 Broadway, New York, New York 10018.

(h) *Gross Vehicle Weight Rating* (GVWR) means the value specified by the manufacturer as the loaded weight of a single vehicle.

(i) *Gross Combination Weight Rating* (GCWR) means the value specified by the manufacturer as the loaded weight of a combination vehicle.

(j) *Highway* means the streets, roads, and public ways in any State.

(k) *Interstate commerce* means the commerce between any place in a State and any place in another State or between places in the same State through another State, whether such commerce moves wholly by motor vehicle or partly by motor vehicle and partly by rail, express, water or air. This definition of ''interstate commerce'' for purposes of these regulations is the same as the definition of ''interstate commerce'' in section 203(a) of the Interstate Commerce Act. [49 U.S.C. 303(a)]

(l) *Motor carrier* means a common carrier by motor vehicle, a contract carrier by motor vehicle, or a private carrier of property by motor vehicle as those terms are defined by paragraphs (14), (15), and (17) of section 203(a) of

Safety Advisory Committee (RSAC) has been established to advise the agency on the development and revision of railroad safety standards. The committee consists of a wide range of industry representatives, including organizations that represent the interests of small business. The small entity representative groups that sit on the RSAC may appoint members of their choice to participate in the development of new safety standards. This reflects FRA's policy that small business interests must be heard and considered in the development of new standards to ensure that FRA does not impose unnecessary economic burdens on small businesses, and to create more effective standards. Finally, FRA's Web site (*http://www.fra.dot.gov*) makes pertinent agency information available instantly to the public.

FRA's longstanding policy of open communication with small entities is apparent in these practices. FRA will make every effort to develop new and equally responsive communication procedures as is warranted by new developments in the railroad industry.

SMALL ENTITY ENFORCEMENT POLICY

FRA has adopted an enforcement policy that addresses the unique nature of small entities in the imposition of civil penalties and resolution of those assessments. Pursuant to FRA's statutory authority, and as described in Appendix A to 49 CFR part 209, it is FRA's policy to consider a variety of factors in determining whether to take enforcement action against persons, including small entities, who have violated the safety laws and regulations. In addition to the seriousness of the violation and the person's history of compliance, FRA inspectors consider ''such other factors as the immediate circumstances make relevant.'' In the context of violations by small entities, those factors include whether the violations were made in good faith (*e.g.*, based on an honest misunderstanding of the law), and whether the small entity has moved quickly and thoroughly to remedy the violation(s). In general, the presence of both good faith and prompt remedial action militates against taking a civil penalty action, especially if the violations are isolated events. On the other hand, violations involving willful actions and/or posing serious health, safety, or environmental threats should ordinarily result in enforcement actions, regardless of the entity's size.

Once FRA has assessed a civil penalty, it is authorized to adjust or compromise the initial penalty claims based on a wide variety of mitigating factors, unless FRA must terminate the claim for some reason. FRA has the discretion to reduce the penalty as it deems fit, but not below the statutory minimums. The mitigating criteria FRA evaluates are found in the railroad safety statutes and SBREFA: The severity of the safety or health risk presented; the existence of alternative methods of eliminating the safety hazard; the entity's culpability; the entity's compliance history; the entity's ability to pay the assessment; the impacts an assessment might exact on the entity's continued business; and evidence that the entity acted in good faith. FRA staff attorneys regularly invite small entities to present any information related to these factors, and reduce civil penalty assessments based on the value and integrity of the information presented. Staff attorneys conduct conference calls or meet with small entities to discuss pending violations, and explain FRA's view on the merits of any defenses or mitigating factors presented that may have resulted or failed to result in penalty reductions. Among the ''other factors'' FRA considers at this stage is the promptness and thoroughness of the entity's remedial action to correct the violations and prevent a recurrence. Small entities should be sure to address these factors in communications with FRA concerning civil penalty cases. Long-term solutions to compliance problems will be given great weight in FRA's determinations of a final settlement offer.

Finally, under FRA's Safety Assurance and Compliance Program (SACP), FRA identifies systemic safety hazards that continue to occur in a carrier or shipper operation, and in cooperation with the subject business, develops an improvement plan to eliminate those safety concerns. Often, the plan provides small entities with a reasonable time frame in which to make improvements without the threat of civil penalty. If FRA determines that the entity has failed to comply with the improvement plan, however, enforcement action is initiated.

FRA's small entity enforcement policy is flexible and comprehensive. FRA's first priority in its compliance and enforcement activities is public and employee safety. However, FRA is committed to obtaining compliance and enhancing safety with reasoned, fair methods that do not inflict undue hardship on small entities.

[68 FR 24894, May 9, 2003]

PART 210—RAILROAD NOISE EMISSION COMPLIANCE REGULATIONS

Subpart A—General Provisions

Sec.

AUTHORITY: Sec. 17, Pub. L. 92–574, 86 Stat. 1234 (42 U.S.C. 4916); sec. 1.49(o) of the regulations of the Office of the Secretary of Transportation, 49 CFR 1.49(o).

SOURCE: 48 FR 56758, Dec. 23, 1983, unless otherwise noted.

Subpart A—General Provisions

§ 210.1 Scope of part.

This part prescribes minimum compliance regulations for enforcement of the Railroad Noise Emission Standards established by the Environmental Protection Agency in 40 CFR part 201.

§ 210.3 Applicability.

(a) Except as provided in paragraph (b) of this section, the provisions of this part apply to the total sound emitted by moving rail cars and locomotives (including the sound produced by refrigeration and air conditioning units that are an integral element of such equipment), active retarders, switcher locomotives, car coupling operations, and load cell test stands, operated by a railroad as defined in 45 U.S.C. 22, under the conditions described in this part and in 40 CFR part 201.

(b) The provisions of this part do not apply to—

(1) Steam locomotives;

(2) Street, suburban, or interurban electric railways unless operated as a part of the general railroad system of transportation;

(3) Sound emitted by warning devices, such as horns, whistles, or bells when operated for the purpose of safety;

(4) Special purpose equipment that may be located on or operated from rail cars;

(5) As prescribed in 40 CFR 201.10, the provisions of 40 CFR 201.11 (a) and (b) and (c) do not apply to gas turbinepowered locomotives or any locomotive type that cannot be connected by any standard method to a load cell; or

(6) Inert retarders.

[48 FR 56758, Dec. 23, 1983, as amended at 54 FR 33228, Aug. 14, 1989]

§ 210.5 Definitions.

(a) *Statutory definitions.* All terms used in this part and defined in the Noise Control Act of 1972 (42 U.S.C. 4901 *et seq.*) have the definition set forth in that Act.

(b) *Definitions in standards.* All terms used in this part and defined in § 201.1 of the Railroad Noise Emission Standards, 40 CFR 201.1, have the definition set forth in that section.

(c) *Additional definitions.* As used in this part—

Administrator means the Federal Railroad Administrator, the Deputy Administrator, or any official of FRA to whom the Administrator has delegated authority to act in the Administrator's stead.

Consist of a locomotive and rail cars means one or more locomotives coupled to a rail car or rail cars.

FRA means the Federal Railroad Administration.

Inert retarder means a device or system for holding a classified cut of cars and preventing it from rolling out the bottom of a railyard.

Inspector means FRA inspectors or FRA specialists.

Noise defective means the condition in which railroad equipment is found to exceed the Railroad Noise Emission Standards, 40 CFR part 201.

Railroad equipment means rail cars, locomotives, active retarders, and load cell test stands.

Standards means the Railroad Noise Emission Standards, 40 CFR part 201. (See appendix A in this part for a listing.)

§ 210.7 Responsibility for noise defective railroad equipment.

Any railroad that uses railroad equipment that is noise defective or engages in a car coupling operating that results in excessive noise according to the criteria established in this part and in the Standards is responsible for compliance with this part. Subject to § 210.9, such railroad shall—

(a) Correct the noise defect;

(b) Remove the noise defective railroad equipment from service; or

(c) Modify the car coupling procedure to bring it within the prescribed noise limits.

§ 210.9 Movement of a noise defective locomotive, rail car, or consist of a locomotive and rail cars.

A locomotive, rail car, or consist of a locomotive and rail cars that is noise defective may be moved no farther than the nearest forward facility where the noise defective conditions can be eliminated only after the locomotive, rail car, or consist of a locomotive and rail cars has been inspected and been determined to be safe to move.

§ 210.11 Waivers.

(a) Any person may petition the Administrator for a waiver of compliance with any requirement in this part. A waiver of compliance with any requirement prescribed in the Standards may not be granted under this provision.

(b) Each petition for a waiver under this section must be filed in the manner and contain information required by 49 CFR part 211.

(c) If the Administrator finds that a waiver of compliance applied for under paragraph (a) of this section is in the public interest and is consistent with railroad noise abatement and safety, the Administrator may grant a waiver subject to any condition he deems necessary. Notice of each waiver granted, including a statement of the reasons therefor, will be published in the FEDERAL REGISTER.

§ 210.13 Penalty.

Any person who operates railroad equipment subject to the Standards in violation of any requirement of this part or of the Standards is liable to penalty as prescribed in section 11 of the Noise Control Act of 1972 (42 U.S.C. 4910), as amended.

Subpart B—Inspection and Testing

§ 210.21 Scope of subpart.

This subpart prescribes the compliance criteria concerning the requirements for inspection and testing of railroad equipment or operations covered by the Standards.

§ 210.23 Authorization.

(a) An inspector is authorized to perform any noise test prescribed in the Standards and in the procedures of this part at any time, at any appropriate location, and without prior notice to the railroad, for the purpose of determining whether railroad equipment is in compliance with the Standards.

(b)(1) An inspector is authorized to request that railroad equipment and appropriate railroad personnel be made available for a passby or stationary noise emission test, as prescribed in the Standards and in the procedures of this part, and to conduct such test, at a reasonable time and location, for the purpose of determining whether the railroad equipment is in compliance with the Standards.

(2) If the railroad has the capability to perform an appropriate noise emission test, as prescribed in the Standards and in the procedures of this part, an inspector is authorized to request that the railroad test railroad equipment. The railroad shall perform the appropriate test as soon as practicable.

(3) The request referred to in this paragraph will be in writing, will state the grounds upon which the inspector has reason to believe that the railroad equipment does not conform to the Standards, and will be presented to an appropriate operating official of the railroad.

(4) Testing or submission for testing is not required if the cause of the noise defect is readily apparent and the inspector verifies that it is corrected by the replacement of defective components or by instituting a normal maintenance or repair procedure.

(c)(1) An inspector is authorized to inspect or examine a locomotive, rail car, or consist of a locomotive and rail

cars operated by a railroad, or to request that the railroad inspect or examine the locomotive, rail car, or consist of a locomotive and rail cars, whenever the inspector has reason to believe that it does not conform to the requirements of the Standards.

(2) An inspector may request that a railroad conduct an inspection or examination of a locomotive, rail car, or consist of a locomotive and rail cars on the basis of an excessive noise emission level measured by a passby test. If, after such inspection or examination, no mechanical condition that would result in a noise defect can be found and the inspector verifies that no such mechanical condition exists, the locomotive, rail car, or consist of a locomotive and rail cars may be continued in service.

(3) The requests referred to in this paragraph will be in writing, will state the grounds upon which the inspector has reason to believe that the locomotive, rail car, or consist of a locomotive and rail cars does not conform to the Standards, and will be presented to an appropriate operating official of the railroad.

(4) The inspection or examination referred to in this paragraph may be conducted only at recognized inspection points or scheduled stopping points.

§ 210.25 Measurement criteria and procedures.

The parameters and procedures for the measurement of the noise emission levels are prescribed in the Standards.

(a) Quantities measured are defined in § 201.21 of the Standards.

(b) Requirements for measurement instrumentation are prescribed in § 201.22 of the Standards. In addition, the following calibration procedures shall be used:

(1)(i) The sound level measurement system including the microphone shall be calibrated and appropriately adjusted at one or more nominal frequencies in the range from 250 through 1000 Hz at the beginning of each series of measurements, at intervals not exceeding 1 (one) hour during continual use, and immediately following a measurement indicating a violation.

(ii) The sound level measurement system shall be checked not less than once each year by its manufacturer, a representative of its manufacturer, or a person of equivalent special competence to verify that its accuracy meets the manufacturer's design criteria.

(2) An acoustical calibrator of the microphone coupler type designed for the sound level measurement system in use shall be used to calibrate the sound level measurement system in accordance with paragraph (b)(1)(i) of this section. The calibration must meet or exceed the accuracy requirements specified in section 5.4.1 of the American National Standard Institute Standards, ''Method for Measurement of Sound Pressure Levels,'' (ANSI S1.13–1971) for field method measurements.

(c) Acoustical environment, weather conditions, and background noise requirements are prescribed in § 201.23 of the Standards. In addition, a measurement tolerance of 2 dB(A) for a given measurement will be allowed to take into account the effects of the factors listed below and the interpretations of these effects by enforcement personnel:

(1) The common practice of reporting field sound level measurements to the nearest whole decibel;

(2) Variations resulting from commercial instrument tolerances;

(3) Variations resulting from the topography of the noise measurement site;

(4) Variations resulting from atmospheric conditions such as wind, ambient temperature, and atmospheric pressure; and

(5) Variations resulting from reflected sound from small objects allowed within the test site.

§ 210.27 New locomotive certification.

(a) A railroad shall not operate a locomotive built after December 31, 1979, unless the locomotive has been certified to be in compliance with the Standards.

(b) The certification prescribed in this section shall be determined for each locomotive model, by either—

(1) Load cell testing in accordance with the criteria prescribed in the Standards; or

(2) Passby testing in accordance with the criteria prescribed in the Standards.

(c) If passby testing is used under paragraph (b)(2) of this section, it shall be conducted with the locomotive operating at maximum rated horsepower output.

(d) Each new locomotive certified under this section shall be identified by a permanent badge or tag attached in the cab of the locomotive near the location of the inspection Form F 6180.49. The badge or tag shall state:

(1) Whether a load cell or passby test was used;

(2) The date and location of the test; and

(3) The A-weighted sound level reading in decibels obtained during the passby test, or the readings obtained at idle throttle setting and maximum throttle setting during a load cell test.

§210.29 Operation standards (moving locomotives and rail cars).

The operation standards for the noise emission levels of moving locomotives, rail cars, or consists of locomotives and rail cars are prescribed in the Standards and duplicated in appendix A of this part.

(a) Measurements for compliance shall be made in compliance with the provisions of subpart C of the Standards and the following:

(1) Consists of locomotives containing at least one locomotive unit manufactured prior to December 31, 1979, shall be evaluated for compliance in accordance with §201.12(a) of the Standards, unless a locomotive within the consist is separated by at least 10 rail car lengths or 500 feet from other locomotives in the consist, in which case such separated locomotives may be evaluated for compliance according to their respective built dates.

(2) Consists of locomotives composed entirely of locomotive units manufactured after December 31, 1979, shall be evaluated for compliance in accordance with §201.12(b) of the Standards.

(3) If the inspector cannot establish the built dates of all locomotives in a consist of locomotives measured under moving conditions, evaluation for compliance shall be made in accordance with §201.12(a) of the Standards.

(b) Noise emission standards for rail cars operating under moving conditions are contained in §201.13 of the Standards and are stated in appendix A of this part. If speed measurement equipment used by the inspector at the time of the measurement is not operating within an accuracy of 5 miles per hour, evaluation for compliance shall be made in accordance with §201.13(2) of the Standards.

(c) Locomotives and rail cars tested pursuant to the procedures prescribed in this part and in the Standards shall be considered in noncompliance whenever the test measurement, minus the appropriate tolerance (§210.25), exceeds the noise emission levels prescribed in appendix A of this part.

§210.31 Operation standards (stationary locomotives at 30 meters).

(a) For stationary locomotives at load cells:

(1) Each noise emission test shall begin after the engine of the locomotive has attained the normal cooling water operating temperature as prescribed by the locomotive manufacturer.

(2) Noise emission testing in idle or maximum throttle setting shall start after a 40 second stabilization period in the throttle setting selected for the test.

(3) After the stabilization period as prescribed in paragraph (a)(2) of this section, the A-weighted sound level reading in decibels shall be observed for an additional 30-second period in the throttle setting selected for the test.

(4) The maximum A-weighted sound level reading in decibels that is observed during the 30-second period of time prescribed in paragraph (a)(3) of this section shall be used for test measurement purposes.

(b) The following data determined by any locomotive noise emission test conducted after December 31, 1976, shall be recorded in the ''Remarks'' section on the reverse side of Form F 6180.49:

(1) Location of test;

(2) Type of test;

(3) Date of test; and

(4) The A-weighted sound level reading in decibels obtained during the passby test, or the readings obtained at idle throttle setting and maximum throttle setting during a load cell test.

(c) Any locomotive subject to this part that is found not to be in compliance with the Standards as a result of a passby test shall be subjected to a load cell test or another passby test prior to return to service, except that no such retest shall be required if the cause of the noise defect is readily apparent and is corrected by the replacement of defective components or by a normal maintenance or repair procedure.

(d) The last entry recorded on Form F 6180.49 as required in paragraph (b) of this section shall be transcribed to a new Form FRA F 6180.49 when it is posted in the locomotive cab.

(e) Locomotives tested pursuant to the procedures prescribed in this part and in the Standards shall be considered in noncompliance wherever the test measurement, minus the appropriate tolerance (§ 210.25), exceeds the noise emission levels precribed in appendix A of this part.

§ 210.33 Operation standards (switcher locomotives, load cell test stands, car coupling operations, and retarders).

(a) Measurement on receiving property of the noise emission levels from switcher locomotives, load cell test stands, car coupling operations, and retarders shall be performed in accordance with the requirements of 40 CFR part 201 and § 210.25 of this part.

(b) These sources shall be considered in noncompliance whenever the test measurement, minus the appropriate tolerance (§ 210.25), exceeds the noise emission levels prescribed in appendix A of this part.

APPENDIX A TO PART 210—SUMMARY OF NOISE STANDARDS, 40 CFR PART 201

Paragraph and section	Noise source	Noise standard—A weighted sound level in dB	Noise measure [1]	Measurement location
	All Locomotives Manufactured on or Before 31 December 1979			
201.11(a)	Stationary, Idle Throttle Setting	73	L_{max} (slow)	30 m (100 ft)
201.11(a)	Stationary, All Other Throttle Settings	93	....do	Do.
201.12(a)	Moving	96	L_{max} (fast)	Do.
	All Locomotives Manufactured After 31 December 1979			
201.11(b)	Stationary, Idle Throttle Setting	70	L_{max} (slow)	Do.
201.11(b)	Stationary, All Other Throttle Settings	87	....do	Do.
201.12(b)	Moving	90	L_{max} (fast)	Do.
201.11(c) and 201.12(c).	*Additional Requirement for Switcher Locomotives Manufactured on or Before 31 December 1979 Operating in Yards Where Stationary Switcher and other Locomotive Noise Exceeds the Receiving Property Limit of.*	65	L_{90} (fast) [2]	Receiving property
201.11(c)	Stationary, Idle Throttle Setting	70	L_{max} (slow)	30 m (100 ft)
201.11(c)	Stationary, All Other Throttle Settings	87	....do	Do.
201.12(c)	Moving	90	L_{max} (fast)	Do.
	Rail Cars			
201.13(1)	Moving at Speeds of 45 mph or Less	88	....do	Do.
201.13(2)	Moving at Speeds Greater than 45 mph	93	....do	Do.
	Other Yard Equipment and Facilities			
201.14	Retarders	83	$L_{adjavemax}$ (fast)	Receiving property
201.15	Car-Coupling Operations	92	....do	Do.
201.16	*Locomotive Load Cell Test Stands, Where the Noise from Locomotive Load Cell Operations Exceeds the Receiving Property Limits of.*	65	L_{90} (fast) [2]	Do.
201.16(a)	Primary Standard	78	L_{max} (slow)	30 m (100 ft).

Paragraph and section	Noise source	Noise standard—A weighted sound level in dB	Noise measure [1]	Measurement location
201.16(b)	Secondary Standard if 30-m Measurement Not Feasible.	65	L_{90} (fast)	Receiving property located more than 120 m from Load Cell.

[1] L_{max}=Maximum sound level; L_{90}=Statistical sound level exceeded 90% of the time; $L_{adjavemax}$=Adjusted average maximum sound level.
[2] L_{90} must be validated by determining that L_{10}–L_{99} is less than or equal to 4dB (A).

[48 FR 56758, Dec. 23, 1983; 49 FR 1521, Jan. 12, 1984]

APPENDIX B TO PART 210—SWITCHER LOCOMOTIVE ENFORCEMENT POLICY

The EPA standards require that the noise emissions from all switcher locomotives in a particular facility be less than prescribed levels measured at 30 meters, under all operating modes. This requirement is deemed to be met unless ''receiving property'' noise due to switcher locomotives exceeds 65 dB(A), when measured in accordance with subpart C of 40 CFR part 201. The 65 dB(A) receiving property standard is the ''trigger'' for requiring the 30-meter test of switcher locomotives.

The purpose underlying FRA's enforcement of the noise standards is to reduce the impact of rail operations noise on receiving properties. In some instances, measures other than the 30-meter test approach may more effectively reduce the noise levels at receiving properties; therefore, FRA enforcement efforts will focus on abatement procedures that will achieve a reduction of receiving property noise levels to less than 65 dB(A).

For example, a parked, idling locomotive, even if equipped with exhaust silencing that meets the stationary locomotive standard (30-meter test), may cause the receiving property standard to be exceeded if located on trackage adjacent to the receiving property. In that case, application of the 30-meter test to other switcher locomotives at the facility may not serve to reduce the receiving property noise level. On the other hand, operational changes by the railroad could significantly reduce receiving property noise levels. In such case, FRA would consider retesting after abatement measures have been taken. If the receiving property noise level is below the trigger and the abatement action is adopted, FRA would not make a 30-meter test of the switcher locomotives at the facility.

PART 211—RULES OF PRACTICE

Subpart A—General

Subpart B—Rulemaking Procedures

Subpart C—Waivers

Subpart D—Emergency Orders

Subpart E—Miscellaneous Safety-Related Proceedings and Inquiries

APPENDIX B TO PART 221—APPROVED REAR END MARKING DEVICES

PART I—APPROVED DEVICES TESTED FOR OR BY MANUFACTURERS

1. Manufacturer: Star Headlight & Lantern Co., 168 West Main Street, Honeoye Falls, NY 14472.

FRA identification Nos. FRA-PLE-STAR-845-F (flasher) and FRA-PLE-STAR-845-C (steady burn).

2. Manufacturer: Julian A. McDermott Corp., 1639 Stephen Street, Ridgewood, Long Island, NY 11227.

FRA identification Nos. FRA-MEC-MCD-100-C (steady burn), FRA-MEC-MCD-100-F (flasher), FRA-MEC-MCD-300-C (steady burn), and FRA-MEC-MCD-300-F (flasher).

3. Manufacturer: American Electronics, Inc.,[1] 40 Essex Street, Hackensack, NJ 07601.

FRA identification Nos. FRA-DRGW-YANK-300 (portable strobe), FRA-WP-YANK-301R (flashing), FRA-WP-YANK-305R (flashing), and FRA-WP-YANK-306R (steady burn).

PART II—APPROVED DEVICES TESTED FOR OR BY RAIL CARRIERS

1. Carrier: Atchison, Topeka & Santa Fe Railway Co., Technical Research & Development Department, 1001 Northeast Atchison Street, Topeka, Kans. 66616.

Manufacturer: Trans-Lite, Inc., P.O. Box 70, Milford, Conn. 06460.

FRA identification Nos. FRA-ATSF-TL-875-150, FRA-ATSF-TL-875-60, FRA-ATSF-TL-875-4412, and FRA-ATSF-TL-200.

2. Carrier: Amtrak—National Railroad Passenger Corporation, 400 North Capitol Street NW., Washington, DC 20001.

Manufacturer: (a) Trans-Lite, Inc., P.O. Box 70, Milford, Conn. 06460.

FRA identification Nos. FRA-ATK-TL-3895-1, FRA-ATK-TL-4491-2, FRA-ATK-TL-4491-3, and FRA-ATK-TL-FM-4491-1.

Manufacturer: (b) Luminator Division of Gulfton Industries, Inc., 1200 East Dallas North Parkway, Plano, Tex. 75074.

FRA identification No. FRA-ATK-LUM-0101890-001.

Manufacturer: (c) Whelen Engineering Co., Inc., Deep River, Conn. 06417.

FRA identification No. FRA-ATK-WHE-WERT-12.

[43 FR 36447, Aug. 17, 1978]

[1] NOTE: Yankee Metal Products Corp. previously produced these devices.

APPENDIX C TO PART 221—SCHEDULE OF CIVIL PENALTIES[1]

Section	Violation	Willful violation
221.13 Marking device display:		
(a) device not present, not displayed, or not properly illuminated	$5,000	$7,500
(d) device too close to rail	1,000	2,000
221.14 Marking devices: Use of unapproved or noncomplying device	2,500	5,000
221.15 Marking device inspection:		
(a) Failure to inspect at crew change	2,500	5,000
(b), (c) improper inspection	2,500	5,000
221.16 Inspection procedure:		
(a) Failure to obtain protection	5,000	7,500
(b) Improper protection	2,500	5,000
221.17 Movement of defective equipment	(1)	(1)

[53 FR 52930, Dec. 29, 1988, as amended at 69 FR 62818, Oct. 28, 2004]

PART 222—USE OF LOCOMOTIVE HORNS AT PUBLIC HIGHWAY-RAIL GRADE CROSSINGS

Subpart A—General

Sec.

Subpart B—Use of Locomotive Horns

[1] A penalty may be assessed against an individual only for a willful violation. The Administrator reserves the right to assess a penalty of up to $27,000 for any violation where circumstances warrant. See 49 CFR part 209, appendix A. Where the conditions for movement of defective equipment set forth in §221.17 of this part are not met, the movement constitutes a violation of §221.13 of this part.

AUTHORITY: 28 U.S.C. 2461, note; 49 U.S.C. 20103, 20107, 20153, 21301, 21304; 49 CFR 1.49.

SOURCE: 71 FR 47634, Aug. 17, 2006, unless otherwise noted.

Subpart A—General

§ 222.1 What is the purpose of this regulation?

The purpose of this part is to provide for safety at public highway-rail grade crossings by requiring locomotive horn use at public highway-rail grade crossings except in quiet zones established and maintained in accordance with this part.

§ 222.3 What areas does this regulation cover?

(a) This part prescribes standards for sounding locomotive horns when locomotives approach and pass through public highway-rail grade crossings. This part also provides standards for the creation and maintenance of quiet zones within which locomotive horns need not be sounded.

(b) The provisions of this part are separate and severable from one another. If any provision is stayed or determined to be invalid, it is the intent of FRA that the remaining provisions shall continue in effect.

(c) This part does not apply to any Chicago Region highway-rail grade crossing where the railroad was excused from sounding the locomotive horn by the Illinois Commerce Commission, and where the railroad did not sound the horn, as of December 18, 2003.

§ 222.5 What railroads does this regulation apply to?

This part applies to all railroads except:

(a) A railroad that exclusively operates freight trains only on track which is not part of the general railroad system of transportation;

(b) Passenger railroads that operate only on track which is not part of the general railroad system of transportation and that operate at a maximum speed of 15 miles per hour over public highway-rail grade crossings; and

(c) Rapid transit operations within an urban area that are not connected

to the general railroad system of transportation. See 49 CFR part 209, appendix A for the definitive statement of the meaning of the preceding sentence.

§ 222.7 What is this regulation's effect on State and local laws and ordinances?

(a) Except as provided in paragraph (b) of this section, issuance of this part preempts any State law, rule, regulation, or order governing the sounding of the locomotive horn at public highway-rail grade crossings, in accordance with 49 U.S.C. 20106.

(b) This part does not preempt any State law, rule, regulation, or order governing the sounding of locomotive audible warning devices at any highway-rail grade crossing described in § 222.3(c) of this part.

(c) Except as provided in §§ 222.25 and 222.27, this part does not preempt any State law, rule, regulation, or order governing the sounding of locomotive horns at private highway-rail grade crossings or pedestrian crossings.

(d) Inclusion of SSMs and ASMs in this part or approved subsequent to issuance of this part does not constitute federal preemption of State law regarding whether those measures may be used for traffic control. Individual states may continue to determine whether specific SSMs or ASMs are appropriate traffic control measures for that State, consistent with Federal Highway Administration regulations and the MUTCD. However, except for the SSMs and ASMs implemented at highway-rail grade crossings described in § 222.3(c) of this part, inclusion of SSMs and ASMs in this part does constitute federal preemption of State law concerning the sounding of the locomotive horn in relation to the use of those measures.

(e) Issuance of this part does not constitute federal preemption of administrative procedures required under State law regarding the modification or installation of engineering improvements at highway-rail grade crossings.

§ 222.9 Definitions.

As used in this part—

Administrator means the Administrator of the Federal Railroad Administration or the Administrator's delegate.

Alternative safety measures (ASM) means a safety system or procedure, other than an SSM, established in accordance with this part which is provided by the appropriate traffic control authority or law enforcement authority and which, after individual review and analysis by the Associate Administrator, is determined to be an effective substitute for the locomotive horn in the prevention of highway-rail casualties at specific highway-rail grade crossings. Appendix B to this part lists such measures.

Associate Administrator means the Associate Administrator for Safety of the Federal Railroad Administration or the Associate Administrator's delegate.

Channelization device means a traffic separation system made up of a raised longitudinal channelizer, with vertical panels or tubular delineators, that is placed between opposing highway lanes designed to alert or guide traffic around an obstacle or to direct traffic in a particular direction. ''Tubular markers'' and ''vertical panels'', as described in the MUTCD, are acceptable channelization devices for purposes of this part. Additional design specifications are determined by the standard traffic design specifications used by the governmental entity constructing the channelization device.

Chicago Region means the following six counties in the State of Illinois: Cook, DuPage, Lake, Kane, McHenry and Will.

Crossing Corridor Risk Index means a number reflecting a measure of risk to the motoring public at public grade crossings along a rail corridor, calculated in accordance with the procedures in appendix D of this part, representing the average risk at each public crossing within the corridor. This risk level is determined by averaging among all public crossings within the corridor, the product of the number of predicted collisions per year and the predicted likelihood and severity of casualties resulting from those collisions at each public crossing within the corridor.

Diagnostic team as used in this part, means a group of knowledgeable representatives of parties of interest in a

highway-rail grade crossing, organized by the public authority responsible for that crossing, who, using crossing safety management principles, evaluate conditions at a grade crossing to make determinations or recommendations for the public authority concerning safety needs at that crossing.

Effectiveness rate means a number between zero and one which represents the reduction of the likelihood of a collision at a public highway-rail grade crossing as a result of the installation of an SSM or ASM when compared to the same crossing equipped with conventional active warning systems of flashing lights and gates. Zero effectiveness means that the SSM or ASM provides no reduction in the probability of a collision, while an effectiveness rating of one means that the SSM or ASM is totally effective in eliminating collision risk. Measurements between zero and one reflect the percentage by which the SSM or ASM reduces the probability of a collision.

FRA means the Federal Railroad Administration.

Grade Crossing Inventory Form means the U.S. DOT National Highway-Rail Grade Crossing Inventory Form, FRA Form F6180.71. This form is available through the FRA's Office of Safety, or on FRA's Web site at *http://www.fra.dot.gov*.

Intermediate Partial Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail grade crossings at which State statutes or local ordinances restricted the routine sounding of locomotive horns for a specified period of time during the evening or nighttime hours, or at which locomotive horns did not sound due to formal or informal agreements between the community and the railroad or railroads for a specified period of time during the evening and/or nighttime hours, and at which such statutes, ordinances or agreements were in place and enforced or observed as of December 18, 2003, but not as of October 9, 1996.

Intermediate Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail grade crossings at which State statutes or local ordinances restricted the routine sounding of locomotive horns, or at which locomotive horns did not sound due to formal or informal agreements between the community and the railroad or railroads, and at which such statutes, ordinances or agreements were in place and enforced or observed as of December 18, 2003, but not as of October 9, 1996.

Locomotive means a piece of on-track equipment other than hi-rail, specialized maintenance, or other similar equipment—

(1) With one or more propelling motors designed for moving other equipment;

(2) With one or more propelling motors designed to carry freight or passenger traffic or both; or

(3) Without propelling motors but with one or more control stands.

Locomotive audible warning device means a horn, whistle, siren, or bell affixed to a locomotive that is capable of producing an audible signal.

Locomotive horn means a locomotive air horn, steam whistle, or similar audible warning device (see 49 CFR 229.129) mounted on a locomotive or control cab car. The terms ''locomotive horn'', ''train whistle'', ''locomotive whistle'', and ''train horn'' are used interchangeably in the railroad industry. For purposes of this part, locomotive horns used in rapid transit operations must be suitable for street usage and/or designed in accordance with State law requirements.

Median means the portion of a divided highway separating the travel ways for traffic in opposite directions.

MUTCD means the Manual on Uniform Traffic Control Devices published by the Federal Highway Administration.

Nationwide Significant Risk Threshold means a number reflecting a measure of risk, calculated on a nationwide basis, which reflects the average level of risk to the motoring public at public highway-rail grade crossings equipped with flashing lights and gates and at which locomotive horns are sounded. For purposes of this rule, a risk level above the Nationwide Significant Risk Threshold represents a significant risk with respect to loss of life or serious

personal injury. The Nationwide Significant Risk Threshold is calculated in accordance with the procedures in appendix D of this part. Unless otherwise indicated, references in this part to the Nationwide Significant Risk Threshold reflect its level as last published by FRA in the FEDERAL REGISTER.

New Partial Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail crossings at which locomotive horns are not routinely sounded between the hours of 10 p.m. and 7 a.m., but are routinely sounded during the remaining portion of the day, and which does not qualify as a Pre-Rule Partial Quiet Zone or an Intermediate Partial Quiet Zone.

New Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail grade crossings at which routine sounding of locomotive horns is restricted pursuant to this part and which does not qualify as either a Pre-Rule Quiet Zone or Intermediate Quiet Zone.

Non-traversable curb means a highway curb designed to discourage a motor vehicle from leaving the roadway. Non-traversable curbs are used at locations where highway speeds do not exceed 40 miles per hour and are at least six inches high. Additional design specifications are determined by the standard traffic design specifications used by the governmental entity constructing the curb.

Partial Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail grade crossings at which locomotive horns are not routinely sounded for a specified period of time during the evening and/or nighttime hours.

Pedestrian grade crossing means, for purposes of this part, a separate designed sidewalk or pathway where pedestrians, but not vehicles, cross railroad tracks. Sidewalk crossings contiguous with, or separate but adjacent to, public highway-rail grade crossings are presumed to be part of the public highway-rail grade crossing and are not considered pedestrian grade crossings.

Power-out indicator means a device which is capable of indicating to trains approaching a grade crossing equipped with an active warning system whether commercial electric power is activating the warning system at that crossing. This term includes remote health monitoring of grade crossing warning systems if such monitoring system is equipped to indicate power status.

Pre-existing Modified Supplementary Safety Measure (Pre-existing Modified SSM) means a safety system or procedure that is listed in appendix A to this Part, but is not fully compliant with the standards set forth therein, which was installed before December 18, 2003 by the appropriate traffic control or law enforcement authority responsible for safety at the highway-rail grade crossing. The calculation of risk reduction credit for pre-existing modified SSMs is addressed in appendix B of this part.

Pre-existing Supplementary Safety Measure (Pre-existing SSM) means a safety system or procedure established in accordance with this part before December 18, 2003 which was provided by the appropriate traffic control or law enforcement authority responsible for safety at the highway-rail grade crossing. These safety measures must fully comply with the SSM requirements set forth in appendix A of this part. The calculation of risk reduction credit for qualifying pre-existing SSMs is addressed in appendix A.

Pre-Rule Partial Quiet Zone means a segment of a rail line within which is situated one or a number of consecutive public highway-rail crossings at which State statutes or local ordinances restricted the routine sounding of locomotive horns for a specified period of time during the evening and/or nighttime hours, or at which locomotive horns did not sound due to formal or informal agreements between the community and the railroad or railroads for a specified period of time during the evening and/or nighttime hours, and at which such statutes, ordinances or agreements were in place and enforced or observed as of October 9, 1996 and on December 18, 2003.

Pre-Rule Quiet Zone means a segment of a rail line within which is situated

one or a number of consecutive public highway-rail crossings at which State statutes or local ordinances restricted the routine sounding of locomotive horns, or at which locomotive horns did not sound due to formal or informal agreements between the community and the railroad or railroads, and at which such statutes, ordinances or agreements were in place and enforced or observed as of October 9, 1996 and on December 18, 2003.

Private highway-rail grade crossing means, for purposes of this part, a highway-rail grade crossing which is not a public highway-rail grade crossing.

Public authority means the public entity responsible for traffic control or law enforcement at the public highway-rail grade or pedestrian crossing.

Public highway-rail grade crossing means, for purposes of this part, a location where a public highway, road, or street, including associated sidewalks or pathways, crosses one or more railroad tracks at grade. If a public authority maintains the roadway on both sides of the crossing, the crossing is considered a public crossing for purposes of this part.

Quiet zone means a segment of a rail line, within which is situated one or a number of consecutive public highway-rail crossings at which locomotive horns are not routinely sounded.

Quiet Zone Risk Index means a measure of risk to the motoring public which reflects the Crossing Corridor Risk Index for a quiet zone, after adjustment to account for increased risk due to lack of locomotive horn use at the crossings within the quiet zone (if horns are presently sounded at the crossings) and reduced risk due to implementation, if any, of SSMs and ASMs with the quiet zone. The calculation of the Quiet Zone Risk Index, which is explained in appendix D of this part, does not differ for partial quiet zones.

Railroad means any form of non-highway ground transportation that runs on rails or electromagnetic guideways and any entity providing such transportation, including:

(1) Commuter or other short-haul railroad passenger service in a metropolitan or suburban area and commuter railroad service that was operated by the Consolidated Rail Corporation on January 1, 1979; and

(2) High speed ground transportation systems that connect metropolitan areas, without regard to whether those systems use new technologies not associated with traditional railroads; but does not include rapid transit operations in an urban area that are not connected to the general railroad system of transportation.

Recognized State agency means, for purposes of this part, a State agency, responsible for highway-rail grade crossing safety or highway and road safety, that has applied for and been approved by FRA as a participant in the quiet zone development process.

Relevant collision means a collision at a highway-rail grade crossing between a train and a motor vehicle, excluding the following: a collision resulting from an activation failure of an active grade crossing warning system; a collision in which there is no driver in the motor vehicle; or a collision in which the highway vehicle struck the side of the train beyond the fourth locomotive unit or rail car. With respect to Pre-Rule Partial Quiet Zones, a relevant collision shall not include collisions that occur during the time period within which the locomotive horn is routinely sounded.

Risk Index With Horns means a measure of risk to the motoring public when locomotive horns are routinely sounded at every public highway-rail grade crossing within a quiet zone. In Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones, the Risk Index With Horns is determined by adjusting the Crossing Corridor Risk Index to account for the decreased risk that would result if locomotive horns were routinely sounded at each public highway-rail grade crossing.

Supplementary safety measure (SSM) means a safety system or procedure established in accordance with this part which is provided by the appropriate traffic control authority or law enforcement authority responsible for safety at the highway-rail grade crossing, that is determined by the Associate Administrator to be an effective substitute for the locomotive horn in

the prevention of highway-rail casualties. Appendix A of this part lists such SSMs.

Waiver means a temporary or permanent modification of some or all of the requirements of this part as they apply to a specific party under a specific set of facts. Waiver does not refer to the process of establishing quiet zones or approval of quiet zones in accordance with the provisions of this part.

Wayside horn means a stationary horn located at a highway rail grade crossing, designed to provide, upon the approach of a locomotive or train, audible warning to oncoming motorists of the approach of a train.

§ 222.11 What are the penalties for failure to comply with this regulation?

Any person who violates any requirement of this part or causes the violation of any such requirement is subject to a civil penalty of least $550 and not more than $11,000 per violation, except that: Penalties may be assessed against individuals only for willful violations, and, where a grossly negligent violation or a pattern of repeated violations has created an imminent hazard of death or injury to persons, or has caused death or injury, a penalty not to exceed $27,000 per violation may be assessed. Each day a violation continues shall constitute a separate offense. Any person who knowingly and willfully falsifies a record or report required by this part may be subject to criminal penalties under 49 U.S.C. 21311. Appendix G of this part contains a schedule of civil penalty amounts used in connection with this part.

EFFECTIVE DATE NOTE: At 72 FR 51197, Sept. 6, 2007, § 222.11 was amended by removing the numerical amount "$11,000" and adding in its place the numerical amount "$16,000", effective October 9, 2007.

§ 222.13 Who is responsible for compliance?

Any person, including but not limited to a railroad, contractor for a railroad, or a local or State governmental entity that performs any function covered by this part, must perform that function in accordance with this part.

§ 222.15 How does one obtain a waiver of a provision of this regulation?

(a) Except as provided in paragraph (b) of this section, two parties must jointly file a petition (request) for a waiver. They are the railroad owning or controlling operations over the railroad tracks crossing the public highway-rail grade crossing and the public authority which has jurisdiction over the roadway crossing the railroad tracks.

(b) If the railroad and the public authority cannot reach agreement to file a joint petition, either party may file a request for a waiver; however, the filing party must specify in its petition the steps it has taken in an attempt to reach agreement with the other party, and explain why applying the requirement that a joint submission be made in that instance would not be likely to contribute significantly to public safety. If the Associate Administrator determines that applying the requirement for a jointly filed submission to that particular petition would not be likely to significantly contribute to public safety, the Associate Administrator shall waive the requirement for joint submission and accept the petition for consideration. The filing party must also provide the other party with a copy of the petition filed with FRA.

(c) Each petition for waiver must be filed in accordance with 49 CFR part 211.

(d) If the Administrator finds that a waiver of compliance with a provision of this part is in the public interest and consistent with the safety of highway and railroad users, the Administrator may grant the waiver subject to any conditions the Administrator deems necessary.

§ 222.17 How can a State agency become a recognized State agency?

(a) Any State agency responsible for highway-rail grade crossing safety and/or highway and road safety may become a recognized State agency by submitting an application to the Associate Administrator that contains:

(1) A detailed description of the proposed scope of involvement in the quiet zone development process;

(2) The name, address, and telephone number of the person(s) who may be

contacted to discuss the State agency application; and

(3) A statement from State agency counsel which affirms that the State agency is authorized to undertake the responsibilities proposed in its application.

(b) The Associate Administrator will approve the application if, in the Associate Administrator's judgment, the proposed scope of State agency involvement will facilitate safe and effective quiet zone development. The Associate Administrator may include in any decision of approval such conditions as he/she deems necessary and appropriate.

Subpart B—Use of Locomotive Horns

§ 222.21 When must a locomotive horn be used?

(a) Except as provided in this part, the locomotive horn on the lead locomotive of a train, lite locomotive consist, individual locomotive or lead cab car shall be sounded when such locomotive or lead cab car is approaching a public highway-rail grade crossing. Sounding of the locomotive horn with two long blasts, one short blast and one long blast shall be initiated at a location so as to be in accordance with paragraph (b) of this section and shall be repeated or prolonged until the locomotive occupies the crossing. This pattern may be varied as necessary where crossings are spaced closely together.

(b)(1) Railroads to which this part applies shall comply with all the requirements contained in this paragraph (b) beginning on December 15, 2006. On and after June 24, 2005, but prior to December 15, 2006, a railroad shall, at its option, comply with this section or shall sound the locomotive horn in the manner required by State law, or in the absence of State law, in the manner required by railroad operating rules in effect immediately prior to June 24, 2005.

(2) Except as provided in paragraphs (b)(3) and (d) of this section, or when the locomotive horn is defective and the locomotive is being moved for repair consistent with section 229.9 of this chapter, the locomotive horn shall begin to be sounded at least 15 seconds, but no more than 20 seconds, before the locomotive enters the crossing. It shall not constitute a violation of this section if, acting in good faith, a locomotive engineer begins sounding the locomotive horn not more than 25 seconds before the locomotive enters the crossing, if the locomotive engineer is unable to precisely estimate the time of arrival of the train at the crossing for whatever reason.

(3) Trains, locomotive consists and individual locomotives traveling at speeds in excess of 60 mph shall not begin sounding the horn more than one-quarter mile (1,320 feet) in advance of the nearest public highway-rail grade crossing, even if the advance warning provided by the locomotive horn will be less than 15 seconds in duration.

(c) As stated in § 222.3(c) of this part, this section does not apply to any Chicago Region highway-rail grade crossing at which railroads were excused from sounding the locomotive horn by the Illinois Commerce Commission, and where railroads did not sound the horn, as of December 18, 2003.

(d) Trains, locomotive consists and individual locomotives that have stopped in close proximity to a public highway-rail grade crossing may approach the crossing and sound the locomotive horn for less than 15 seconds before the locomotive enters the highway-rail grade crossing, if the locomotive engineer is able to determine that the public highway-rail grade crossing is not obstructed and either:

(1) The public highway-rail grade crossing is equipped with automatic flashing lights and gates and the gates are fully lowered; or

(2) There are no conflicting highway movements approaching the public highway-rail grade crossing.

(e) Where State law requires the sounding of a locomotive audible warning device other than the locomotive horn at public highway-rail grade crossings, that locomotive audible warning device shall be sounded in accordance with paragraphs (b) and (d) of this section.

§ 222.23 How does this regulation affect sounding of a horn during an emergency or other situations?

(a)(1) Notwithstanding any other provision of this part, a locomotive engineer may sound the locomotive horn to provide a warning to animals, vehicle operators, pedestrians, trespassers or crews on other trains in an emergency situation if, in the locomotive engineer's sole judgment, such action is appropriate in order to prevent imminent injury, death, or property damage.

(2) Notwithstanding any other provision of this part, including provisions addressing the establishment of a quiet zone, limits on the length of time in which a horn may be sounded, or installation of wayside horns within quiet zones, this part does not preclude the sounding of locomotive horns in emergency situations, nor does it impose a legal duty to sound the locomotive horn in such situations.

(b) Nothing in this part restricts the use of the locomotive horn in the following situations:

(1) When a wayside horn is malfunctioning;

(2) When active grade crossing warning devices have malfunctioned and use of the horn is required by one of the following sections of this chapter: §§ 234.105, 234.106, or 234.107;

(3) When grade crossing warning systems are temporarily out of service during inspection, maintenance, or testing of the system; or

(4) When SSMs, modified SSMs or engineering SSMs no longer comply with the requirements set forth in appendix A of this part or the conditions contained within the Associate Administrator's decision to approve the quiet zone in accordance with section 222.39(b) of this part.

(c) Nothing in this part restricts the use of the locomotive horn for purposes other than highway-rail crossing safety (e.g., to announce the approach of a train to roadway workers in accordance with a program adopted under part 214 of this chapter, or where required for other purposes under railroad operating rules).

§ 222.25 How does this rule affect private highway-rail grade crossings?

This rule does not require the routine sounding of locomotive horns at private highway-rail grade crossings. However, where State law requires the sounding of a locomotive horn at private highway-rail grade crossings, the locomotive horn shall be sounded in accordance with § 222.21 of this part. Where State law requires the sounding of a locomotive audible warning device other than the locomotive horn at private highway-rail grade crossings, that locomotive audible warning device shall be sounded in accordance with §§ 222.21(b) and (d) of this part.

(a) Private highway-rail grade crossings located within the boundaries of a quiet zone must be included in the quiet zone.

(b)(1) Private highway-rail grade crossings that are located in New Quiet Zones or New Partial Quiet Zones and allow access to the public, or which provide access to active industrial or commercial sites, must be evaluated by a diagnostic team and equipped or treated in accordance with the recommendations of such diagnostic team.

(2) The public authority shall provide the State agency responsible for grade crossing safety and all affected railroads an opportunity to participate in the diagnostic team review of private highway-rail grade crossings.

(c)(1) At a minimum, each approach to every private highway-rail grade crossing within a New Quiet Zone or New Partial Quiet Zone shall be marked by a crossbuck and a ''STOP'' sign, which are compliant with MUTCD standards unless otherwise prescribed by State law, and shall be equipped with advance warning signs in compliance with § 222.35(c) of this part.

(2) At a minimum, each approach to every private highway-rail grade crossing within a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone shall, by June 24, 2008, be marked by a crossbuck and a ''STOP'' sign, which are compliant with MUTCD standards unless otherwise prescribed by State law, and shall be equipped with advance warning signs in compliance with § 222.35(c) of this part.

§ 222.27 How does this rule affect pedestrian grade crossings?

This rule does not require the routine sounding of locomotive horns at pedestrian grade crossings. However, where State law requires the sounding of a locomotive horn at pedestrian grade crossings, the locomotive horn shall be sounded in accordance with §222.21 of this part. Where State law requires the sounding of a locomotive audible warning device other than the locomotive horn at pedestrian grade crossings, that locomotive audible warning device shall be sounded in accordance with §§222.21(b) and (d) of this part.

(a) Pedestrian grade crossings located within the boundaries of a quiet zone must be included in the quiet zone.

(b) Pedestrian grade crossings that are located in New Quiet Zones or New Partial Quiet Zones must be evaluated by a diagnostic team and equipped or treated in accordance with the recommendations of such diagnostic team.

(c) The public authority shall provide the State agency responsible for grade crossing safety and all affected railroads an opportunity to participate in diagnostic team reviews of pedestrian grade crossings.

(d) *Advance warning signs.* (1) Each approach to every pedestrian grade crossing within a New Quiet Zone shall be equipped with a sign that advises the pedestrian that train horns are not sounded at the crossing. Such sign shall conform to the standards contained in the MUTCD.

(2) Each approach to every pedestrian grade crossing within a New Partial Quiet Zone shall be equipped with a sign that advises the pedestrian that train horns are not sounded at the crossing or that train horns are not sounded at the crossing between the hours of 10 p.m. and 7 a.m., whichever is applicable. Such sign shall conform to the standards contained in the MUTCD.

(3) Each approach to every pedestrian grade crossing within a Pre-Rule Quiet Zone shall be equipped by June 24, 2008 with a sign that advises the pedestrian that train horns are not sounded at the crossing. Such sign shall conform to the standards contained in the MUTCD.

(4) Each approach to every pedestrian grade crossing within a Pre-Rule Partial Quiet Zone shall be equipped by June 24, 2008 with a sign that advises the pedestrian that train horns are not sounded at the crossing or that train horns are not sounded at the crossing for a specified period of time, whichever is applicable. Such sign shall conform to the standards contained in the MUTCD.

Subpart C—Exceptions to the Use of the Locomotive Horn

§ 222.31 [Reserved]

SILENCED HORNS AT INDIVIDUAL CROSSINGS

§ 222.33 Can locomotive horns be silenced at an individual public highway-rail grade crossing which is not within a quiet zone?

(a) A railroad operating over an individual public highway-rail crossing may, at its discretion, cease the sounding of the locomotive horn if the locomotive speed is 15 miles per hour or less and train crew members, or appropriately equipped flaggers, as defined in 49 CFR 234.5, flag the crossing to provide warning of approaching trains to motorists.

(b) This section does not apply where active grade crossing warning devices have malfunctioned and use of the horn is required by 49 CFR 234.105, 234.106, or 234.107.

SILENCED HORNS AT GROUPS OF CROSSINGS—QUIET ZONES

§ 222.35 What are the minimum requirements for quiet zones?

The following requirements apply to quiet zones established in conformity with this part.

(a) *Minimum length.* (1)(i) Except as provided in paragraph (a)(1)(ii) of this section, the minimum length of a New Quiet Zone or New Partial Quiet Zone established under this part shall be one-half mile along the length of railroad right-of-way.

(ii) The one-half mile minimum length requirement shall be waived for any New Quiet Zone or New Partial Quiet Zone that is added onto an existing quiet zone, provided there is no

public highway-rail grade crossing at which locomotive horns are routinely sounded within one-half mile of the New Quiet Zone or New Partial Quiet Zone.

(iii) New Quiet Zones and New Partial Quiet Zones established along the same rail line within a single political jurisdiction shall be separated by at least one public highway-rail grade crossing, unless a New Quiet Zone or New Partial Quiet Zone is being added onto an existing quiet zone.

(2)(i) The length of a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone may continue unchanged from that which existed as of October 9, 1996.

(ii) With the exception of combining adjacent Pre-Rule Quiet Zones or Pre-Rule Partial Quiet Zones, the addition of any public highway-rail grade crossing to a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone shall end the grandfathered status of that quiet zone and transform it into a New Quiet Zone or New Partial Quiet Zone that must comply with all requirements applicable to New Quiet Zones and New Partial Quiet Zones.

(iii) The deletion of any public highway-rail grade crossing from a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone, with the exception of a grade separation or crossing closure, must result in a quiet zone of at least one-half mile in length in order to retain Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone status.

(3) A quiet zone may include grade crossings on a segment of rail line crossing more than one political jurisdiction.

(b) *Active grade crossing warning devices.* (1) Each public highway-rail grade crossing in a New Quiet Zone established under this part must be equipped, no later than the quiet zone implementation date, with active grade crossing warning devices comprising both flashing lights and gates which control traffic over the crossing and that conform to the standards contained in the MUTCD. Such warning devices shall be equipped with constant warning time devices, if reasonably practical, and power-out indicators.

(2) With the exception of public highway-rail grade crossings that will be temporarily closed in accordance with appendix A of this part, each public highway-rail grade crossing in a New Partial Quiet Zone established under this part must be equipped, no later than the quiet zone implementation date, with active grade crossing warning devices comprising both flashing lights and gates which control traffic over the crossing and that conform to the standards contained in the MUTCD. Such warning devices shall be equipped with constant warning time devices, if reasonably practical, and power-out indicators.

(3) Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones must retain, and may upgrade, the grade crossing safety warning system which existed as of December 18, 2003. Any upgrade involving the installation or renewal of an automatic warning device system shall include constant warning time devices, where reasonably practical, and power-out indicators. In no event may the grade crossing safety warning system, which existed as of December 18, 2003, be downgraded. Risk reduction resulting from upgrading to flashing lights or gates may be credited in calculating the Quiet Zone Risk Index.

(c) *Advance warning signs.* (1) Each highway approach to every public and private highway-rail grade crossing within a New Quiet Zone shall be equipped with an advance warning sign that advises the motorist that train horns are not sounded at the crossing. Such sign shall conform to the standards contained in the MUTCD.

(2) Each highway approach to every public and private highway-rail grade crossing within a New Partial Quiet Zone shall be equipped with an advance warning sign that advises the motorist that train horns are not sounded at the crossing or that train horns are not sounded at the crossing between the hours of 10 p.m. and 7 a.m., whichever is applicable. Such sign shall conform to the standards contained in the MUTCD.

(3) Each highway approach to every public and private highway-rail grade crossing within a Pre-Rule Quiet Zone shall be equipped by June 24, 2008 with an advance warning sign that advises the motorist that train horns are not sounded at the crossing. Such sign

shall conform to the standards contained in the MUTCD.

(4) Each highway approach to every public and private highway-rail grade crossing within a Pre-Rule Partial Quiet Zone shall be equipped by June 24, 2008 with an advance warning sign that advises the motorist that train horns are not sounded at the crossing or that train horns are not sounded at the crossing for a specified period of time, whichever is applicable. Such sign shall conform to the standards contained in the MUTCD.

(5) This paragraph (c) does not apply to public and private highway-rail grade crossings equipped with wayside horns that conform to the requirements set forth in §222.59 and Appendix E of this part.

(d) *Bells.* (1) Each public highway-rail grade crossing in a New Quiet Zone or New Partial Quiet Zone that is subjected to pedestrian traffic and equipped with one or more automatic bells shall retain those bells in working condition.

(2) Each public highway-rail grade crossing in a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone that is subjected to pedestrian traffic and equipped with one or more automatic bells shall retain those bells in working condition.

(e) All private highway-rail grade crossings within the quiet zone must be treated in accordance with this section and §222.25 of this part.

(f) All pedestrian grade crossings within a quiet zone must be treated in accordance with §222.27 of this part.

(g) All public highway-rail grade crossings within the quiet zone must be in compliance with the requirements of the MUTCD.

§222.37 Who may establish a quiet zone?

(a) A public authority may establish quiet zones that are consistent with the provisions of this part. If a proposed quiet zone includes public highway-rail grade crossings under the authority and control of more than one public authority (such as a county road and a State highway crossing the railroad tracks at different crossings), both public authorities must agree to establishment of the quiet zone, and must jointly, or by delegation provided to one of the authorities, take such actions as are required by this part.

(b) A public authority may establish quiet zones irrespective of State laws covering the subject matter of sounding or silencing locomotive horns at public highway-rail grade crossings. Nothing in this part, however, is meant to affect any other applicable role of State agencies or the Federal Highway Administration in decisions regarding funding or construction priorities for grade crossing safety projects, selection of traffic control devices, or engineering standards for roadways or traffic control devices.

(c) A State agency may provide administrative and technical services to public authorities by advising them, acting on their behalf, or acting as a central contact point in dealing with FRA; however, any public authority eligible to establish a quiet zone under this part may do so.

§222.38 Can a quiet zone be created in the Chicago Region?

Public authorities that are eligible to establish quiet zones under this part may create New Quiet Zones or New Partial Quiet Zones in the Chicago Region, provided the New Quiet Zone or New Partial Quiet Zone does not include any highway-rail grade crossing described in §222.3(c) of this part.

§222.39 How is a quiet zone established?

(a) *Public authority designation.* This paragraph (a) describes how a quiet zone may be designated by a public authority without the need for formal application to, and approval by, FRA. If a public authority complies with either paragraph (a)(1), (a)(2), or (a)(3) of this section, and complies with the information and notification provisions of §222.43 of this part, a public authority may designate a quiet zone without the necessity for FRA review and approval.

(1) A quiet zone may be established by implementing, at every public highway-rail grade crossing within the quiet zone, one or more SSMs identified in appendix A of this part.

(2) A quiet zone may be established if the Quiet Zone Risk Index is at, or

below, the Nationwide Significant Risk Threshold, as follows:

(i) If the Quiet Zone Risk Index is already at, or below, the Nationwide Significant Risk Threshold without being reduced by implementation of SSMs; or

(ii) If SSMs are implemented which are sufficient to reduce the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Threshold.

(3) A quiet zone may be established if SSMs are implemented which are sufficient to reduce the Quiet Zone Risk Index to a level at or below the Risk Index With Horns.

(b) *Public authority application to FRA.* (1) A public authority may apply to the Associate Administrator for approval of a quiet zone that does not meet the standards for public authority designation under paragraph (a) of this section, but in which it is proposed that one or more safety measures be implemented. Such proposed quiet zone may include only ASMs, or a combination of ASMs and SSMs at various crossings within the quiet zone. Note that an engineering improvement which does not fully comply with the requirements for an SSM under appendix A of this part, is considered to be an ASM. The public authority's application must:

(i) Contain an accurate, complete and current Grade Crossing Inventory Form for each public, private and pedestrian grade crossing within the proposed quiet zone;

(ii) Contain sufficient detail concerning the present safety measures at each public, private and pedestrian grade crossing proposed to be included in the quiet zone to enable the Associate Administrator to evaluate their effectiveness;

(iii) Contain detailed information about diagnostic team reviews of any crossing within the proposed quiet zone, including a membership list and a list of recommendations made by the diagnostic team;

(iv) Contain a statement describing efforts taken by the public authority to address comments submitted by each railroad operating the public highway-rail grade crossings within the quiet zone, the State agency responsible for highway and road safety, and the State agency responsible for grade crossing safety in response to the Notice of Intent. This statement shall also list any objections to the proposed quiet zone that were raised by the railroad(s) and State agencies;

(v) Contain detailed information as to which safety improvements are proposed to be implemented at each public, private, or pedestrian grade crossing within the proposed quiet zone;

(vi) Contain a commitment to implement the proposed safety improvements within the proposed quiet zone; and

(vii) Demonstrate through data and analysis that the proposed implementation of these measures will reduce the Quiet Zone Risk Index to a level at, or below, either the Risk Index With Horns or the Nationwide Significant Risk Threshold.

(2) If the proposed quiet zone contains newly established public or private highway-rail grade crossings, the public authority's application for approval must also include five-year projected vehicle and rail traffic counts for each newly established grade crossing;

(3) *60-day comment period.* (i) The public authority application for FRA approval of the proposed quiet zone shall be provided, by certified mail, return receipt requested, to: all railroads operating over the public highway-rail grade crossings within the quiet zone; the highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone; the landowner having control over any private highway-rail grade crossings within the quiet zone; the State agency responsible for highway and road safety; the State agency responsible for grade crossing safety; and the Associate Administrator.

(ii) Except as provided in paragraph (b)(3)(iii) of this section, any party that receives a copy of the public authority application may submit comments on the public authority application to the Associate Administrator during the 60-day period after the date on which the public authority application was mailed.

(iii) If the public authority application for FRA approval contains written

statements from each railroad operating over the public highway-rail grade crossings within the quiet zone, the highway or traffic control authority or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety stating that the railroad, vehicular traffic authority and State agencies have waived their rights to provide comments on the public authority application, the 60-day comment period under paragraph (b)(3)(ii) of this section shall be waived.

(4)(i) After reviewing any comments submitted under paragraph (b)(3)(ii) of this section, the Associate Administrator will approve the quiet zone if, in the Associate Administrator's judgment, the public authority is in compliance with paragraphs (b)(1) and (b)(2) of this section and has satisfactorily demonstrated that the SSMs and ASMs proposed by the public authority result in a Quiet Zone Risk Index that is either:

(A) At or below the Risk Index With Horns or

(B) At or below the Nationwide Significant Risk Threshold.

(ii) The Associate Administrator may include in any decision of approval such conditions as may be necessary to ensure that the proposed safety improvements are effective. If the Associate Administrator does not approve the quiet zone, the Associate Administrator will describe, in the decision, the basis upon which the decision was made. Decisions issued by the Associate Administrator on quiet zone applications shall be provided to all parties listed in paragraph (b)(3)(i) of this section and may be reviewed as provided in §§ 222.57(b) and (d) of this part.

(c) Appendix C of this part contains guidance on how to create a quiet zone.

§ 222.41 How does this rule affect Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones?

(a) *Pre-Rule Quiet Zones that will be established by automatic approval.* (1) A Pre-Rule Quiet Zone may be established by automatic approval and remain in effect, subject to § 222.51, if the Pre-Rule Quiet Zone is in compliance with §§ 222.35 (minimum requirements for quiet zones) and 222.43 of this part (notice and information requirements) and:

(i) The Pre-Rule Quiet Zone has at every public highway-rail grade crossing within the quiet zone one or more SSMs identified in appendix A of this part; or

(ii) The Quiet Zone Risk Index is at, or below, the Nationwide Significant Risk Threshold, as last published by FRA in the FEDERAL REGISTER; or

(iii) The Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold, as last published by FRA in the FEDERAL REGISTER, but less than twice the Nationwide Significant Risk Threshold and there have been no relevant collisions at any public highway-rail grade crossing within the quiet zone since April 27, 2000 or

(iv) The Quiet Zone Risk Index is at, or below, the Risk Index with Horns.

(2) The public authority shall provide Notice of Quiet Zone Establishment, in accordance with § 222.43 of this part, no later than December 24, 2005.

(b) *Pre-Rule Partial Quiet Zones that will be established by automatic approval.* (1) A Pre-Rule Partial Quiet Zone may be established by automatic approval and remain in effect, subject to § 222.51, if the Pre-Rule Partial Quiet Zone is in compliance with §§ 222.35 (minimum requirements for quiet zones) and 222.43 of this part (notice and information requirements) and:

(i) The Pre-Rule Partial Quiet Zone has at every public highway-rail grade crossing within the quiet zone one or more SSMs identified in appendix A of this part; or

(ii) The Quiet Zone Risk Index is at, or below, the Nationwide Significant Risk Threshold, as last published by FRA in the FEDERAL REGISTER; or

(iii) The Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold, as last published by FRA in the FEDERAL REGISTER, but less than twice the Nationwide Significant Risk Threshold and there have been no relevant collisions at any public highway-rail grade crossing within the quiet zone since April 27, 2000. With respect

to Pre-Rule Partial Quiet Zones, collisions that occurred during the time period within which the locomotive horn was routinely sounded shall not be considered ''relevant collisions''; or

(iv) The Quiet Zone Risk Index is at, or below, the Risk Index with Horns.

(2) The public authority shall provide Notice of Quiet Zone Establishment, in accordance with § 222.43 of this part, no later than December 24, 2005.

(c) *Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones that will not be established by automatic approval.* (1) If a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone will not be established by automatic approval under paragraph (a) or (b) of this section, existing restrictions may, at the public authority's discretion, remain in place until June 24, 2008, if a Notice of Quiet Zone Continuation is provided in accordance with § 222.43 of this part.

(2)(i) Existing restrictions on the routine sounding of the locomotive horn may remain in place until June 24, 2010, if:

(A) Notice of Intent is mailed, in accordance with § 222.43 of this part, by February 24, 2008; and

(B) A detailed plan for quiet zone improvements is filed with the Associate Administrator by June 24, 2008. The detailed plan shall include a detailed explanation of, and timetable for, the safety improvements that will be implemented at each public, private and pedestrian grade crossing located within the Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone which are necessary to comply with §§ 222.25, 222.27, 222.35 and 222.39 of this part.

(ii) In the event that the safety improvements planned for the quiet zone require approval of FRA under § 222.39(b) of this part, the public authority should apply for such approval prior to December 24, 2007, to ensure that FRA has ample time in which to review such application prior to the end of the extension period.

(3) Locomotive horn restrictions may continue for an additional three years beyond June 24, 2010, if:

(i) Prior to June 24, 2008, the appropriate State agency provides to the Associate Administrator: A comprehensive State-wide implementation plan and funding commitment for implementing improvements at Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones which, when implemented, would enable them to qualify as quiet zones under this part; and

(ii) Prior to June 24, 2009, either safety improvements are initiated at a portion of the crossings within the quiet zone, or the appropriate State agency has participated in quiet zone improvements in one or more Pre-Rule Quiet Zones or Pre-Rule Partial Quiet Zones elsewhere within the State.

(4) A public authority may establish a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone upon compliance with:

(A) The Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone requirements contained within §§ 222.25, 222.27, and 222.35 of this part;

(B) The quiet zone standards set forth in § 222.39 of this part; and

(C) All applicable notification and filing requirements contained within this paragraph (c) and § 222.43 of this part.

(d) *Pre-Rule Partial Quiet Zones that will be converted to 24-hour New Quiet Zones.* A Pre-Rule Partial Quiet Zone may be converted into a 24-hour New Quiet Zone, if:

(1) The quiet zone is brought into compliance with the New Quiet Zone requirements set forth in §§ 222.25, 222.27, and 222.35 of this part;

(2) The quiet zone is brought into compliance with the quiet zone standards set forth in § 222.39 of this part; and

(3) The public authority complies with all applicable notification and filing requirements contained within this paragraph (c) and § 222.43 of this part.

§ 222.42 How does this rule affect Intermediate Quiet Zones and Intermediate Partial Quiet Zones?

(a)(1) Existing restrictions may, at the public authority's discretion, remain in place within the Intermediate Quiet Zone or Intermediate Partial Quiet Zone until June 24, 2006, if the public authority provides Notice of Quiet Zone Continuation, in accordance with § 222.43 of this part.

(2) A public authority may continue locomotive horn sounding restrictions beyond June 24, 2006 by establishing a New Quiet Zone or New Partial Quiet Zone. A public authority may establish

a New Quiet Zone or New Partial Quiet Zone if:

(i) Notice of Intent is mailed, in accordance with § 222.43 of this part;

(ii) The quiet zone complies with the standards set forth in § 222.39 of this part;

(iii) The quiet zone complies with the New Quiet Zone standards set forth in §§ 222.25, 222.27, and 222.35 of this part;

(iv) Notice of Quiet Zone Establishment is mailed, in accordance with § 222.43 of this part, by June 3, 2006.

(b) *Conversion of Intermediate Partial Quiet Zones into 24-hour New Quiet Zones.* An Intermediate Partial Quiet Zone may be converted into a 24-hour New Quiet Zone if:

(1) Notice of Intent is mailed, in accordance with § 222.43 of this part;

(2) The quiet zone complies with the standards set forth in § 222.39 of this part;

(3) The quiet zone is brought into compliance with the New Quiet Zone requirements set forth in §§ 222.25, 222.27, and 222.35 of this part; and

(4) Notice of Quiet Zone Establishment is mailed, in accordance with § 222.43 of this part, by June 3, 2006.

§ 222.43 What notices and other information are required to create or continue a quiet zone?

(a)(1) The public authority shall provide written notice, by certified mail, return receipt requested, of its intent to create a New Quiet Zone or New Partial Quiet Zone under § 222.39 of this part or to implement new SSMs or ASMs within a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone under § 222.41(c) or (d) of this part. Such notification shall be provided to: All railroads operating over the public highway-rail grade crossings within the quiet zone; the State agency responsible for highway and road safety; and the State agency responsible for grade crossing safety.

(2) The public authority shall provide written notification, by certified mail, return receipt requested, to continue a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone under § 222.41 of this part or to continue an Intermediate Quiet Zone or Intermediate Partial Quiet Zone under § 222.42 of this part. Such notification shall be provided to: All railroads operating over the public highway-rail grade crossings within the quiet zone; the highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone; the landowner having control over any private highway-rail grade crossings within the quiet zone; the State agency responsible for highway and road safety; the State agency responsible for grade crossing safety; and the Associate Administrator.

(3) The public authority shall provided written notice, by certified mail, return receipt requested, of the establishment of a quiet zone under § 222.39 or 222.41 of this part. Such notification shall be provided to: All railroads operating over the public highway-rail grade crossings within the quiet zone; the highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone; the landowner having control over any private highway-rail grade crossings within the quiet zone; the State agency responsible for highway and road safety; the State agency responsible for grade crossing safety; and the Associate Administrator.

(b) *Notice of Intent*—(1) *Timing.* (i) The Notice of Intent shall be mailed at least 60 days before the mailing of the Notice of Quiet Zone Establishment, unless the public authority obtains written comments and/or ''no-comment'' statements from each railroad operating over public highway-rail grade crossings within the quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety, in accordance with paragraph (b)(3)(ii) of this section.

(ii) The Notice of Intent shall be mailed no later than February 24, 2008 for all Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones governed by §§ 222.41(c) and (d) of this part, in order to continue existing locomotive horn sounding restrictions beyond June 24, 2008 without interruption.

(2) *Required Contents.* The Notice of Intent shall include the following:

(i) A list of each public, private, and pedestrian grade crossing within the quiet zone, identified by both U.S. DOT

National Highway-Rail Grade Crossing Inventory Number and street or highway name, if applicable.

(ii) A statement of the time period within which restrictions would be imposed on the routine sounding of the locomotive horn (i.e., 24 hours or from 10 p.m. until 7 a.m.).

(iii) A brief explanation of the public authority's tentative plans for implementing improvements within the proposed quiet zone.

(iv) The name and title of the person who will act as point of contact during the quiet zone development process and the manner in which that person can be contacted.

(v) A list of the names and addresses of each party that will receive notification in accordance with paragraph (a)(1) of this section.

(3) *60-day comment period.* (i) A party that receives a copy of the public authority's Notice of Intent may submit information or comments about the proposed quiet zone to the public authority during the 60-day period after the date on which the Notice of Intent was mailed.

(ii) The 60-day comment period established under paragraph (b)(3)(i) of this section may terminate when the public authority obtains from each railroad operating over public highway-rail grade crossings within the proposed quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety:

(A) Written comments; or

(B) Written statements that the railroad and State agency do not have any comments on the Notice of Intent (''no-comment statements'').

(c) *Notice of Quiet Zone Continuation*—(1) *Timing.* (i) In order to prevent the resumption of locomotive horn sounding on June 24, 2005, the Notice of Quiet Zone Continuation under § 222.41 or 222.42 of this part shall be served no later than June 3, 2005.

(ii) If the Notice of Quiet Zone Continuation under § 222.41 or 222.42 of this part is mailed after June 3, 2005, the Notice of Quiet Zone Continuation shall state on which date locomotive horn use at grade crossings within the quiet zone shall cease, but in no event shall that date be earlier than 21 days after the date of mailing.

(2) *Required Contents.* The Notice of Quiet Zone Continuation shall include the following:

(i) A list of each public, private, and pedestrian grade crossing within the quiet zone, identified by both U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name.

(ii) A specific reference to the regulatory provision that provides the basis for quiet zone continuation, citing as appropriate, § 222.41 or 222.42 of this part.

(iii) A statement of the time period within which restrictions on the routine sounding of the locomotive horn will be imposed (i.e., 24 hours or nighttime hours only.)

(iv) An accurate and complete Grade Crossing Inventory Form for each public, private, and pedestrian grade crossing within the quiet zone that reflects conditions currently existing at the crossing.

(v) The name and title of the person responsible for monitoring compliance with the requirements of this part and the manner in which that person can be contacted.

(vi) A list of the names and addresses of each party that will receive notification in accordance with paragraph (a)(2) of this section.

(vii) A statement signed by the chief executive officer of each public authority participating in the continuation of the quiet zone, in which the chief executive officer certifies that the information submitted by the public authority is accurate and complete to the best of his/her knowledge and belief.

(d) *Notice of Quiet Zone Establishment*—(1) *Timing.* (i) The Notice of Quiet Zone Establishment shall provide the date upon which the quiet zone will be established, but in no event shall the date be earlier than 21 days after the date of mailing.

(ii) If the public authority was required to provide a Notice of Intent, in accordance with paragraph (a)(1) of this section, the Notice of Quiet Zone Establishment shall not be mailed less than 60 days after the date on which the Notice of Intent was mailed, unless

the Notice of Quiet Zone Establishment contains a written statement affirming that written comments and/or ''no-comment'' statements have been received from each railroad operating over public highway-rail grade crossings within the proposed quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety, in accordance with paragraph (b)(3)(ii) of this section.

(2) *Required contents.* The Notice of Quiet Zone Establishment shall include the following:

(i) A list of each public, private, and pedestrian grade crossing within the quiet zone, identified by both U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name, if applicable.

(ii) A specific reference to the regulatory provision that provides the basis for quiet zone establishment, citing as appropriate, §222.39(a)(1), 222.39(a)(2)(i), 222.39(a)(2)(ii), 222.39(a)(3), 222.39(b), 222.41(a)(1)(i), 222.41(a)(1)(ii), 222.41(a)(1)(iii), 222.41(a)(1)(iv), 222.41(b)(1)(i), 222.41(b)(1)(ii), 222.41(b)(1)(iii), or 222.41(b)(1)(iv) of this part.

(A) If the Notice contains a specific reference to §222.39(a)(2)(i), 222.39(a)(2)(ii), 222.39(a)(3), 222.41(a)(1)(ii), 222.41(a)(1)(iii), 222.41(a)(1)(iv), 222.41(b)(1)(ii), 222.41(b)(1)(iii), or 222.41(b)(1)(iv) of this part, it shall include a copy of the FRA Web page that contains the quiet zone data upon which the public authority is relying (*http://www.fra.dot.gov/us/content/1337*).

(B) If the Notice contains a specific reference to §222.39(b) of this part, it shall include a copy of FRA's notification of approval.

(iii) If a diagnostic team review was required under §222.25 or 222.27 of this part, the Notice shall include a statement affirming that the State agency responsible for grade crossing safety and all affected railroads were provided an opportunity to participate in the diagnostic team review. The Notice shall also include a list of recommendations made by the diagnostic team.

(iv) A statement of the time period within which restrictions on the routine sounding of the locomotive horn will be imposed (i.e., 24 hours or from 10 p.m. until 7 a.m.).

(v) An accurate and complete Grade Crossing Inventory Form for each public, private, and pedestrian grade crossing within the quiet zone that reflects the conditions existing at the crossing before any new SSMs or ASMs were implemented.

(vi) An accurate, complete and current Grade Crossing Inventory Form for each public, private, and pedestrian grade crossing within the quiet zone that reflects SSMs and ASMs in place upon establishment of the quiet zone. SSMs and ASMs that cannot be fully described on the Inventory Form shall be separately described.

(vii) If the public authority was required to provide a Notice of Intent, in accordance with paragraph (a)(1) of this section, the Notice of Quiet Zone Establishment shall contain a written statement affirming that the Notice of Intent was provided in accordance with paragraph (a)(1) of this section. This statement shall also state the date on which the Notice of Intent was mailed.

(viii) If the public authority was required to provide a Notice of Intent, in accordance with paragraph (a)(1) of this section, and the Notice of Intent was mailed less than 60 days before the mailing of the Notice of Quiet Zone Establishment, the Notice of Quiet Zone Establishment shall also contain a written statement affirming that written comments and/or ''no-comment'' statements have been received from each railroad operating over public highway-rail grade crossings within the proposed quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety, in accordance with paragraph (b)(3)(ii) of this section.

(ix) The name and title of the person responsible for monitoring compliance with the requirements of this part and the manner in which that person can be contacted.

(x) A list of the names and addresses of each party that shall be notified in accordance with paragraph (a)(3) of this section.

(xi) A statement signed by the chief executive officer of each public authority participating in the establishment

of the quiet zone, in which the chief executive officer shall certify that the information submitted by the public authority is accurate and complete to the best of his/her knowledge and belief.

§ 222.45 When is a railroad required to cease routine sounding of locomotive horns at crossings?

On the date specified in a Notice of Quiet Zone Continuation or Notice of Quiet Zone Establishment that complies with the requirements set forth in § 222.43 of this part, a railroad shall refrain from, or cease, routine sounding of the locomotive horn at all public, private and pedestrian grade crossings identified in the Notice.

§ 222.47 What periodic updates are required?

(a) *Quiet zones with SSMs at each public crossing.* This paragraph addresses quiet zones established pursuant to §§ 222.39(a)(1), 222.41(a)(1)(i), and 222.41(b)(1)(i) (quiet zones with an SSM implemented at every public crossing within the quiet zone) of this part. Between 4½ and 5 years after the date of the quiet zone establishment notice provided by the public authority under § 222.43 of this part, and between 4½ and 5 years after the last affirmation under this section, the public authority must:

(1) Affirm in writing to the Associate Administrator that the SSMs implemented within the quiet zone continue to conform to the requirements of appendix A of this part. Copies of such affirmation must be provided by certified mail, return receipt requested, to the parties identified in § 222.43(a)(3) of this part; and

(2) Provide to the Associate Administrator an up-to-date, accurate, and complete Grade Crossing Inventory Form for each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone.

(b) *Quiet zones which do not have a supplementary safety measure at each public crossing.* This paragraph addresses quiet zones established pursuant to §§ 222.39(a)(2) and (a)(3), § 222.39(b), §§ 222.41(a)(1)(ii), (a)(1)(iii), and (a)(1)(iv), and §§ 222.41(b)(1)(ii), (b)(1)(iii), and (b)(1)(iv) (quiet zones which do not have an SSM at every public crossing within the quiet zone) of this part. Between 2½ and 3 years after the date of the quiet zone establishment notice provided by the public authority under § 222.43 of this part, and between 2½ and 3 years after the last affirmation under this section, the public authority must:

(1) Affirm in writing to the Associate Administrator that all SSMs and ASMs implemented within the quiet zone continue to conform to the requirements of Appendices A and B of this part or the terms of the Quiet Zone approval. Copies of such notification must be provided to the parties identified in § 222.43(a)(3) of this part by certified mail, return receipt requested; and

(2) Provide to the Associate Administrator an up-to-date, accurate, and complete Grade Crossing Inventory Form for each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian grade crossing within the quiet zone.

§ 222.49 Who may file Grade Crossing Inventory Forms?

(a) Grade Crossing Inventory Forms required to be filed with the Associate Administrator in accordance with §§ 222.39, 222.43 and 222.47 of this part may be filed by the public authority if, for any reason, such forms are not timely submitted by the State and railroad.

(b) Within 30 days after receipt of a written request of the public authority, the railroad owning the line of railroad that includes public or private highway rail grade crossings within the quiet zone or proposed quiet zone shall provide to the State and public authority sufficient current information regarding the grade crossing and the railroad's operations over the grade crossing to enable the State and public authority to complete the Grade Crossing Inventory Form.

§ 222.51 Under what conditions will quiet zone status be terminated?

(a) *New Quiet Zones—Annual risk review.* (1) FRA will annually calculate the Quiet Zone Risk Index for each quiet zone established pursuant to §§ 222.39(a)(2) and 222.39(b) of this part, and in comparison to the Nationwide

Significant Risk Threshold. FRA will notify each public authority of the Quiet Zone Risk Index for the preceding calendar year. FRA will not conduct annual risk reviews for quiet zones established by having an SSM at every public crossing within the quiet zone or for quiet zones established by reducing the Quiet Zone Risk Index to the Risk Index With Horns.

(2) *Actions to be taken by public authority to retain quiet zone.* If the Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold, the quiet zone will terminate six months from the date of receipt of notification from FRA that the Quiet Zone Risk Index exceeds the Nationwide Significant Risk Threshold, unless the public authority takes the following actions:

(i) Within six months after the date of receipt of notification from FRA that the Quiet Zone Risk Index exceeds the Nationwide Significant Risk Threshold, provide to the Associate Administrator a written commitment to lower the potential risk to the traveling public at the crossings within the quiet zone to a level at, or below, the Nationwide Significant Risk Threshold or the Risk Index With Horns. Included in the commitment statement shall be a discussion of the specific steps to be taken by the public authority to increase safety at the crossings within the quiet zone; and

(ii) Within three years after the date of receipt of notification from FRA that the Quiet Zone Risk Index exceeds the Nationwide Significant Risk Threshold, complete implementation of SSMs or ASMs sufficient to reduce the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Threshold, or the Risk Index With Horns, and receive approval from the Associate Administrator, under the procedures set forth in § 222.39(b) of this part, for continuation of the quiet zone. If the Quiet Zone Risk Index is reduced to the Risk Index With Horns, the quiet zone will be considered to have been established pursuant to § 222.39(a)(3) of this part and subsequent annual risk reviews will not be conducted for that quiet zone.

(iii) Failure to comply with paragraph (a)(2)(i) of this section shall result in the termination of the quiet zone six months after the date of receipt of notification from FRA that the Quiet Zone Risk Index exceeds the Nationwide Significant Risk Threshold. Failure to comply with paragraph (a)(2)(ii) of this section shall result in the termination of the quiet zone three years after the date of receipt of notification from FRA that the Quiet Zone Risk Index exceeds the Nationwide Significant Risk Threshold.

(b) *Pre-Rule Quiet Zones—Annual risk review.* (1) FRA will annually calculate the Quiet Zone Risk Index for each Pre-Rule Quiet Zone and Pre-Rule Partial Quiet Zone that qualified for automatic approval pursuant to §§ 222.41(a)(1)(ii), 222.41(a)(1)(iii), 222.41(b)(1)(ii), and 222.41(b)(1)(iii) of this part. FRA will notify each public authority of the Quiet Zone Risk Index for the preceding calendar year. FRA will also notify each public authority if a relevant collision occurred at a grade crossing within the quiet zone during the preceding calendar year.

(2) *Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones authorized under §§ 222.41(a)(1)(ii) and 222.41(b)(1)(ii).* (i) If a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone originally qualified for automatic approval because the Quiet Zone Risk Index was at, or below, the Nationwide Significant Risk Threshold, the quiet zone may continue unchanged if the Quiet Zone Risk Index as last calculated by the FRA remains at, or below, the Nationwide Significant Risk Threshold.

(ii) If the Quiet Zone Risk Index as last calculated by FRA is above the Nationwide Significant Risk Threshold, but is lower than twice the Nationwide Significant Risk Threshold and no relevant collisions have occurred at crossings within the quiet zone within the five years preceding the annual risk review, then the quiet zone may continue as though it originally received automatic approval pursuant to § 222.41(a)(1)(iii) or 222.41(b)(1)(iii) of this part.

(iii) If the Quiet Zone Risk Index as last calculated by FRA is at, or above, twice the Nationwide Significant Risk Threshold, or if the Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold, but is lower than twice the Nationwide Significant Risk

Threshold *and* a relevant collision occurred at a crossing within the quiet zone within the preceding five calendar years, the quiet zone will terminate six months after the date of receipt of notification from FRA of the Nationwide Significant Risk Threshold level, unless the public authority takes the actions specified in paragraph (b)(4) of this section.

(3) *Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones authorized under §§ 222.41(a)(1)(iii) and 222.41(b)(1)(iii).* (i) If a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone originally qualified for automatic approval because the Quiet Zone Risk Index was above the Nationwide Significant Risk Threshold, but below twice the Nationwide Significant Risk Threshold, and no relevant collisions had occurred within the five-year qualifying period, the quiet zone may continue unchanged if the Quiet Zone Risk Index as last calculated by FRA remains below twice the Nationwide Significant Risk Threshold and no relevant collisions occurred at a public grade crossing within the quiet zone during the preceding calendar year.

(ii) If the Quiet Zone Risk Index as last calculated by FRA is at, or above, twice the Nationwide Significant Risk Threshold, or if a relevant collision occurred at a public grade crossing within the quiet zone during the preceding calendar year, the quiet zone will terminate six months after the date of receipt of notification from FRA that the Quiet Zone Risk Index is at, or exceeds twice the Nationwide Significant Risk Threshold or that a relevant collision occurred at a crossing within the quiet zone, unless the public authority takes the actions specified in paragraph (b)(4) of this section.

(4) *Actions to be taken by the public authority to retain a quiet zone.*

(i) Within six months after the date of FRA notification, the public authority shall provide to the Associate Administrator a written commitment to lower the potential risk to the traveling public at the crossings within the quiet zone by reducing the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Threshold or the Risk Index With Horns. Included in the commitment statement shall be a discussion of the specific steps to be taken by the public authority to increase safety at the public crossings within the quiet zone; and

(ii) Within three years of the date of FRA notification, the public authority shall complete implementation of SSMs or ASMs sufficient to reduce the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Threshold, or the Risk Index With Horns, and receive approval from the Associate Administrator, under the procedures set forth in § 222.39(b) of this part, for continuation of the quiet zone. If the Quiet Zone Risk Index is reduced to a level that fully compensates for the absence of the train horn, the quiet zone will be considered to have been established pursuant to § 222.39(a)(3) of this part and subsequent annual risk reviews will not be conducted for that quiet zone.

(iii) Failure to comply with paragraph (b)(4)(i) of this section shall result in the termination of the quiet zone six months after the date of receipt of notification from FRA. Failure to comply with paragraph (b)(4)(ii) of this section shall result in the termination of the quiet zone three years after the date of receipt of notification from FRA.

(c) *Review at FRA's initiative.* (1) The Associate Administrator may, at any time, review the status of any quiet zone.

(2) If the Associate Administrator makes any of the following preliminary determinations, the Associate Administrator will provide written notice to the public authority, all railroads operating over public highway-rail grade crossings within the quiet zone, the highway or traffic control authority or law enforcement authority having control over vehicular traffic at the crossings within the quiet zone, the landowner having control over any private crossings within the quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety and will publish a notice of the determination in the FEDERAL REGISTER:

(i) Safety systems and measures implemented within the quiet zone do not fully compensate for the absence of the

locomotive horn due to a substantial increase in risk;

(ii) Documentation relied upon to establish the quiet zone contains substantial errors that may have an adverse impact on public safety; or

(iii) Significant risk with respect to loss of life or serious personal injury exists within the quiet zone.

(3) After providing an opportunity for comment, the Associate Administrator may require that additional safety measures be taken or that the quiet zone be terminated. The Associate Administrator will provide a copy of his/her decision to the public authority and all parties listed in paragraph (c)(2) of this section. The public authority may appeal the Associate Administrator's decision in accordance with §222.57(c) of this part. Nothing in this section is intended to limit the Administrator's emergency authority under 49 U.S.C. 20104 and 49 CFR part 211.

(d) *Termination by the public authority.* (1) Any public authority that participated in the establishment of a quiet zone under the provisions of this part may, at any time, withdraw its quiet zone status.

(2) A public authority may withdraw its quiet zone status by providing written notice of termination, by certified mail, return receipt requested, to all railroads operating the public highway-rail grade crossings within the quiet zone, the highway or traffic control authority or law enforcement authority having control over vehicular traffic at the crossings within the quiet zone, the landowner having control over any private crossings within the quiet zone, the State agency responsible for grade crossing safety, the State agency responsible for highway and road safety, and the Associate Administrator.

(3)(i) If the quiet zone that is being withdrawn was part of a multi-jurisdictional quiet zone, the remaining quiet zones may remain in effect, provided the public authorities responsible for the remaining quiet zones provide statements to the Associate Administrator certifying that the Quiet Zone Risk Index for each remaining quiet zone is at, or below, the Nationwide Significant Risk Threshold or the Risk Index With Horns. These statements shall be provided, no later than six months after the date on which the notice of quiet zone termination was mailed, to all parties listed in paragraph (d)(2) of this section.

(ii) If any remaining quiet zone has a Quiet Zone Risk Index in excess of the Nationwide Significant Risk Threshold and the Risk Index With Horns, the public authority responsible for the quiet zone shall submit a written commitment, to all parties listed in paragraph (d)(2) of this section, to reduce the Quiet Zone Risk Index to a level at or below the Nationwide Significant Risk Threshold or the Risk Index With Horns within three years. Included in the commitment statement shall be a discussion of the specific steps to be taken by the public authority to reduce the Quiet Zone Risk Index. This commitment statement shall be provided to all parties listed in paragraph (d)(2) of this section no later than six months after the date on which the notice of quiet zone termination was mailed.

(iii) Failure to comply with paragraphs (d)(3)(i) and (d)(3)(ii) of this section shall result in the termination of the remaining quiet zone(s) six months after the date on which the notice of quiet zone termination was mailed by the withdrawing public authority in accordance with paragraph (d)(2) of this section.

(iv) Failure to complete implementation of SSMs and/or ASMs to reduce the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Index or the Risk Index With Horns, in accordance with the written commitment provided under paragraph (d)(3)(ii) of this section, shall result in the termination of quiet zone status three years after the date on which the written commitment was received by FRA.

(e) *Notification of termination.* (1) In the event that a quiet zone is terminated under the provisions of this section, it shall be the responsibility of the public authority to immediately provide written notification of the termination by certified mail, return receipt requested, to all railroads operating over public highway-rail grade crossings within the quiet zone, the highway or traffic control authority or

law enforcement authority having control over vehicular traffic at the crossings within the quiet zone, the landowner having control over any private crossings within the quiet zone, the State agency responsible for grade crossing safety, the State agency responsible for highway and road safety, and the Associate Administrator.

(2) Notwithstanding paragraph (e)(1) of this section, if a quiet zone is terminated under the provisions of this section, FRA shall also provide written notification to all parties listed in paragraph (e)(1) of this section.

(f) *Requirement to sound the locomotive horn.* Upon receipt of notification of quiet zone termination pursuant to paragraph (e) of this section, railroads shall, within seven days, and in accordance with the provisions of this part, sound the locomotive horn when approaching and passing through every public highway-rail grade crossing within the former quiet zone.

§ 222.53 What are the requirements for supplementary and alternative safety measures?

(a) Approved SSMs are listed in appendix A of this part. Approved SSMs can qualify for quiet zone risk reduction credit in the manner specified in appendix A of this part.

(b) Additional ASMs that may be included in a request for FRA approval of a quiet zone under §222.39(b) of this part are listed in appendix B of this part. Modified SSMs can qualify for quiet zone risk reduction credit in the manner specified in appendix B of this part.

(c) The following do not, individually or in combination, constitute SSMs or ASMs: Standard traffic control device arrangements such as reflectorized crossbucks, STOP signs, flashing lights, or flashing lights with gates that do not completely block travel over the line of railroad, or traffic signals.

§ 222.55 How are new supplementary or alternative safety measures approved?

(a) The Associate Administrator may add new SSMs and standards to appendix A of this part and new ASMs and standards to appendix B of this part when the Associate Administrator determines that such measures or standards are an effective substitute for the locomotive horn in the prevention of collisions and casualties at public highway-rail grade crossings.

(b) Interested parties may apply for approval from the Associate Administrator to demonstrate proposed new SSMs or ASMs to determine whether they are effective substitutes for the locomotive horn in the prevention of collisions and casualties at public highway-rail grade crossings.

(c) The Associate Administrator may, after notice and opportunity for comment, order railroad carriers operating over a public highway-rail grade crossing or crossings to temporarily cease the sounding of locomotive horns at such crossings to demonstrate proposed new SSMs or ASMs, provided that such proposed new SSMs or ASMs have been subject to prior testing and evaluation. In issuing such order, the Associate Administrator may impose any conditions or limitations on such use of the proposed new SSMs or ASMs which the Associate Administrator deems necessary in order to provide the level of safety at least equivalent to that provided by the locomotive horn.

(d) Upon completion of a demonstration of proposed new SSMs or ASMs, interested parties may apply to the Associate Administrator for their approval. Applications for approval shall be in writing and shall include the following:

(1) The name and address of the applicant;

(2) A description and design of the proposed new SSM or ASM;

(3) A description and results of the demonstration project in which the proposed SSMs or ASMs were tested;

(4) Estimated costs of the proposed new SSM or ASM; and

(5) Any other information deemed necessary.

(e) If the Associate Administrator is satisfied that the proposed safety measure fully compensates for the absence of the warning provided by the locomotive horn, the Associate Administrator will approve its use as an SSM to be used in the same manner as the measures listed in appendix A of this part, or the Associate Administrator

may approve its use as an ASM to be used in the same manner as the measures listed in appendix B of this part. The Associate Administrator may impose any conditions or limitations on use of the SSMs or ASMs which the Associate Administrator deems necessary in order to provide the level of safety at least equivalent to that provided by the locomotive horn.

(f) If the Associate Administrator approves a new SSM or ASM, the Associate Administrator will: Notify the applicant, if any; publish notice of such action in the FEDERAL REGISTER; and add the measure to the list of approved SSMs or ASMs.

(g) A public authority or other interested party may appeal to the Administrator from a decision by the Associate Administrator granting or denying an application for approval of a proposed SSM or ASM, or the conditions or limitations imposed on its use, in accordance with §222.57 of this part.

§222.57 Can parties seek review of the Associate Administrator's actions?

(a) A public authority or other interested party may petition the Administrator for review of any decision by the Associate Administrator granting or denying an application for approval of a new SSM or ASM under §222.55 of this part. The petition must be filed within 60 days of the decision to be reviewed, specify the grounds for the requested relief, and be served upon the following parties: All railroads ordered to temporarily cease sounding of the locomotive horn over public highway-rail grade crossings for the demonstration of the proposed new SSM or ASM , the highway or traffic control authority or law enforcement authority having control over vehicular traffic at the crossings affected by the new SSM/ASM demonstration, the State agency responsible for grade crossing safety, the State agency responsible for highway and road safety, and the Associate Administrator. Unless the Administrator specifically provides otherwise, and gives notice to the petitioner or publishes a notice in the FEDERAL REGISTER, the filing of a petition under this paragraph does not stay the effectiveness of the action sought to be reviewed. The Administrator may reaffirm, modify, or revoke the decision of the Associate Administrator without further proceedings and shall notify the petitioner and other interested parties in writing or by publishing a notice in the FEDERAL REGISTER.

(b) A public authority may request reconsideration of a decision by the Associate Administrator to deny an application by that authority for approval of a quiet zone, or to require additional safety measures, by filing a petition for reconsideration with the Associate Administrator. The petition must specify the grounds for asserting that the Associate Administrator improperly exercised his/her judgment in finding that the proposed SSMs and ASMs would not result in a Quiet Zone Risk Index that would be at or below the Risk Index With Horns or the Nationwide Significant Risk Threshold. The petition shall be filed within 60 days of the date of the decision to be reconsidered and be served upon all parties listed in §222.39(b)(3) of this part. Upon receipt of a timely and proper petition, the Associate Administrator will provide the petitioner an opportunity to submit additional materials and to request an informal hearing. Upon review of the additional materials and completion of any hearing requested, the Associate Administrator shall issue a decision on the petition that will be administratively final.

(c) A public authority may request reconsideration of a decision by the Associate Administrator to terminate quiet zone status by filing a petition for reconsideration with the Associate Administrator. The petition must be filed within 60 days of the date of the decision, specify the grounds for the requested relief, and be served upon all parties listed in §222.51(c)(2) of this part. Unless the Associate Administrator publishes a notice in the FEDERAL REGISTER that specifically stays the effectiveness of his/her decision, the filing of a petition under this paragraph will not stay the termination of quiet zone status. Upon receipt of a timely and proper petition, the Associate Administrator will provide the petitioner an opportunity to submit additional materials and to request an informal hearing. Upon review of the additional materials and completion of

any hearing requested, the Associate Administrator shall issue a decision on the petition that will be administratively final. A copy of this decision shall be served upon all parties listed in § 222.51(c)(2) of this part.

(d) A railroad may request reconsideration of a decision by the Associate Administrator to approve an application for approval of a proposed quiet zone under § 222.39(b) of this part by filing a petition for reconsideration with the Associate Administrator. The petition must specify the grounds for asserting that the Associate Administrator improperly exercised his/her judgment in finding that the proposed SSMs and ASMs would result in a Quiet Zone Risk Index that would be at or below the Risk Index With Horns or the Nationwide Significant Risk Threshold. The petition shall be filed within 60 days of the date of the decision to be reconsidered, and be served upon all parties listed in § 222.39(b)(3) of this part. Upon receipt of a timely and proper petition, the Associate Administrator will provide the petitioner an opportunity to submit additional materials and to request an informal hearing. Upon review of the additional materials and completion of any hearing requested, the Associate Administrator shall issue a decision that will be administratively final.

§ 222.59 When may a wayside horn be used?

(a)(1) A wayside horn conforming to the requirements of appendix E of this part may be used in lieu of a locomotive horn at any highway-rail grade crossing equipped with an active warning system consisting of, at a minimum, flashing lights and gates.

(2) A wayside horn conforming to the requirements of appendix E of this part may be installed within a quiet zone. For purposes of calculating the length of a quiet zone, the presence of a wayside horn at a highway-grade crossing within a quiet zone shall be considered in the same manner as a grade crossing treated with an SSM. A grade crossing equipped with a wayside horn shall not be considered in calculating the Quiet Zone Risk Index or Crossing Corridor Risk Index.

(b) A public authority installing a wayside horn at a grade crossing within a quiet zone shall provide written notice that a wayside horn is being installed to all railroads operating over the public highway-rail grade crossings within the quiet zone, the highway or traffic control authority or law enforcement authority having control over vehicular traffic at the crossings within the quiet zone, the landowner having control over any private crossings within the quiet zone, the State agency responsible for grade crossing safety, the State agency responsible for highway and road safety, and the Associate Administrator. This notice shall provide the date on which the wayside horn will be operational and identify the grade crossing at which the wayside horn shall be installed by both the U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name. The railroad or public authority shall provide notification of the operational date at least 21 days in advance.

(c) A railroad or public authority installing a wayside horn at a grade crossing located outside a quiet zone shall provide written notice that a wayside horn is being installed to all railroads operating over the public highway-rail grade crossing, the highway or traffic control authority or law enforcement authority having control over vehicular traffic at the crossing, the State agency responsible for grade crossing safety, the State agency responsible for highway and road safety, and the Associate Administrator. This notice shall provide the date on which the wayside horn will be operational and identify the grade crossing at which the wayside horn shall be installed by both the U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name. The railroad or public authority shall provide notification of the operational date at least 21 days in advance.

(d) A railroad operating over a grade crossing equipped with an operational wayside horn installed within a quiet zone pursuant to this section shall cease routine locomotive horn use at the grade crossing. A railroad operating over a grade crossing that is

equipped with a wayside horn and located outside of a quiet zone shall cease routine locomotive horn use at the grade crossing on the operational date specified in the notice required by paragraph (c) of this section.

APPENDIX A TO PART 222—APPROVED SUPPLEMENTARY SAFETY MEASURES

A. Requirements and Effectiveness Rates for Supplementary Safety Measures

This section provides a list of approved supplementary safety measures (SSMs) that may be installed at highway-rail grade crossings within quiet zones for risk reduction credit. Each SSM has been assigned an effectiveness rate, which may be subject to adjustment as research and demonstration projects are completed and data is gathered and refined. Sections B and C govern the process through which risk reduction credit for pre-existing SSMs can be determined.

1. *Temporary Closure of a Public Highway-Rail Grade Crossing:* Close the crossing to highway traffic during designated quiet periods. (This SSM can only be implemented within Partial Quiet Zones.)

Effectiveness: 1.0.

Because an effective closure system prevents vehicle entrance onto the crossing, the probability of a collision with a train at the crossing is zero during the period the crossing is closed. Effectiveness would therefore equal 1. However, analysis should take into consideration that traffic would need to be redistributed among adjacent crossings or grade separations for the purpose of estimating risk following the silencing of train horns, unless the particular ''closure'' was accomplished by a grade separation.

Required:

a. The closure system must completely block highway traffic on all approach lanes to the crossing.

b. The closure system must completely block adjacent pedestrian crossings.

c. Public highway-rail grade crossings located within New Partial Quiet Zones shall be closed from 10 p.m. until 7 a.m. every day. Public highway-rail grade crossings located within Pre-Rule Partial Quiet Zones may only be closed during one period each 24 hours.

d. Barricdes and signs used for closure of the roadway shall conform to the standards contained in the MUTCD.

e. Daily activation and deactivation of the system is the responsibility of the public authority responsible for maintenance of the street or highway crossing the railroad tracks. The public authority may provide for third party activation and deactivation; however, the public authority shall remain fully responsible for compliance with the requirements of this part.

f. The system must be tamper and vandal resistant to the same extent as other traffic control devices.

g. The closure system shall be equipped with a monitoring device that contains an indicator which is visible to the train crew prior to entering the crossing. The indicator shall illuminate whenever the closure device is deployed.

Recommended:

Signs for alternate highway traffic routes should be erected in accordance with MUTCD and State and local standards and should inform pedestrians and motorists that the streets are closed, the period for which they are closed, and that alternate routes must be used.

2. *Four-Quadrant Gate System:* Install gates at a crossing sufficient to fully block highway traffic from entering the crossing when the gates are lowered, including at least one gate for each direction of traffic on each approach.

Effectiveness:

Four-quadrant gates only, no presence detection: .82.

Four-quadrant gates only, with presence detection: .77.

Four-quadrant gates with traffic of at least 60 feet (with or without presence detection): .92.

NOTE: The higher effectiveness rate for four-quadrant gates without presence detection does not mean that they are inherently safer than four-quadrant gates with presence detection. Four-quadrant gates with presence detection have been assigned a lower effectiveness rate because motorists may learn to delay the lowering of the exit gates by driving onto the opposing lane of traffic immediately after an opposing car has driven over the grade crossing. Since the presence detection will keep the exit gate raised, other motorists at the crossing who observe this scenario may also be tempted to take advantage of the raised exit gate by driving around the lowered entrance gates, thus increasing the potential for a crossing collision.

It should, however, be noted that there are site-specific circumstances (such as nearby highway intersections that could cause traffic to back up and stop on the grade crossing), under which the use of presence detection would be advisable. For this reason, the various effectiveness rates assigned to four-quadrant gate systems should not be the sole determining factor as to whether presence detection would be advisable. A site-specific study should be performed to determine the best application for each proposed installation. Please refer to paragraphs (f) and (g) for more information.

Required:

Four-quadrant gate systems shall conform to the standards for four-quadrant gates contained in the MUTCD and shall, in addition, comply with the following:

a. When a train is approaching, all highway approach and exit lanes on both sides of the highway-rail crossing must be spanned by gates, thus denying to the highway user the option of circumventing the conventional approach lane gates by switching into the opposing (oncoming) traffic lane in order to enter the crossing and cross the tracks.

b. Crossing warning systems must be activated by use of constant warning time devices unless existing conditions at the crossing would prevent the proper operation of the constant warning time devices.

c. Crossing warning systems must be equipped with power-out indicators.

NOTE: Requirements b and c apply only to New Quiet Zones or New Partial Quiet Zones. Constant warning time devices and power-out indicators are not required to be added to existing warning systems in Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones. However, if existing automatic warning device systems in Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones are renewed, or new automatic warning device systems are installed, power-out indicators and constant warning time devices are required, unless existing conditions at the crossing would prevent the proper operation of the constant warning devices.

d. The gap between the ends of the entrance and exit gates (on the same side of the railroad tracks) when both are in the fully lowered, or down, position must be less than two feet if no median is present. If the highway approach is equipped with a median or a channelization device between the approach and exit lanes, the lowered gates must reach to within one foot of the median or channelization device, measured horizontally across the road from the end of the lowered gate to the median or channelization device or to a point over the edge of the median or channelization device. The gate and the median top or channelization device do not have to be at the same elevation.

e. ''Break-away'' channelization devices must be frequently monitored to replace broken elements.

Recommendations for new installations only:

f. Gate timing should be established by a qualified traffic engineer based on site specific determinations. Such determination should consider the need for and timing of a delay in the descent of the exit gates (following descent of the conventional entrance gates). Factors to be considered may include available storage space between the gates that is outside the fouling limits of the track(s) and the possibility that traffic flows may be interrupted as a result of nearby intersections.

g. A determination should be made as to whether it is necessary to provide vehicle presence detectors (VPDs) to open or keep open the exit gates until all vehicles are clear of the crossing. VPD should be installed on one or both sides of the crossing and/or in the surface between the rails closest to the field. Among the factors that should be considered are the presence of intersecting roadways near the crossing, the priority that the traffic crossing the railroad is given at such intersections, the types of traffic control devices at those intersections, and the presence and timing of traffic signal preemption.

h. Highway approaches on one or both sides of the highway-rail crossing may be provided with medians or channelization devices between the opposing lanes. Medians should be defined by a non-traversable curb or traversable curb, or by reflectorized channelization devices, or by both.

i. Remote monitoring (in addition to power-out indicators, which are required) of the status of these crossing systems is preferable. This is especially important in those areas in which qualified railroad signal department personnel are not readily available.

3. *Gates With Medians or Channelization Devices:* Install medians or channelization devices on both highway approaches to a public highway-rail grade crossing denying to the highway user the option of circumventing the approach lane gates by switching into the opposing (oncoming) traffic lane and driving around the lowered gates to cross the tracks.

Effectiveness:

Channelization devices—.75.

Non-traversable curbs with or without channelization devices— .80.

Required:

a. Opposing traffic lanes on both highway approaches to the crossing must be separated by either: (1) medians bounded by non-traversable curbs or (2) channelization devices.

b. Medians or channelization devices must extend at least 100 feet from the gate arm, or if there is an intersection within 100 feet of the gate, the median or channelization device must extend at least 60 feet from the gate arm.

c. Intersections of two or more streets, or a street and an alley, that are within 60 feet of the gate arm must be closed or relocated. Driveways for private, residential properties (up to four units) within 60 feet of the gate arm are not considered to be intersections under this part and need not be closed. However, consideration should be given to taking steps to ensure that motorists exiting the driveways are not able to move against the flow of traffic to circumvent the purpose of the median and drive around lowered gates. This may be accomplished by the posting of

''no left turn'' signs or other means of notification. For the purpose of this part, driveways accessing commercial properties are considered to be intersections and are not allowed. It should be noted that if a public authority can not comply with the 60 feet or 100 feet requirement, it may apply to FRA for a quiet zone under §222.39(b), ''Public authority application to FRA.'' Such arrangement may qualify for a risk reduction credit in calculation of the Quiet Zone Risk Index. Similarly, if a public authority finds that it is feasible to only provide channelization on one approach to the crossing, it may also apply to FRA for approval under §222.39(b). Such an arrangement may also qualify for a risk reduction credit in calculation of the Quiet Zone Risk Index.

d. Crossing warning systems must be activated by use of constant warning time devices unless existing conditions at the crossing would prevent the proper operation of the constant warning time devices.

e. Crossing warning systems must be equipped with power-out indicators. Note: Requirements d and e apply only to New Quiet Zones and New Partial Quiet Zones. Constant warning time devices and power-out indicators are not required to be added to existing warning systems in Pre-Rule Quiet Zones or Pre-Rule Partial Quiet Zones. However, if existing automatic warning device systems in Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones are renewed, or new automatic warning device systems are installed, power-out indicators and constant warning time devices are required, unless existing conditions at the crossing would prevent the proper operation of the constant warning devices.

f. The gap between the lowered gate and the curb or channelization device must be one foot or less, measured horizontally across the road from the end of the lowered gate to the curb or channelization device or to a point over the curb edge or channelization device. The gate and the curb top or channelization device do not have to be at the same elevation.

g. ''Break-away'' channelization devices must be frequently monitored to replace broken elements.

4. *One Way Street with Gate(s):* Gate(s) must be installed such that all approaching highway lanes to the public highway-rail grade crossing are completely blocked.

Effectiveness: .82.

Required:

a. Gate arms on the approach side of the crossing should extend across the road to within one foot of the far edge of the pavement. If a gate is used on each side of the road, the gap between the ends of the gates when both are in the lowered, or down, position must be no more than two feet.

b. If only one gate is used, the edge of the road opposite the gate mechanism must be configured with a non-traversable curb extending at least 100 feet.

c. Crossing warning systems must be activated by use of constant warning time devices unless existing conditions at the crossing would prevent the proper operation of the constant warning time devices.

d. Crossing warning systems must be equipped with power-out indicators.

NOTE: Requirements c and d apply only to New Quiet Zones and New Partial Quiet Zones. Constant warning time devices and power-out indicators are not required to be added to existing warning systems in Pre-Rule Quiet Zones or Pre-Rule Partial Quiet Zones. If automatic warning systems are, however, installed or renewed in a Pre-Rule Quiet or Pre-Rule Partial Quiet Zone, power-out indicators and constant warning time devices shall be installed, unless existing conditions at the crossing would prevent the proper operation of the constant warning time devices.

5. *Permanent Closure of a Public Highway-Rail Grade Crossing:* Permanently close the crossing to highway traffic.

Effectiveness: 1.0.

Required:

a. The closure system must completely block highway traffic from entering the grade crossing.

b. Barricades and signs used for closure of the roadway shall conform to the standards contained in the MUTCD.

c. The closure system must be tamper and vandal resistant to the same extent as other traffic control devices.

d. Since traffic will be redistributed among adjacent crossings, the traffic counts for adjacent crossings shall be increased to reflect the diversion of traffic from the closed crossing.

B. Credit for Pre-Existing SSMs in New Quiet Zones and New Partial Quiet Zones

A community that has implemented a pre-existing SSM at a public grade crossing can receive risk reduction credit by inflating the Risk Index With Horns as follows:

1. Calculate the current risk index for the grade crossing that is equipped with a qualifying, pre-existing SSM. (See appendix D. FRA's web-based Quiet Zone Calculator may be used to complete this calculation.)

2. Adjust the risk index by accounting for the increased risk that was avoided by implementing the pre-existing SSM at the public grade crossing. This adjustment can be made by dividing the risk index by one minus the SSM effectiveness rate. (For example, the risk index for a crossing equipped with pre-existing channelization devices would be divided by .25.)

3. Add the current risk indices for the other public grade crossings located within the proposed quiet zone and divide by the number of crossings. The resulting risk index

will be the new Risk Index With Horns for the proposed quiet zone.

C. Credit for Pre-Existing SSMs in Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones

A community that has implemented a pre-existing SSM at a public grade crossing can receive risk reduction credit by inflating the Risk Index With Horns as follows:

1. Calculate the current risk index for the grade crossing that is equipped with a qualifying, pre-existing SSM. (See appendix D. FRA's web-based Quiet Zone Calculator may be used to complete this calculation.)

2. Reduce the current risk index for the grade crossing to reflect the risk reduction that would have been achieved if the locomotive horn was routinely sounded at the crossing. The following list sets forth the estimated risk reduction for certain types of crossings:

a. Risk indices for passive crossings shall be reduced by 43%;

b. Risk indices for grade crossings equipped with automatic flashing lights shall be reduced by 27%; and

c. Risk indices for gated crossings shall be reduced by 40%.

3. Adjust the risk index by accounting for the increased risk that was avoided by implementing the pre-existing SSM at the public grade crossing. This adjustment can be made by dividing the risk index by one minus the SSM effectiveness rate. (For example, the risk index for a crossing equipped with pre-existing channelization devices would be divided by .25.)

4. Adjust the risk indices for the other crossings that are included in the Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone by reducing the current risk index to reflect the risk reduction that would have been achieved if the locomotive horn was routinely sounded at each crossing. Please refer to step two for the list of approved risk reduction percentages by crossing type.

5. Add the new risk indices for each crossing located within the proposed quiet zone and divide by the number of crossings. The resulting risk index will be the new Risk Index With Horns for the quiet zone.

APPENDIX B TO PART 222—ALTERNATIVE SAFETY MEASURES

Introduction

A public authority seeking approval of a quiet zone under public authority application to FRA (§222.39(b)) may include ASMs listed in this appendix in its proposal. This appendix addresses three types of ASMs: Modified SSMs, Non-Engineering ASMs, and Engineering ASMs. Modified SSMs are SSMs that do not fully comply with the provisions listed in appendix A. As provided in section I.B. of this appendix, public authorities can obtain risk reduction credit for pre-existing modified SSMs under the final rule. Non-engineering ASMs consist of programmed enforcement, public education and awareness, and photo enforcement programs that may be used to reduce risk within a quiet zone. Engineering ASMs consist of engineering improvements that address underlying geometric conditions, including sight distance, that are the source of increased risk at crossings.

I. MODIFIED SSMS

A. Requirements and Effectiveness Rates for Modified SSMs

1. If there are unique circumstances pertaining to a specific crossing or number of crossings which prevent SSMs from being fully compliant with all of the SSM requirements listed in appendix A, those SSM requirements may be adjusted or revised. In that case, the SSM, as modified by the public authority, will be treated as an ASM under this appendix B, and not as a SSM under appendix A. After reviewing the estimated safety effect of the modified SSM and the proposed quiet zone, FRA will approve the proposed quiet zone if FRA finds that the Quiet Zone Risk Index will be reduced to a level at or below either the Risk Index With Horns or the Nationwide Significant Risk Threshold.

2. The public authority must provide estimates of effectiveness. These estimates may be based upon adjustments from the effectiveness levels provided in appendix A or from actual field data derived from the crossing sites. The specific crossing and applied mitigation measure will be assessed to determine the effectiveness of the modified SSM. FRA will continue to develop and make available effectiveness estimates and data from experience under the final rule.

3. If one or more of the requirements associated with an SSM as listed in appendix A is revised or deleted, data or analysis supporting the revision or deletion must be provided to FRA for review. The following engineering types of ASMs may be included in a proposal for approval by FRA for creation of a quiet zone: (1) Temporary Closure of a Public Highway-Rail Grade Crossing, (2) Four-Quadrant Gate System, (3) Gates With Medians or Channelization Devices, and (4) One-Way Street With Gate(s).

B. Credit for Pre-Existing Modified SSMs in New Quiet Zones and New Partial Quiet Zones

A community that has implemented a pre-existing modified SSM at a public grade crossing can receive risk reduction credit by inflating the Risk Index With Horns as follows:

1. Calculate the current risk index for the grade crossing that is equipped with a pre-existing modified SSM. (See appendix D.

FRA's web-based Quiet Zone Calculator may be used to complete this calculation.)

2. Obtain FRA approval of the estimated effectiveness rate for the pre-existing modified SSM. Estimated effectiveness rates may be based upon adjustments from the SSM effectiveness rates provided in appendix A or actual field data derived from crossing sites.

3. Adjust the risk index by accounting for the increased risk that was avoided by implementing the pre-existing modified SSM at the public grade crossing. This adjustment can be made by dividing the risk index by one minus the FRA-approved modified SSM effectiveness rate.

4. Add the current risk indices for the other public grade crossings located within the proposed quiet zone and divide by the number of crossings. The resulting risk index will be the new Risk Index With Horns for the proposed quiet zone.

C. Credit for Pre-Existing Modified SSMs in Pre-Rule Quiet Zones and Pre-Rule Partial Quiet Zones

A community that has implemented a pre-existing modified SSM at a public grade crossing can receive risk reduction credit by inflating the Risk Index With Horns as follows:

1. Calculate the current risk index for the grade crossing that is equipped with a pre-existing modified SSM. (See appendix D. FRA's web-based Quiet Zone Calculator may be used to complete this calculation.)

2. Reduce the current risk index for the grade crossing to reflect the risk reduction that would have been achieved if the locomotive horn was routinely sounded at the crossing. The following list sets forth the estimated risk reduction for certain types of crossings:

a. Risk indices for passive crossings shall be reduced by 43%;

b. Risk indices for grade crossings equipped with automatic flashing lights shall be reduced by 27%; and

c. Risk indices for gated crossings shall be reduced by 40%.

3. Obtain FRA approval of the estimated effectiveness rate for the pre-existing modified SSM. Estimated effectiveness rates may be based upon adjustments from the SSM effectiveness rates provided in appendix A or actual field data derived from crossing sites.

4. Adjust the risk index by accounting for the increased risk that was avoided by implementing the pre-existing modified SSM at the public grade crossing. This adjustment can be made by dividing the risk index by one minus the FRA-approved modified SSM effectiveness rate.

5. Adjust the risk indices for the other crossings that are included in the Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone by reducing the current risk index to reflect the risk reduction that would have been achieved if the locomotive horn was routinely sounded at each crossing. Please refer to step two for the list of approved risk reduction percentages by crossing type.

6. Add the new risk indices for each crossing located within the proposed quiet zone and divide by the number of crossings. The resulting risk index will be the new Risk Index With Horns for the quiet zone.

II. NON-ENGINEERING ASMS

A. The following non-engineering ASMs may be used in the creation of a Quiet Zone: (The method for determining the effectiveness of the non-engineering ASMs, the implementation of the quiet zone, subsequent monitoring requirements, and dealing with an unacceptable effectiveness rate is provided in paragraph B.)

1. *Programmed Enforcement:* Community and law enforcement officials commit to a systematic and measurable crossing monitoring and traffic law enforcement program at the public highway-rail grade crossing, alone or in combination with the Public Education and Awareness ASM.

Required:

a. Subject to audit, a statistically valid baseline violation rate must be established through automated or systematic manual monitoring or sampling at the subject crossing(s); and

b. A law enforcement effort must be defined, established and continued along with continual or regular monitoring that provides a statistically valid violation rate that indicates the effectiveness of the law enforcement effort.

c. The public authority shall retain records pertaining to monitoring and sampling efforts at the grade crossing for a period of not less than five years. These records shall be made available, upon request, to FRA as provided by 49 U.S.C. 20107.

2. *Public Education and Awareness:* Conduct, alone or in combination with programmed law enforcement, a program of public education and awareness directed at motor vehicle drivers, pedestrians and residents near the railroad to emphasize the risks associated with public highway-rail grade crossings and applicable requirements of state and local traffic laws at those crossings.

Requirements:

a. Subject to audit, a statistically valid baseline violation rate must be established through automated or systematic manual monitoring or sampling at the subject crossing(s); and

b. A sustainable public education and awareness program must be defined, established and continued along with continual or regular monitoring that provides a statistically valid violation rate that indicates the effectiveness of the public education and

awareness effort. This program shall be provided and supported primarily through local resources.

c. The public authority shall retain records pertaining to monitoring and sampling efforts at the grade crossing for a period of not less than five years. These records shall be made available, upon request, to FRA as provided by 49 U.S.C. 20107.

3. *Photo Enforcement:* This ASM entails automated means of gathering valid photographic or video evidence of traffic law violations at a public highway-rail grade crossing together with follow-through by law enforcement and the judiciary.

Requirements:

a. State law authorizing use of photographic or video evidence both to bring charges and sustain the burden of proof that a violation of traffic laws concerning public highway-rail grade crossings has occurred, accompanied by commitment of administrative, law enforcement and judicial officers to enforce the law;

b. Sanction includes sufficient minimum fine (e.g., $100 for a first offense, ''points'' toward license suspension or revocation) to deter violations;

c. Means to reliably detect violations (e.g., loop detectors, video imaging technology);

d. Photographic or video equipment deployed to capture images sufficient to document the violation (including the face of the driver, if required to charge or convict under state law).

NOTE: This does not require that each crossing be continually monitored. The objective of this option is deterrence, which may be accomplished by moving photo/video equipment among several crossing locations, as long as the motorist perceives the strong possibility that a violation will lead to sanctions. Each location must appear identical to the motorist, whether or not surveillance equipment is actually placed there at the particular time. Surveillance equipment should be in place and operating at each crossing at least 25 percent of each calendar quarter.

e. Appropriate integration, testing and maintenance of the system to provide evidence supporting enforcement;

f. Public awareness efforts designed to reinforce photo enforcement and alert motorists to the absence of train horns;

g. Subject to audit, a statistically valid baseline violation rate must be established through automated or systematic manual monitoring or sampling at the subject crossing(s); and

h. A law enforcement effort must be defined, established and continued along with continual or regular monitoring.

i. The public authority shall retain records pertaining to monitoring and sampling efforts at the grade crossing for a period of not less than five years. These records shall be made available, upon request, to FRA as provided by 49 U.S.C. 20107.

B. The effectiveness of an ASM will be determined as follows:

1. Establish the quarterly (three months) baseline violation rates for each crossing in the proposed quiet zone.

a. A violation in this context refers to a motorist not complying with the automatic warning devices at the crossing (not stopping for the flashing lights and driving over the crossing after the gate arms have started to descend, or driving around the lowered gate arms). A violation does not have to result in a traffic citation for the violation to be considered.

b. Violation data may be obtained by any method that can be shown to provide a statistically valid sample. This may include the use of video cameras, other technologies (e.g., inductive loops), or manual observations that capture driver behavior when the automatic warning devices are operating.

c. If data is not collected continuously during the quarter, sufficient detail must be provided in the application in order to validate that the methodology used results in a statistically valid sample. FRA recommends that at least a minimum of 600 samples (one sample equals one gate activation) be collected during the baseline and subsequent quarterly sample periods.

d. The sampling methodology must take measures to avoid biases in their sampling technique. Potential sampling biases could include: Sampling on certain days of the week but not others; sampling during certain times of the day but not others; sampling immediately after implementation of an ASM while the public is still going through an adjustment period; or applying one sample method for the baseline rate and another for the new rate.

e. The baseline violation rate should be expressed as the number of violations per gate activations in order to normalize for unequal gate activations during subsequent data collection periods.

f. All subsequent quarterly violation rate calculations must use the same methodology as stated in this paragraph unless FRA authorizes another methodology.

2. The ASM should then be initiated for each crossing. Train horns are still being sounded during this time period.

3. In the calendar quarter following initiation of the ASM, determine a new quarterly violation rate using the same methodology as in paragraph (1) above.

4. Determine the violation rate reduction for each crossing by the following formula:

Violation rate reduction = (new rate − baseline rate)/baseline rate

5. Determine the effectiveness rate of the ASM for each crossing by multiplying the violation rate reduction by .78.

6. Using the effectiveness rates for each grade crossing treated by an ASM, determine the Quiet Zone Risk Index. If and when the Quiet Zone Risk Index for the proposed quiet zone has been reduced to a level at, or below, the Risk Index With Horns or the Nationwide Significant Risk Threshold, the public authority may apply to FRA for approval of the proposed quiet zone. Upon receiving written approval of the quiet zone application from FRA, the public authority may then proceed with notifications and implementation of the quiet zone.

7. Violation rates must be monitored for the next two calendar quarters and every second quarter thereafter. If, after five years from the implementation of the quiet zone, the violation rate for any quarter has never exceeded the violation rate that was used to determine the effectiveness rate that was approved by FRA, violation rates may be monitored for one quarter per year.

8. In the event that the violation rate is ever greater than the violation rate used to determine the effectiveness rate that was approved by FRA, the public authority may continue the quiet zone for another quarter. If, in the second quarter the violation rate is still greater than the rate used to determine the effectiveness rate that was approved by FRA, a new effectiveness rate must be calculated and the Quiet Zone Risk Index recalculated using the new effectiveness rate. If the new Quiet Zone Risk Index indicates that the ASM no longer fully compensates for the lack of a train horn, or that the risk level is equal to, or exceeds the National Significant Risk Threshold, the procedures for dealing with unacceptable effectiveness after establishment of a quiet zone should be followed.

III. Engineering ASMs

A. Engineering improvements, other than modified SSMs, may be used in the creation of a Quiet Zone. These engineering improvements, which will be treated as ASMs under this appendix, may include improvements that address underlying geometric conditions, including sight distance, that are the source of increased risk at the crossing.

B. The effectiveness of an Engineering ASM will be determined as follows:

1. Establish the quarterly (three months) baseline violation rate for the crossing at which the Engineering ASM will be applied.

a. A violation in this context refers to a motorist not complying with the automatic warning devices at the crossing (not stopping for the flashing lights and driving over the crossing after the gate arms have started to descend, or driving around the lowered gate arms). A violation does not have to result in a traffic citation for the violation to be considered.

b. Violation data may be obtained by any method that can be shown to provide a statistically valid sample. This may include the use of video cameras, other technologies (e.g. inductive loops), or manual observations that capture driver behavior when the automatic warning devices are operating.

c. If data is not collected continuously during the quarter, sufficient detail must be provided in the application in order to validate that the methodology used results in a statistically valid sample. FRA recommends that at least a minimum of 600 samples (one sample equals one gate activation) be collected during the baseline and subsequent quarterly sample periods.

d. The sampling methodology must take measures to avoid biases in their sampling technique. Potential sampling biases could include: Sampling on certain days of the week but not others; sampling during certain times of the day but not others; sampling immediately after implementation of an ASM while the public is still going through an adjustment period; or applying one sample method for the baseline rate and another for the new rate.

e. The baseline violation rate should be expressed as the number of violations per gate activations in order to normalize for unequal gate activations during subsequent data collection periods.

f. All subsequent quarterly violation rate calculations must use the same methodology as stated in this paragraph unless FRA authorizes another methodology.

2. The Engineering ASM should be initiated at the crossing. Train horns are still being sounded during this time period.

3. In the calendar quarter following initiation of the Engineering ASM, determine a new quarterly violation rate using the same methodology as in paragraph (1) above.

4. Determine the violation rate reduction for the crossing by the following formula:

Violation rate reduction = (new rate − baseline rate)/baseline rate

5. Using the Engineering ASM effectiveness rate, determine the Quiet Zone Risk Index. If and when the Quiet Zone Risk Index for the proposed quiet zone has been reduced to a risk level at or below the Risk Index With Horns or the Nationwide Significant Risk Threshold, the public authority may apply to FRA for approval of the quiet zone. Upon receiving written approval of the quiet zone application from FRA, the public authority may then proceed with notifications and implementation of the quiet zone.

6. Violation rates must be monitored for the next two calendar quarters. Unless otherwise provided in FRA's notification of quiet zone approval, if the violation rate for these two calendar quarters does not exceed the violation rate that was used to determine the effectiveness rate that was approved by FRA, the public authority can cease violation rate monitoring.

7. In the event that the violation rate over either of the next two calendar quarters are greater than the violation rate used to determine the effectiveness rate that was approved by FRA, the public authority may continue the quiet zone for a third calendar quarter. However, if the third calendar quarter violation rate is also greater than the rate used to determine the effectiveness rate that was approved by FRA, a new effectiveness rate must be calculated and the Quiet Zone Risk Index re-calculated using the new effectiveness rate. If the new Quiet Zone Risk Index exceeds the Risk Index With Horns and the Nationwide Significant Risk Threshold, the procedures for dealing with unacceptable effectiveness after establishment of a quiet zone should be followed.

APPENDIX C TO PART 222—GUIDE TO ESTABLISHING QUIET ZONES

Introduction

This Guide to Establishing Quiet Zones (Guide) is divided into five sections in order to address the variety of methods and conditions that affect the establishment of quiet zones under this rule.

Section I of the Guide provides an overview of the different ways in which a quiet zone may be established under this rule. This includes a brief discussion on the safety thresholds that must be attained in order for train horns to be silenced and the relative merits of each. It also includes the two general methods that may be used to reduce risk in the proposed quiet zone, and the different impacts that the methods have on the quiet zone implementation process. This section also discusses Partial (e.g. night time only quiet zones) and Intermediate Quiet Zones. An Intermediate Quiet Zone is one where horn restrictions were in place after October 9, 1996, but as of December 18, 2003.

Section II of the Guide provides information on establishing New Quiet Zones. A New Quiet Zone is one at which train horns are currently being sounded at crossings. The Public Authority Designation and Public Authority Application to FRA methods will be discussed in depth.

Section III of the Guide provides information on establishing Pre-Rule Quiet Zones. A Pre-Rule Quiet Zone is one where train horns were not routinely sounded as of October 9, 1996 and December 18, 2003. The differences between New and Pre-Rule Quiet Zones will be explained. Public Authority Designation and Public Authority Application to FRA methods also apply to Pre-Rule Quiet Zones.

Section IV of the Guide deals with the required notifications that must be provided by public authorities when establishing both New and continuing Pre-Rule or Intermediate Quiet Zones.

Section V of the Guide provides examples of quiet zone implementation.

SECTION I—OVERVIEW

In order for a quiet zone to be qualified under this rule, it must be shown that the lack of the train horn does not present a significant risk with respect to loss of life or serious personal injury, or that the significant risk has been compensated for by other means. The rule provides four basic ways in which a quiet zone may be established. Creation of both New Quiet Zones and Pre-Rule Quiet Zones are based on the same general guidelines; however, there are a number of differences that will be noted in the discussion on Pre-Rule Quiet Zones.

A. Qualifying Conditions

(1) One of the following four conditions or scenarios must be met in order to show that the lack of the train horn does not present a significant risk, or that the significant risk has been compensated for by other means:

a. One or more SSMs as identified in appendix A are installed at each public crossing in the quiet zone; or

b. The Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold without implementation of additional safety measures at any crossings in the quiet zone; or

c. Additional safety measures are implemented at selected crossings resulting in the Quiet Zone Risk Index being reduced to a level equal to, or less than, the Nationwide Significant Risk Threshold; or

d. Additional safety measures are taken at selected crossings resulting in the Quiet Zone Risk Index being reduced to at least the level of the Risk Index With Horns (that is, the risk that would exist if train horns were sounded at every public crossing in the quiet zone).

(2) It is important to consider the implications of each approach before deciding which one to use. If a quiet zone is qualified based on reference to the Nationwide Significant Risk Threshold (i.e. the Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold—see the second and third scenarios above), then an annual review will be done by FRA to determine if the Quiet Zone Risk Index remains equal to, or less than, the Nationwide Significant Risk Threshold. Since the Nationwide Significant Risk Threshold and the Quiet Zone Risk Index may change from year to year, there is no guarantee that the quiet zone will remain qualified. The circumstances that cause the disqualification may not be subject to the control of the public authority. For example, an overall national improvement in safety at gated crossings may cause the Nationwide Significant Risk Threshold to fall. This may cause the

Quiet Zone Risk Index to become greater than the Nationwide Significant Risk Threshold. If the quiet zone is no longer qualified, then the public authority will have to take additional measures, and may incur additional costs that might not have been budgeted, to once again lower the Quiet Zone Risk Index to at least the Nationwide Significant Risk Threshold in order to retain the quiet zone. Therefore, while the initial cost to implement a quiet zone under the second or third scenario may be lower than the other options, these scenarios also carry a degree of uncertainty about the quiet zone's continued existence.

(3) The use of the first or fourth scenarios reduces the risk level to at least the level that would exist if train horns were sounding in the quiet zone. These methods may have higher initial costs because more safety measures may be necessary in order to achieve the needed risk reduction. Despite the possibility of greater initial costs, there are several benefits to these methods. The installation of SSMs at every crossing will provide the greatest safety benefit of any of the methods that may be used to initiate a quiet zone. With both of these methods (first and fourth scenarios), the public authority will never need to be concerned about the Nationwide Significant Risk Threshold, annual reviews of the Quiet Zone Risk Index, or failing to be qualified because the Quiet Zone Risk Index is higher than the Nationwide Significant Risk Threshold. Public authorities are strongly encouraged to carefully consider both the pros and cons of all of the methods and to choose the method that will best meet the needs of its citizens by providing a safer and quieter community.

(4) For the purposes of this Guide, the term ''Risk Index with Horns'' is used to represent the level of risk that would exist if train horns were sounded at every public crossing in the proposed quiet zone. If a public authority decides that it would like to fully compensate for the lack of a train horn and not install SSMs at each public crossing in the quiet zone, it must reduce the Quiet Zone Risk Index to a level that is equal to, or less than, the Risk Index with Horns. The Risk Index with Horns is similar to the Nationwide Significant Risk Threshold in that both are targets that must be reached in order to establish a quiet zone under the rule. Quiet zones that are established by reducing the Quiet Zone Risk Index to at least the level of the Nationwide Significant Risk Threshold will be reviewed annually by FRA to determine if they still qualify under the rule to retain the quiet zone. Quiet zones that are established by reducing the Quiet Zone Risk Index to at least the level of the Risk Index with Horns will not be subject to annual reviews.

(5) The use of FRA's web-based Quiet Zone Calculator is recommended to aid in the decision making process (*http://www.fra.dot.gov/us/content/1337*). The Quiet Zone Calculator will allow the public authority to consider a variety of options in determining which SSMs make the most sense. It will also perform the necessary calculations used to determine the existing risk level and whether enough risk has been mitigated in order to create a quiet zone under this rule.

B. Risk Reduction Methods

FRA has established two general methods to reduce risk in order to have a quiet zone qualify under this rule. The method chosen impacts the manner in which the quiet zone is implemented.

1. *Public Authority Designation (SSMs)*—The Public Authority Designation method (§222.39(a)) involves the use of SSMs (see appendix A) at some or all crossings within the quiet zone. The use of only SSMs to reduce risk will allow a public authority to designate a quiet zone without approval from FRA. If the public authority installs SSMs at every crossing within the quiet zone, it need not demonstrate that they will reduce the risk sufficiently in order to qualify under the rule since FRA has already assessed the ability of the SSMs to reduce risk. In other words, the Quiet Zone Calculator does not need to be used. However, if only SSMs are installed within the quiet zone, but not at every crossing, the public authority must calculate that sufficient risk reduction will be accomplished by the SSMs. Once the improvements are made, the public authority must make the required notifications (which includes a copy of the report generated by the Quiet Zone Calculator showing that the risk in the quiet zone has been sufficiently reduced), and the quiet zone may be implemented. FRA does not need to approve the plan as it has already assessed the ability of the SSMs to reduce risk.

2. *Public Authority Application to FRA (ASMs)*—The Public Authority Application to FRA method (§222.39(b)) involves the use ASMs (see appendix B). ASMs include modified SSMs that do not fully comply with the provisions found in appendix A (e.g., shorter than required traffic channelization devices), non-engineering ASMs (e.g., programmed law enforcement), and engineering ASMs (i.e., engineering improvements other than modified SSMs). If the use of ASMs (or a combination of ASMs and SSMs) is elected to reduce risk, then the public authority must provide a Notice of Intent and then apply to FRA for approval of the quiet zone. The application must contain sufficient data and analysis to confirm that the proposed ASMs do indeed provide the necessary risk reduction. FRA will review the application and will issue a formal approval if it determines that risk is reduced to a level that is necessary in order to comply with the rule.

Once FRA approval has been received and the safety measures fully implemented, the public authority would then provide a Notice of Quiet Zone Establishment and the quiet zone may be implemented. The use of non-engineering ASMs will require continued monitoring and analysis throughout the existence of the quiet zone to ensure that risk continues to be reduced.

3. *Calculating Risk Reduction*—The following should be noted when calculating risk reductions in association with the establishment of a quiet zone. This information pertains to both New Quiet Zones and Pre-Rule Quiet Zones and to the Public Authority Designation and Public Authority Application to FRA methods.

Crossing closures: If any public crossing within the quiet zone is proposed to be closed, include that crossing when calculating the Risk Index with Horns. The effectiveness of a closure is 1.0. However, be sure to increase the traffic counts at other crossings within the quiet zone and recalculate the risk indices for those crossings that will handle the traffic diverted from the closed crossing. It should be noted that crossing closures that are already in existence are not considered in the risk calculations.

Example: A proposed New Quiet Zone contains four crossings: A, B, C and D streets. A, B and D streets are equipped with flashing lights and gates. C Street is a passive crossbuck crossing with a traffic count of 400 vehicles per day. It is decided that C Street will be closed as part of the project. Compute the risk indices for all four streets. The calculation for C Street will utilize flashing lights and gates as the warning device. Calculate the Crossing Corridor Risk Index by averaging the risk indices for all four of the crossings. This value will also be the Risk Index with Horns since train horns are currently being sounded. To calculate the Quiet Zone Risk Index, first re-calculate the risk indices for B and D streets by increasing the traffic count for each crossing by 200. (Assume for this example that the public authority decided that the traffic from C Street would be equally divided between B and D streets.) Increase the risk indices for A, B and D streets by 66.8% and divide the sum of the three remaining crossings by four. This is the initial Quiet Zone Risk Index and accounts for the risk reduction caused by closing C Street.

Grade Separation: Grade separated crossings that were in existence before the creation of a quiet zone are not included in any of the calculations. However, any public crossings within the quiet zone that are proposed to be treated by grade separation should be treated in the same manner as crossing closures. Highway traffic that may be diverted from other crossings within the quiet zone to the new grade separated crossing should be considered when computing the Quiet Zone Risk Index.

Example: A proposed New Quiet Zone contains four crossings: A, B, C and D streets. All streets are equipped with flashing lights and gates. C Street is a busy crossing with a traffic count of 25,000 vehicles per day. It is decided that C Street will be grade separated as part of the project and the existing at-grade crossing closed. Compute the risk indices for all four streets. Calculate the Crossing Corridor Risk Index, which will also be the Risk Index with Horns, by averaging the risk indices for all four of the crossings. To calculate the Quiet Zone Risk Index, first recalculate the risk indices for B and D streets by decreasing the traffic count for each crossing by 1,200. (The public authority decided that 2,400 motorists will decide to use the grade separation at C Street in order to avoid possible delays caused by passing trains.) Increase the risk indices for A, B and D streets by 66.8% and divide the sum of the three remaining crossings by four. This is the initial Quiet Zone Risk Index and accounts for the risk reduction caused by the grade separation at C Street.

Pre-Existing SSMs: Risk reduction credit may be taken by a public authority for a SSM that was previously implemented and is currently in place in the quiet zone. If an existing improvement meets the criteria for a SSM as provided in appendix A, the improvement is deemed a Pre-Existing SSM. Risk reduction credit is obtained by inflating the Risk Index With Horns to show what the risk would have been at the crossing if the pre-existing SSM had not been implemented. Crossing closures and grade separations that occurred prior to the implementation of the quiet zone are not Pre-Existing SSMs and do not receive any risk reduction credit.

Example 1—A proposed New Quiet Zone has one crossing that is equipped with flashing lights and gates and has medians 100 feet in length on both sides of the crossing. The medians conform to the requirements in appendix A and qualify as a Pre-Existing SSM. The risk index as calculated for the crossing is 10,000. To calculate the Risk Index With Horns for this crossing, you divide the risk index by difference between one and the effectiveness rate of the pre-existing SSM ($10,000 \div (1–0.75) = 40,000$). This value (40,000) would then be averaged in with the risk indices of the other crossings to determine the proposed quiet zone's Risk Index With Horns. To calculate the Quiet Zone Risk Index, the original risk index is increased by 66.8% to account for the additional risk attributed to the absence of the train horn ($10,000 \times 1.668 = 16,680$). This value (16,680) is then averaged into the risk indices of the other crossings that have also been increased by 66.8%. The resulting average is the Quiet Zone Risk Index.

Example 2—A Pre-Rule Quiet Zone consisting of four crossings has one crossing that is equipped with flashing lights and gates and has medians 100 feet in length on both sides of the crossing. The medians conform to the requirements in appendix A and qualify as a Pre-Existing SSM. The risk index as calculated for the crossing is 20,000. To calculate the Risk Index With Horns for this crossing, first reduce the risk index by 40 percent to reflect the risk reduction that would be achieved if train horns were routinely sounded ($20,000 \times 0.6 = 12,000$). Next, divide the resulting risk index by difference between one and the effectiveness rate of the pre-existing SSM ($12,000 \div (1 - 0.75) = 48,000$). This value (48,000) would then be averaged with the adjusted risk indices of the other crossings to determine the pre-rule quiet zone's Risk Index With Horns. To calculate the Quiet Zone Risk Index, the original risk index (20,000) is then averaged into the risk original indices of the other crossings. The resulting average is the Quiet Zone Risk Index.

Pre-Existing Modified SSMs: Risk reduction credit may be taken by a public authority for a modified SSM that was previously implemented and is currently in place in the quiet zone. Modified SSMs are Alternative Safety Measures which must be approved by FRA. If an existing improvement is approved by FRA as a modified SSM as provided in appendix B, the improvement is deemed a Pre-Existing Modified SSM. Risk reduction credit is obtained by inflating the Risk Index With Horns to show what the risk would have been at the crossing if the pre-existing SSM had not been implemented. The effectiveness rate of the modified SSM will be determined by FRA. The public authority may provide information to FRA to be used in determining the effectiveness rate of the modified SSM. Once an effectiveness rate has been determined, follow the procedure previously discussed for Pre-Existing SSMs to determine the risk values that will be used in the quiet zone calculations.

Wayside Horns: Crossings with wayside horn installations will be treated as a one for one substitute for the train horn and are not to be included when calculating the Crossing Corridor Risk Index, the Risk Index with Horns or the Quiet Zone Risk Index.

Example—A proposed New Quiet Zone contains four crossings: A, B, C and D streets. All streets are equipped with flashing lights and gates. It is decided that C Street will have a wayside horn installed. Compute the risk indices for A, B and D streets. Since C Street is being treated with a wayside horn, it is not included in the calculation of risk. Calculate the Crossing Corridor Risk Index by averaging the risk indices for A, B and D streets. This value is also the Risk Index with Horns. Increase the risk indices for A, B and D streets by 66.8% and average the results. This is the initial Quiet Zone Risk Index for the proposed quiet zone.

C. Partial Quiet Zones

A Partial Quiet Zone is a quiet zone in which locomotive horns are not routinely sounded at public crossings for a specified period of time each day. For example, a quiet zone during only the nighttime hours would be a partial quiet zone. Partial quiet zones may be either New or Pre-Rule and follow the same rules as 24 hour quiet zones. New Partial Quiet Zones must be in effect during the hours of 10 p.m. to 7 a.m. All New Partial Quiet Zones must comply with all of the requirements for New Quiet Zones. For example, all public grade crossings that are open during the time that horns are silenced must be equipped with flashing lights and gates that are equipped with constant warning time (where practical) and power out indicators. Risk is calculated in exactly the same manner as for New Quiet Zones. The Quiet Zone Risk Index is calculated for the entire 24-hour period, even though the train horn will only be silenced during the hours of 10 p.m. to 7 a.m.

A Pre-Rule Partial Quiet Zone is a partial quiet zone at which train horns were not sounding as of October 9, 1996 and on December 18, 2003. All of the regulations that pertain to Pre-Rule Quiet Zones also pertain to Pre-Rule Partial Quiet Zones. The Quiet Zone Risk Index is calculated for the entire 24-hour period for Pre-Rule Partial Quiet Zones, even though train horns are only silenced during the nighttime hours. Pre-Rule Partial Quiet Zones may qualify for automatic approval in the same manner as Pre-Rule Quiet Zones with one exception. If the Quiet Zone Risk Index is less than twice the National Significant Risk Threshold, and there have been no relevant collisions during the time period when train horns are silenced, then the Pre-Rule Partial Quiet Zone is automatically qualified. In other words, a relevant collision that occurred during the period of time that train horns were sounded will not disqualify a Pre-Rule Partial Quiet Zone that has a Quiet Zone Risk Index that is less than twice the National Significant Risk Index. Pre-Rule Partial Quiet Zones must provide the notification as required in §222.43 in order to keep train horns silenced. A Pre-Rule Partial Quiet Zone may be converted to a 24 hour New Quiet Zone by complying with all of the New Quiet Zone regulations.

D. Intermediate Quiet Zones

An Intermediate Quiet Zone is one where horn restrictions were in place after October

9, 1996, but as of December 18, 2003 (the publication date of the Interim Final Rule). Intermediate Quiet Zones and Intermediate Partial Quiet Zones will be able to keep train horns silenced until June 24, 2006, provided notification is made per §222.43. This will enable public authority to have additional time to make the improvement necessary to come into compliance with the rule. Intermediate Quiet Zones must conform to all the requirements for New Quiet Zones by June 24, 2006. Other than having the horn silenced for an additional year, Intermediate Quiet Zones are treated exactly like New Quiet Zones.

SECTION II—NEW QUIET ZONES

FRA has established several approaches that may be taken in order to establish a New Quiet Zone under this rule. Please see the preceding discussions on ''Qualifying Conditions'' and ''Risk Reduction Methods'' to assist in the decision-making process on which approach to take. This following discussion provides the steps necessary to establish New Quiet Zones and includes both the Public Authority Designation and Public Authority Application to FRA methods. It must be remembered that in a New Quiet Zone all public crossings must be equipped with flashing lights and gates. The requirements are the same regardless of whether a 24-hour or partial quiet zone is being created.

A. Requirements for Both Public Authority Designation and Public Authority Application

The following steps are necessary when establishing a New Quiet Zone. This information pertains to both the Public Authority Designation and Public Authority Application to FRA methods.

1. The public authority must provide a written Notice of Intent (§222.43(a)(1) and §222.43(b)) to the railroads that operate over the proposed quiet zone, the State agency responsible for highway and road safety and the State agency responsible for grade crossing safety. The purpose of this Notice of Intent is to provide an opportunity for the railroads and the State agencies to provide comments and recommendations to the public authority as it is planning the quiet zone. They will have 60 days to provide these comments to the public authority. The quiet zone cannot be created unless the Notice of Intent has been provided. FRA encourages public authorities to provide the required Notice of Intent early in the quiet zone development process. The railroads and State agencies can provide an expertise that very well may not be present within the public authority. FRA believes that it will be very useful to include these organizations in the planning process. For example, including railroads and State agencies in the inspections of the crossing will help ensure accurate Inventory information for the crossings. The railroad can provide information on whether the flashing lights and gates are equipped with constant warning time and power out indicators. Pedestrian crossings and private crossings with public access, industrial or commercial use that are within the quiet zone must have a diagnostic team review and be treated according to the team's recommendations. Railroads and the State agency responsible for grade crossing safety must be invited to the diagnostic team review. Note: Please see Section IV for details on the requirements of a Notice of Intent.

2. Determine all public, private and pedestrian at-grade crossings that will be included within the quiet zone. Also, determine any existing grade-separated crossings that fall within the quiet zone. Each crossing must be identified by the U.S. DOT Crossing Inventory number and street or highway name. If a crossing does not have a U.S. DOT Crossing Inventory number, then contact FRA's Office of Safety (202–493–6299) for assistance.

3. Ensure that the quiet zone will be at least one-half mile in length. (§222.35(a)(1)) If more than one New Quiet Zone or New Partial Quiet Zone will be created within a single political jurisdiction, ensure that each New Quiet Zone or New Partial Quiet Zone will be separated by at least one public highway-rail grade crossing. (§222.35(a)(1)(iii))

4. A complete and accurate Grade Crossing Inventory Form must be on file with FRA for all crossings (public, private and pedestrian) within the quiet zone. An inspection of each crossing in the proposed quiet zone should be performed and the Grade Crossing Inventory Forms updated, as necessary, to reflect the current conditions at each crossing.

5. Every public crossing within the quiet zone must be equipped with active warning devices comprising both flashing lights and gates. The warning devices must be equipped with power out indicators. Constant warning time circuitry is also required unless existing conditions would prevent the proper operation of the constant warning time circuitry. FRA recommends that these automatic warning devices also be equipped with at least one bell to provide an audible warning to pedestrians. If the warning devices are already equipped with a bell (or bells), the bells may not be removed or deactivated. The plans for the quiet zone may be made assuming that flashing lights and gates are at all public crossings; however the quiet zone may not be implemented until all public crossings are actually equipped with the flashing lights and gates. (§§222.35(b)(1) and 222.35(b)(2))

6. Private crossings must have cross-bucks and ''STOP'' signs on both approaches to the crossing. Private crossings with public access, industrial or commercial use must have

a diagnostic team review and be treated according to the team's recommendations. The public authority must invite the State agency responsible for grade crossing safety and all affected railroads to participate in the diagnostic review. (§§ 222.25(b) and (c))

7. Each highway approach to every public and private crossing must have an advance warning sign (in accordance with the MUTCD) that advises motorists that train horns are not sounded at the crossing, unless the public or private crossing is equipped with a wayside horn. (§ 222.35(c))

8. Each pedestrian crossing must be reviewed by a diagnostic team and equipped or treated in accordance with the recommendation of the diagnostic team. The public authority must invite the State agency responsible for grade crossing safety and all affected railroads to participate in the diagnostic review. At a minimum, each approach to every pedestrian crossing must be equipped with a sign that conforms to the MUTCD and advises pedestrians that train horns are not sounded at the crossing. (§ 222.27)

B. New Quiet Zones—Public Authority Designation

Once again it should be remembered that all public crossings must be equipped with automatic warning devices consisting of flashing lights and gates in accordance with § 222.35(b). In addition, one of the following conditions must be met in order for a public authority to designate a new quiet zone without FRA approval:

a. One or more SSMs as identified in appendix A are installed at *each* public crossing in the quiet zone (§ 222.39(a)(1)); or

b. The Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold without SSMs installed at any crossings in the quiet zone (§ 222.39(a)(2)(i)); or

c. SSMs are installed at selected crossings, resulting in the Quiet Zone Risk Index being reduced to a level equal to, or less than, the Nationwide Significant Risk Threshold (§ 222.39(a)(2)(ii)); or

d. SSMs are installed at selected crossings, resulting in the Quiet Zone Risk Index being reduced to a level of risk that would exist if the horn were sounded at every crossing in the quiet zone (i.e., the Risk Index with Horns) (§ 222.39(a)(3)).

Steps necessary to establish a New Quiet Zone using the Public Authority Application to FRA method:

1. If one or more SSMs as identified in appendix A are installed at each public crossing in the quiet zone, the requirements for a public authority designation quiet zone will have been met. It is not necessary for the same SSM to be used at each crossing. However, before any improvements are implemented, the public authority must provide a Notice of Intent, which will trigger a 60-day comment period. During the 60-day comment period, railroads operating within the proposed quiet zone and State agencies responsible for grade crossing, highway and road safety may submit comments on the proposed quiet zone improvements to the public authority. Once the necessary improvements have been installed, Notice of Quiet Zone Establishment shall be provided and the quiet zone implemented in accordance with the rule. If SSMs are not installed at each public crossing, proceed on to Step 2 and use the risk reduction method.

2. To begin, calculate the risk index for each public crossing within the quiet zone (See appendix D. FRA's web-based Quiet Zone Calculator may be used to do this calculation). If flashing lights and gates have to be installed at any public crossings, calculate the risk indices for such crossings as if lights and gates were installed. (NOTE: Flashing lights and gates must be installed prior to initiation of the quiet zone.) If the Inventory record does not reflect the actual conditions at the crossing, be sure to use the conditions that currently exist when calculating the risk index. Note: Private crossings and pedestrian crossings are not included when computing the risk for the proposed quiet zone.

3. The Crossing Corridor Risk Index is then calculated by averaging the risk index for each public crossing within the proposed quiet zone. Since train horns are routinely being sounded for crossings in the proposed quiet zone, this value is also the Risk Index with Horns.

4. In order to calculate the initial Quiet Zone Risk Index, first adjust the risk index at each public crossing to account for the increased risk due to the absence of the train horn. The absence of the horn is reflected by an increased risk index of 66.8% at gated crossings. The initial Quiet Zone Risk Index is then calculated by averaging the increased risk index for each public crossing within the proposed quiet zone. At this point the Quiet Zone Risk Index will equal the Risk Index with Horns multiplied by 1.668.

5. Compare the Quiet Zone Risk Index to the Nationwide Significant Risk Threshold. If the Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold, then the public authority may decide to designate a quiet zone and provide the Notice of Intent, followed by the Notice of Quiet Zone Establishment. With this approach, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk Index. If the Quiet Zone Risk Index for the quiet zone rises above the Nationwide Significant Risk Threshold, FRA will notify the Public Authority so that appropriate measures can be taken. (See § 222.51(a)).

6. If the Quiet Zone Risk Index is greater than the Nationwide Significant Risk Threshold, then select an appropriate SSM for a crossing. Reduce the inflated risk index calculated in Step 4 for that crossing by the effectiveness rate of the chosen SSM. (See appendix A for the effectiveness rates for the various SSMs). Recalculate the Quiet Zone Risk Index by averaging the revised inflated risk index with the inflated risk indices for the other public crossings. If this new Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold, the quiet zone would qualify for public authority designation. If the Quiet Zone Risk Index is still higher than the Nationwide Significant Risk Threshold, treat another public crossing with an appropriate SSM and repeat the process until the Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold. Once this result is obtained, the quiet zone will qualify for establishment by public authority designation. Early in the quiet zone development process, a Notice of Intent should be provided by the public authority, which will trigger a 60-day comment period. During this 60-day comment period, railroads operating within the proposed quiet zone and State agencies responsible for grade crossing, highway and road safety may provide comments on the proposed quiet zone improvements described in the Notice of Intent. Once all the necessary safety improvements have been implemented, Notice of Quiet Zone Establishment must be provided. With this approach, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk Index. If the Quiet Zone Risk Index for the quiet zone rises above the Nationwide Significant Risk Threshold, FRA will notify the public authority so that appropriate measures can be taken. (See §222.51(a)).

7. If the public authority wishes to reduce the risk of the quiet zone to the level of risk that would exist if the horn were sounded at every crossing within the quiet zone, the public authority should calculate the initial Quiet Zone Risk Index as in Step 4. The objective is to now reduce the Quiet Zone Risk Index to the level of the Risk Index with Horns by adding SSMs at the crossings. The difference between the Quiet Zone Risk Index and the Risk Index with Horns is the amount of risk that will have to be reduced in order to fully compensate for lack of the train horn. The use of the Quiet Zone Calculator will aid in determining which SSMs may be used to reduce the risk sufficiently. Follow the procedure stated in Step 6, except that the Quiet Zone Risk Index must be equal to, or less than, the Risk Index with Horns instead of the Nationwide Significant Risk Threshold. Once this risk level is attained, the quiet zone will qualify for establishment by public authority designation. Early in the quiet zone development process, a Notice of Intent should be provided by the public authority, which will trigger a 60-day comment period. During this 60-day comment period, railroads operating within the proposed quiet zone and State agencies responsible for grade crossing, highway and road safety may provide comments on the proposed quiet zone improvements described in the Notice of Intent. Once all the necessary safety improvements have been implemented, Notice of Quiet Zone Establishment must be provided. One important distinction with this option is that the public authority will never need to be concerned with the Nationwide Significant Risk Threshold or the Quiet Zone Risk Index. The rule's intent is to make the quiet zone as safe as if the train horns were sounding. If this is accomplished, the public authority may designate the crossings as a quiet zone and need not be concerned with possible fluctuations in the Nationwide Significant Risk Threshold or annual risk reviews.

C. New Quiet Zones—Public Authority Application to FRA

A public authority must apply to FRA for approval of a quiet zone under three conditions. First, if any of the SSMs selected for the quiet zone do not fully conform to the design standards set forth in appendix A. These are referred to as modified SSMs in appendix B. Second, when programmed law enforcement, public education and awareness programs, or photo enforcement is used to reduce risk in the quiet zone, these are referred to as non-engineering ASMs in appendix B. It should be remembered that non-engineering ASMs will require periodic monitoring as long as the quiet zone is in existence. Third, when engineering ASMs are used to reduce risk. Please see appendix B for detailed explanations of ASMs and the periodic monitoring of non-engineering ASMs.

The public authority is strongly encouraged to submit the application to FRA for review and comment before the appendix B treatments are initiated. This will enable FRA to provide comments on the proposed ASMs to help guide the application process. If non-engineering ASMs or engineering ASMs are proposed, the public authority also may wish to confirm with FRA that the methodology it plans to use to determine the effectiveness rates of the proposed ASMs is appropriate. A quiet zone that utilizes a combination of SSMs from appendix A and ASMs from appendix B must make a Public Authority Application to FRA. A complete and thoroughly documented application will help to expedite the approval process.

The following discussion is meant to provide guidance on the steps necessary to establish a new quiet zone using the Public Authority Application to FRA method. Once

again it should be remembered that all public crossings must be equipped with automatic warning devices consisting of flashing lights and gates in accordance with §222.35(b).

1. Gather the information previously mentioned in the section on ''Requirements for both Public Authority Designation and Public Authority Application.''

2. Calculate the risk index for each public crossing as directed in Step 2—Public Authority Designation.

3. Calculate the Crossing Corridor Risk Index, which is also the Risk Index with Horns, as directed in Step 3—Public Authority Designation.

4. Calculate the initial Quiet Zone Risk Index as directed in Step 4—Public Authority Designation.

5. Begin to reduce the Quiet Zone Risk Index through the use of ASMs and SSMs. Follow the procedure provided in Step 6—Public Authority Designation until the Quiet Zone Risk Index has been reduced to equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns. (Remember that the public authority may choose which level of risk reduction is the most appropriate for its community.) Effectiveness rates for ASMs should be provided as follows:

a. Modified SSMs—Estimates of effectiveness for modified SSMs may be based upon adjustments from the effectiveness rates provided in appendix A or from actual field data derived from the crossing sites. The application must provide an estimated effectiveness rate and the rationale for the estimate.

b. Non-engineering ASMs—Effectiveness rates are to be calculated in accordance with the provisions of appendix B, paragraph II B.

c. Engineering ASMs—Effectiveness rates are to be calculated in accordance with the provisions of appendix B, paragraph III B.

6. Once it has been determined through analysis that the Quiet Zone Risk Index will be reduced to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns, the public authority must provide a Notice of Intent. The mailing of the Notice of Intent will trigger a 60-day comment period, during which railroads operating within the proposed quiet zone and State agencies responsible for grade crossing, highway and road safety may provide comments on the proposed quiet zone improvements. After reviewing any comments received, the public authority may make application to FRA for a quiet zone under §222.39(b). FRA will review the application to determine the appropriateness of the proposed effectiveness rates, and whether or not the proposed application demonstrates that the quiet zone meets the requirements of the rule. When submitting the application to FRA for approval, the application must contain the following (§222.39(b)(1)):

a. Sufficient detail concerning the present safety measures at all crossings within the proposed quiet zone. This includes current and accurate crossing inventory forms for each public, private, and pedestrian grade crossing.

b. Detailed information on the safety improvements that are proposed to be implemented at public, private and pedestrian grade crossings within the proposed quiet zone.

c. Membership and recommendations of the diagnostic team (if any) that reviewed the proposed quiet zone.

d. Statement of efforts taken to address comments submitted by affected railroads, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety, including a list of any objections raised by the railroads or State agencies.

e. A commitment to implement the proposed safety measures.

f. Demonstrate through data and analysis that the proposed measures will reduce the Quiet Zone Risk Index to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns.

g. A copy of the application must be provided to: All railroads operating over the public highway-rail grade crossings within the quiet zone; the highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone; the landowner having control over any private crossings within the quiet zone; the State agency responsible for highway and road safety; the State agency responsible for grade crossing safety; and the Associate Administrator. (§222.39(b)(3))

7. Upon receiving written approval from FRA of the quiet zone application, the public authority may then provide the Notice of Quiet Zone Establishment and implement the quiet zone. If the quiet zone is qualified by reducing the Quiet Zone Risk Index to a level at, or below, the Nationwide Significant Risk Threshold, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk Index. If the Quiet Zone Risk Index for the quiet zone rises above the Nationwide Significant Risk Threshold, FRA will notify the public authority so that appropriate measures can be taken. (See §222.51(a))

NOTE: The provisions stated above for crossing closures, grade separations, wayside horns, pre-existing SSMs and pre-existing modified SSMs apply for Public Authority Application to FRA as well.

SECTION III—PRE-RULE QUIET ZONES

Pre-Rule Quiet Zones are treated slightly differently from New Quiet Zones in the rule. This is a reflection of the statutory requirement to ''take into account the interest of communities that have in effect restrictions on the sounding of a locomotive horn at highway-rail grade crossings. * * *'' (49 U.S.C. 20153(i)) It also recognizes the historical experience of train horns not being sounded at Pre-Rule Quiet Zones.

Overview

Pre-Rule Quiet Zones that are not established by automatic approval (see discussion that follows) must meet the same requirements as New Quiet Zones as provided in §222.39. In other words, risk must be reduced through the use of SSMs or ASMs so that the Quiet Zone Risk Index for the quiet zone has been reduced to either the risk level which would exist if locomotive horns sounded at all crossings in the quiet zone (*i.e.* the Risk Index with Horns) or to a risk level equal to, or less than, the Nationwide Significant Risk Threshold. There are four differences in the requirements between Pre-Rule Quiet Zones and New Quiet Zones that must be noted.

(1) First, since train horns have not been routinely sounded in the Pre-Rule Quiet Zone, it is not necessary to increase the risk indices of the public crossings to reflect the additional risk caused by the lack of a train horn. Since the train horn has already been silenced, the added risk caused by the lack of a horn is reflected in the actual collision history at the crossings. Collision history is an important part in the calculation of the severity risk indices. In other words, the Quiet Zone Risk Index is calculated by averaging the existing risk index for each public crossing without the need to increase the risk index by 66.8%. For Pre-Rule Quiet Zones, the Crossing Corridor Risk Index and the initial Quiet Zone Risk Index have the same value.

(2) Second, since train horns have been silenced at the crossings, it will be necessary to mathematically determine what the risk level would have been at the crossings if train horns had been routinely sounded. These revised risk levels then will be used to calculate the Risk Index with Horns. This calculation is necessary to determine how much risk must be eliminated in order to compensate for the lack of the train horn. This will allow the public authority to have the choice to reduce the risk to at least the level of the Nationwide Significant Risk Threshold or to fully compensate for the lack of the train horn.

To calculate the Risk Index with Horns, the first step is to divide the existing severity risk index for each crossing by the appropriate value as shown in Table 1. This process eliminates the risk that was caused by the absence of train horns. The table takes into account that the train horn has been found to produce different levels of effectiveness in preventing collisions depending on the type of warning device at the crossing. (Note: FRA's web-based Quiet Zone Calculator will perform this computation automatically for Pre-Rule Quiet Zones.) The Risk Index with Horns is the average of the revised risk indices. The difference between the calculated Risk Index with Horns and the Quiet Zone Risk Index is the amount of risk that would have to be reduced in order to fully compensate for the lack of train horns.

TABLE 1—RISK INDEX DIVISOR VALUES

	Passive	Flashing lights	Lights & gates
U.S	1.749	1.309	1.668

(3) The third difference is that credit is given for the risk reduction that is brought about through the upgrading of the warning devices at public crossings (§222.35(b)(3)). For New Quiet Zones, all crossings must be equipped with automatic warning devices consisting of flashing lights and gates. Crossings without gates must have gates installed. The severity risk index for that crossing is then calculated to establish the risk index that is used in the Risk Index with Horns. The Risk Index with Horns is then increased by 66.8% to adjust for the lack of the train horn. The adjusted figure is the initial Quiet Zone Risk Index. There is no credit received for the risk reduction that is attributable to warning device upgrades in New Quiet Zones.

For Pre-Rule Quiet Zones, the Risk Index with Horns is calculated from the initial risk indices which use the warning devices that are currently installed. If a public authority elects to upgrade an existing warning device as part of its quiet zone plan, the accident prediction value for that crossing will be recalculated based on the upgraded warning device. (Once again, FRA's web-based Quiet Zone Calculator can do the actual computation.) The new accident prediction value is then used in the severity risk index formula to determine the risk index for the crossing. This adjusted risk index is then used to compute the new Quiet Zone Risk Index. This computation allows the risk reduction attributed to the warning device upgrades to be used in establishing a quiet zone.

(4) The fourth difference is that Pre-Rule Quiet Zones have different minimum requirements under §222.35. A Pre-Rule Quiet Zone may be less than one-half mile in length if that was its length as of October 9, 1996 (§222.35(a)(2)). A Pre-Rule Quiet Zone does not have to have automatic warning devices consisting of flashing lights and gates

at every public crossing (§222.35(b)(3)). The existing crossing safety warning systems in place as of December 18, 2003 may be retained but cannot be downgraded. It also is not necessary for the automatic warning devices to be equipped with constant warning time devices or power out indicators; however, when the warning devices are upgraded, constant warning time and power out indicators will be required if reasonably practical (§222.35(b)(3)). Advance warning signs that notify the motorist that train horns are not sounded do not have to be installed on each approach to public, private, and pedestrian grade crossings within the quiet zone until June 24, 2008. (§§222.27(d) and 222.35(c)) Similarly, STOP signs and crossbucks do not have to be installed on each approach to private crossings within the quiet zone until June 24, 2008. (§222.25(c)).

A. Requirements for Both Public Authority Designation and Public Authority Application—Pre-Rule Quiet Zones

The following is necessary when establishing a Pre-Rule Quiet Zone. This information pertains to Automatic Approval, the Public Authority Designation and Public Authority Application to FRA methods.

1. Determine all public, private and pedestrian at-grade crossings that will be included within the quiet zone. Also determine any existing grade separated crossings that fall within the quiet zone. Each crossing must be identified by the U.S. DOT Crossing Inventory number and street name. If a crossing does not have a U.S. DOT crossing number, then contact FRA for assistance.

2. Document the length of the quiet zone. It is not necessary that the quiet zone be at least one-half mile in length. Pre-Rule Quiet Zones may be shorter than one-half mile. However, the addition of a new crossing that is not a part of an existing Pre-Rule Quiet Zone to a quiet zone nullifies its pre-rule status, and the resulting New Quiet Zone must be at least one-half mile. The deletion of a crossing from a Pre-Rule Quiet Zone (except through closure or grade separation) must result in a quiet zone that is at least one-half mile in length. It is the intent of the rule to allow adjacent Pre-Rule Quiet Zones to be combined into one large pre-rule quiet zone if the respective public authorities desire to do so. (§222.35(a)(2))

3. A complete and accurate Grade Crossing Inventory Form must be on file with FRA for all crossings (public, private and pedestrian) within the quiet zone. An inspection of each crossing in the proposed quiet zone should be performed and the Grade Crossing Inventory Forms updated, as necessary, to reflect the current conditions at each crossing.

4. Pre-Rule Quiet Zones must retain, and may upgrade, the existing grade crossing safety warning systems. Unlike New Quiet Zones, it is not necessary that every public crossing within a Pre-Rule Quiet Zone be equipped with active warning devices comprising both flashing lights and gates. Existing warning devices need not be equipped with power out indicators and constant warning time circuitry. If warning devices are upgraded to flashing lights, or flashing lights and gates, the upgraded equipment must include, as is required for New Quiet Zones, power out indicators and constant warning time devices (if reasonably practical). (§222.35(b)(3))

5. By June 24, 2008, private crossings must have cross-bucks and ''STOP'' signs on both approaches to the crossing. (§222.25(c))

6. By June 24, 2008, each approach to a public, private, and pedestrian crossing must be equipped with an advance warning sign that conforms to the MUTCD and advises pedestrians and motorists that train horns are not sounded at the crossing. (§§222.27(d), 222.35(c))

7. It will be necessary for the public authority to provide a Notice of Quiet Zone Continuation in order to prevent the resumption of locomotive horn sounding when the rule becomes effective. A detailed discussion of the requirements of §222.43(c) is provided in Section IV of this appendix. The Notice of Quiet Zone Continuation must be provided to the appropriate parties by all Pre-Rule Quiet Zones that have not established quiet zones by automatic approval. This should be done no later than June 3, 2005 to ensure that train horns will not start being sounded on June 24, 2005. A Pre-Rule Quiet Zone may provide a Notice of Quiet Zone Continuation before it has determined whether or not it qualifies for automatic approval. Once it has been determined that the Pre-Rule Quiet Zone will be established by automatic approval, the Public Authority must provide the Notice of Quiet Zone Establishment. This must be accomplished no later than December 24, 2005. If the Pre-Rule Quiet Zone will not be established by automatic approval, the Notice of Quiet Zone Continuation will enable the train horns to be silenced until June 24, 2008. (Please refer to §222.41(c) for more information.)

B. Pre-Rule Quiet Zones—Automatic Approval

In order for a Pre-Rule Quiet Zone to be established under this rule (§222.41(a)), one of the following conditions must be met:

a. One or more SSMs as identified in appendix A are installed at *each* public crossing in the quiet zone;

b. The Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold;

c. The Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold but less than twice the Nationwide Significant Risk Threshold and there have been no relevant collisions at any public grade crossing

within the quiet zone for the preceding five years; or

d. The Quiet Zone Risk Index is equal to, or less than, the Risk Index With Horns.

Additionally, the Pre-Rule Quiet Zone must be in compliance with the minimum requirements for quiet zones (§222.35) and the notification requirements in §222.43.

The following discussion is meant to provide guidance on the steps necessary to determine if a Pre-Rule Quiet Zone qualifies for automatic approval.

1. All of the items listed in *Requirements for Both Public Authority Designation and Public Authority Application—Pre-Rule Quiet Zones* previously mentioned are to be accomplished. Remember that a Pre-Rule Quiet Zone may be less than one-half mile in length if that was its length as of October 9, 1996. Also, a Pre-Rule Quiet Zone does not have to have automatic warning devices consisting of flashing lights and gates at every public crossing.

2. If one or more SSMs as identified in appendix A are installed at each public crossing in the quiet zone, the quiet zone qualifies and the public authority may provide the Notice of Quiet Zone Establishment. If the Pre-Rule Quiet Zone does not qualify by this step, proceed on to the next step.

3. Calculate the risk index for each public crossing within the quiet zone (See appendix D.) Be sure that the risk index is calculated using the formula appropriate for the type of warning device that is actually installed at the crossing. Unlike New Quiet Zones, it is not necessary to calculate the risk index using flashing lights and gates as the warning device at every public crossing. (FRA's web-based Quiet Zone Calculator may be used to simplify the calculation process). If the Inventory record does not reflect the actual conditions at the crossing, be sure to use the conditions that currently exist when calculating the risk index.

4. The Quiet Zone Risk Index is then calculated by averaging the risk index for each public crossing within the proposed quiet zone. (Note: The initial Quiet Zone Risk Index and the Crossing Corridor Risk Index are the same for Pre-Rule Quiet Zones.)

5. Compare the Quiet Zone Risk Index to the Nationwide Significant Risk Threshold. If the Quiet Zone Risk Index is equal to, or less than, the Nationwide Significant Risk Threshold, then the quiet zone qualifies, and the public authority may provide the Notice of Quiet Zone Establishment. With this approach, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk. If the Quiet Zone Risk Index for the quiet zone is found to be above the Nationwide Significant Risk Threshold, FRA will notify the public authority so that appropriate measures can be taken (See §222.51(b)). If the Pre-Rule Quiet Zone is not established by this step, proceed on to the next step.

6. If the Quiet Zone Risk Index is above the Nationwide Significant Risk Threshold but less than twice the Nationwide Significant Risk Threshold and there have been no relevant collisions at any public grade crossing within the quiet zone for the preceding five years, then the quiet zone qualifies for automatic approval. However, in order to qualify on this basis, the public authority must provide a Notice of Quiet Zone Establishment by December 24, 2005. (Note: A relevant collision means a collision at a highway-rail grade crossing between a train and a motor vehicle, excluding the following: a collision resulting from an activation failure of an active grade crossing warning system; a collision in which there is no driver in the motor vehicle; or a collision where the highway vehicle struck the side of the train beyond the fourth locomotive unit or rail car.) With this approach, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk. If the Quiet Zone Risk Index for the quiet zone is above two times the Nationwide Significant Risk Threshold, or a relevant collision has occurred during the preceding year, FRA will notify the public authority so that appropriate measures can be taken (See §222.51(b)).

If the Pre-Rule Quiet Zone is not established by automatic approval, continuation of the quiet zone may require implementation of SSMs or ASMs to reduce the Quiet Zone Risk Index for the quiet zone to a risk level equal to, or below, either the risk level which would exist if locomotive horns sounded at all crossings in the quiet zone (*i.e.* the Risk Index with Horns) or the Nationwide Significant Risk Threshold. This is the same methodology used to create New Quiet Zones with the exception of the four differences previously noted. A review of the previous discussion on the two methods used to establish quiet zones may prove helpful in determining which would be the most beneficial to use for a particular Pre-Rule Quiet Zone.

C. Pre-Rule Quiet Zones—Public Authority Designation

The following discussion is meant to provide guidance on the steps necessary to establish a Pre-Rule Quiet Zone using the Public Authority Designation method.

1. The public authority must provide a Notice of Intent (§§222.43(a)(1) and 222.43(b)) to the railroads that operate within the proposed quiet zone, the State agency responsible for highway and road safety and the State agency responsible for grade crossing safety. This notice must be mailed by February 24, 2008, in order to continue existing locomotive horn restrictions beyond June 24, 2008 without interruption. The purpose of

this Notice of Intent is to provide an opportunity for the railroads and the State agencies to provide comments and recommendations to the public authority as it is planning the quiet zone. They will have 60 days to provide these comments to the public authority. The Notice of Intent must be provided, if new SSMs or ASMs will be implemented within the quiet zone. FRA encourages public authorities to provide the required Notice of Intent early in the quiet zone development process. The railroads and State agencies can provide an expertise that very well may not be present within the public authority. FRA believes that it will be very useful to include these organizations in the planning process. For example, including them in the inspections of the crossing will help ensure accurate Inventory information for the crossings. Note: Please see Section IV for details on the requirements of a Notice of Intent.

2. All of the items listed in ''Requirements for Both Public Authority Designation and Public Authority Application—Pre-Rule Quiet Zones'' previously mentioned are to be accomplished. Remember that a Pre-Rule Quiet Zone may be less than one-half mile in length if that was its length as of October 9, 1996. Also, a Pre-Rule Quiet Zone does not have to have automatic warning devices consisting of flashing lights and gates at every public crossing.

3. Calculate the risk index for each public crossing within the quiet zone as in Step 3—Pre-Rule Quiet Zones—Automatic Approval.

4. The Crossing Corridor Risk Index is then calculated by averaging the risk index for each public crossing within the proposed quiet zone. Since train horns are not being sounded for crossings, this value is actually the initial Quiet Zone Risk Index.

5. Calculate Risk Index with Horns by the following:

a. For each public crossing, divide the risk index that was calculated in Step 2 by the appropriate value in Table 1. This produces the risk index that would have existed had the train horn been sounded.

b. Average these reduced risk indices together. The resulting average is the Risk Index with Horns.

6. Begin to reduce the Quiet Zone Risk Index through the use of SSMs or by upgrading existing warning devices. Follow the procedure provided in Step 6—Public Authority Designation until the Quiet Zone Risk Index has been reduced to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns. A public authority may elect to upgrade an existing warning device as part of its Pre-Rule Quiet Zone plan. When upgrading a warning device, the accident prediction value for that crossing must be re-calculated for the new warning device. Determine the new risk index for the upgraded crossing by using the new accident prediction value in the severity risk index formula. This new risk index is then used to compute the new Quiet Zone Risk Index. (Remember that FRA's web-based Quiet Zone Calculator will be able to do the actual computations.) Once the Quiet Zone Risk Index has been reduced to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns, the quiet zone may be established by the Public Authority Designation method, and the public authority may provide the Notice of Quiet Zone Establishment once all the necessary improvements have been installed. If the quiet zone is established by reducing the Quiet Zone Risk Index to a risk level equal to, or less than, the Nationwide Significant Risk Threshold, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk Index. If the Quiet Zone Risk Index for the quiet zone rises above the Nationwide Significant Risk Threshold, FRA will notify the public authority so that appropriate measures can be taken (See §222.51(b)).

7. If the Pre-Rule Quiet Zone will not be established before June 24, 2008, the public authority must file a detailed plan for quiet zone improvements with the Associate Administrator by June 24, 2008. By providing a Notice of Intent (see Step 1 above) and a detailed plan for quiet zone improvements, existing locomotive horn restrictions may continue until June 24, 2010. (If a comprehensive State-wide implementation plan and funding commitment are also provided and safety improvements are initiated within at least one Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone, existing locomotive horn restrictions may continue until June 24, 2013.) (See §222.41(c) for more information.)

NOTE: The provisions stated above for crossing closures, grade separations, wayside horns, pre-existing SSMs and pre-existing modified SSMs apply for Public Authority Application to FRA as well.

D. Pre-Rule Quiet Zones—Public Authority Application to FRA

The following discussion is meant to provide guidance on the steps necessary to establish a Pre-Rule Quiet Zone using the Public Authority Application to FRA method.

1. The public authority must provide a Notice of Intent (§§222.43(a)(1) and 222.43(b)) to the railroads that operate within the proposed quiet zone, the State agency responsible for highway and road safety and the State agency responsible for grade crossing safety. This notice must be mailed by February 24, 2008, in order to continue existing locomotive horn restrictions beyond June 24, 2008 without interruption. The purpose of

this Notice of Intent is to provide an opportunity for the railroads and the State agencies to provide comments and recommendations to the public authority as it is planning the quiet zone. They will have 60 days to provide these comments to the public authority. The Notice of Intent must be provided, if new SSMs or ASMs will be implemented within the quiet zone. FRA encourages public authorities to provide the required Notice of Intent early in the quiet zone development process. The railroads and State agencies can provide an expertise that very well may not be present within the public authority. FRA believes that it will be very useful to include these organizations in the planning process. For example, including them in the inspections of the crossing will help ensure accurate Inventory information for the crossings. Note: Please see Section IV for details on the requirements of a Notice of Detailed Plan.

2. All of the items listed in ''Requirements for both Public Authority Designation and Public Authority Application—Pre-Rule Quiet Zones'' previously mentioned are to be accomplished. Remember that a Pre-Rule Quiet Zone may be less than one-half mile in length if that was its length as of October 9, 1996. Also, a Pre-Rule Quiet Zone does not have to have automatic warning devices consisting of flashing lights and gates at every public crossing.

3. Calculate the risk index for each public crossing within the quiet zone (See appendix D. FRA's web-based Quiet Zone Calculator may be used to simplify the calculation process). If the Inventory record does not reflect the actual conditions at the crossing, be sure to use the conditions that currently exist when calculating the risk index.

4. The Crossing Corridor Risk Index is then calculated by averaging the risk index for each public crossing within the proposed quiet zone. Since train horns are not being sounded for crossings, this value is actually the initial Quiet Zone Risk Index.

5. Calculate Risk Index with Horns by the following:

a. For each public crossing, divide its risk index that was calculated in Step 2 by the appropriate value in Table 1. This produces the risk index that would have existed had the train horn been sounded.

b. Average these reduced risk indices together. The resulting average is the Risk Index with Horns.

6. Begin to reduce the Quiet Zone Risk Index through the use of ASMs and/or SSMs. Follow the procedure provided in Step 6—New Quiet Zones Public Authority Designation—until the Quiet Zone Risk Index has been reduced to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns. A public authority may elect to upgrade an existing warning device as part of its Pre-Rule Quiet Zone plan. When upgrading a warning device, the accident prediction value for that crossing must be re-calculated for the new warning device. Determine the new risk index for the upgraded crossing by using the new accident prediction value in the severity risk index formula. (Remember that FRA's web-based quiet zone risk calculator will be able to do the actual computations.) This new risk index is then used to compute the new Quiet Zone Risk Index. Effectiveness rates for ASMs should be provided as follows:

a. Modified SSMs—Estimates of effectiveness for modified SSMs may be based upon adjustments from the benchmark levels provided in appendix A or from actual field data derived from the crossing sites. The application must provide an estimated effectiveness rate and the rationale for the estimate.

b. Non-engineering ASMs—Effectiveness rates are to be calculated in accordance with the provisions of appendix B, section II B.

c. Engineering ASMs—Effectiveness rates are to be calculated in accordance with the provisions of appendix B, section III B.

7. Once it has been determined through analysis that the Quiet Zone Risk Index will be reduced to a level equal to, or less than, either the Nationwide Significant Risk Threshold or the Risk Index with Horns, the public authority may make application to FRA for a quiet zone under §222.39(b). FRA will review the application to determine the appropriateness of the proposed effectiveness rates, and whether or not the proposed application demonstrates that the quiet zone meets the requirements of the rule. When submitting the application to FRA for approval, it should be remembered that the application must contain the following (§222.39(b)(1)):

a. Sufficient detail concerning the present safety measures at all crossings within the proposed quiet zone to enable the Associate Administrator to evaluate their effectiveness. This includes current and accurate crossing Inventory forms for each public, private and pedestrian grade crossing.

b. Detailed information on the safety improvements, including upgraded warning devices that are proposed to be implemented at public, private, and pedestrian grade crossings within the proposed quiet zone.

c. Membership and recommendations of the diagnostic team (if any) that reviewed the proposed quiet zone.

d. Statement of efforts taken to address comments submitted by affected railroads, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety, including a list of any objections raised by the railroads or State agencies.

e. A commitment to implement the proposed safety measures.

f. Demonstrate through data and analysis that the proposed measures will reduce the

Quiet Zone Risk Index to a level at, or below, either the Nationwide Significant Risk Threshold or the Risk Index with Horns.

g. A copy of the application must be provided to all railroads operating over the public highway-rail grade crossings within the quiet zone; the highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone; the landowner having control over any private crossings within the quiet zone; the State agency responsible for highway and road safety; the State agency responsible for grade crossing safety; and the Associate Administrator. (§222.39(b)(3))

8. Upon receiving written approval from FRA of the quiet zone application, the public authority may then provide the Notice of Quiet Zone Establishment and implement the quiet zone. If the quiet zone is established by reducing the Quiet Zone Risk Index to a level equal to, or less than, the Nationwide Significant Risk Threshold, FRA will annually recalculate the Nationwide Significant Risk Threshold and the Quiet Zone Risk. If the Quiet Zone Risk Index for the quiet zone is above the Nationwide Significant Risk Threshold, FRA will notify the public authority so that appropriate measures can be taken (See §222.51(b)).

NOTE: The provisions stated above for crossing closures, grade separations, wayside horns, pre-existing SSMs and pre-existing modified SSMs apply for Public Authority Application to FRA as well.

SECTION IV—REQUIRED NOTIFICATIONS

A. Introduction

The public authority is responsible for providing notification to parties that will be affected by the quiet zone. There are several different types of notifications and a public authority may have to make more than one notification during the entire process of complying with the regulation. The notification process is to ensure that interested parties are made aware in a timely manner of the establishment or continuation of quiet zones. It will also provide an opportunity for State agencies and affected railroads to provide input to the public authority during the development of quiet zones. Specific information is to be provided so that the crossings in the quiet zone can be identified. Providing the appropriate notification is important because once the rule becomes effective, railroads will be obligated to sound train horns when approaching all public crossings unless notified in accordance with the rule that a New Quiet Zone has been established or that a Pre-Rule or Intermediate Quiet Zone is being continued.

B. Notice of Intent—§222.43(b)

The purpose of the Notice of Intent is to provide notice to the railroads and State agencies that the public authority is planning on creating a New Quiet Zone or implementing new SSMs or ASMs within a Pre-Rule Quiet Zone. The Notice of Intent provides an opportunity for the railroad and the State agencies to give input to the public authority during the quiet zone development process. The State agencies and railroads will be given sixty days to provide information and comments to the public agency.

The Notice of Intent must be provided under the following circumstances:

1. A New Quiet Zone or New Partial Quiet Zone is under consideration.

2. An Intermediate Quiet Zone or Intermediate Partial Quiet Zone that will be converted into a New Quiet Zone or New Partial Quiet Zone. Please note that Notice of Intent must be mailed by April 3, 2006, in order prevent the resumption of locomotive horn sounding on June 24, 2006.

3. The implementation of SSMs or ASMs within a Pre-Rule Quiet Zone or Pre-Rule Partial Quiet Zone is under consideration. Please note that Notice of Intent must be mailed by February 24, 2008, in order to continue existing restrictions on locomotive horn sounding beyond June 24, 2008 without interruption. Each public authority that is creating a New Quiet Zone must provide written notice, by certified mail, return receipt requested, to the following:

1. All railroads operating within the proposed quiet zone

2. State agency responsible for highway and road safety

3. State agency responsible for grade crossing safety

The Notice of Intent must contain the following information:

1. A list of each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossings within the proposed quiet zone. The crossings are to be identified by both the U.S. DOT Crossing Inventory Number and the street or highway name.

2. A statement of the time period within which the restrictions would be in effect on the routine sounding of train horns (*i.e.*, 24 hours or from 10 p.m. to 7 a.m.).

3. A brief explanation of the public authority's tentative plans for implementing improvements within the proposed quiet zone.

4. The name and title of the person who will act as the point of contact during the quiet zone development process and how that person can be contacted.

5. A list of the names and addresses of each party that will receive a copy of the Notice of Intent.

The parties that receive the Notice of Intent will be able to submit information or comments to the public authority for 60 days. The public authority will not be able to establish the quiet zone during the 60 day comment period unless each railroad and State agency that receives the Notice of Intent provides either written comments to the public authority or a written statement waiving its right to provide comments on the Notice of Intent. The public authority must provide an affirmation in the Notice of Quiet Zone Establishment that each of the required parties was provided the Notice of Intent and the date it was mailed. If the quiet zone is being established within 60 days of the mailing of the Notice of Intent, the public authority also must affirm each of the parties have provided written comments or waived its right to provide comments on the Notice of Intent.

C. Notice of Quiet Zone Continuation—§ 222.43(c)

The purpose of the Notice of Quiet Zone Continuation is to provide a means for the public authority to formally advise affected parties that an existing quiet zone is being continued after the effective date of the rule. All Pre-Rule, Pre-Rule Partial, Intermediate and Intermediate Partial Quiet Zones must provide this Notice of Quiet Zone Continuation no later than June 3, 2005 to ensure that train horns are not sounded at public crossings when the rule becomes effective on June 24, 2005. This will enable railroads to properly comply with the requirements of the Final Rule.

Each public authority that is continuing an existing Pre-Rule, Pre-Rule Partial, Intermediate and Intermediate Partial Quiet Zone must provide written notice, by certified mail, return receipt requested, to the following:

1. All railroads operating over the public highway-rail grade crossings within the quiet zone;
2. The highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone;
3. The landowner having control over any private crossings within the quiet zone;
4. The State agency responsible for highway and road safety;
5. The State agency responsible for grade crossing safety; and
6. The Associate Administrator.

The Notice of Quiet Zone Continuation must contain the following information:

1. A list of each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone, identified by both U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name.
2. A specific reference to the regulatory provision that provides the basis for quiet zone continuation, citing as appropriate, § 222.41 or 222.42.
3. A statement of the time period within which restrictions on the routine sounding of the locomotive horn will be imposed (i.e., 24 hours or nighttime hours only.)
4. An accurate and complete Grade Crossing Inventory Form for each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone that reflects conditions currently existing at the crossing.
5. The name and title of the person responsible for monitoring compliance with the requirements of this part and the manner in which that person can be contacted.
6. A list of the names and addresses of each party that will receive the Notice of Quiet Zone Continuation.
7. A statement signed by the chief executive officer of each public authority participating in the continuation of the quiet zone, in which the chief executive officer certifies that the information submitted by the public authority is accurate and complete to the best of his/her knowledge and belief.

Public authorities should remember that this notice is required to ensure that train horns will remain silent. Even if a public authority has not been able to determine whether its Pre-Rule or Pre-Rule Partial Quiet Zone qualifies for automatic approval under the rule, it should issue a Notice of Quiet Zone Continuation to keep the train horns silent after the effective date of the rule.

E. Notice of Quiet Zone Establishment—§ 222.43(d)

The purpose of the Notice of Quiet Zone Establishment is to provide a means for the public authority to formally advise affected parties that a quiet zone is being established. Notice of Quiet Zone Establishment must be provided under the following circumstances:

1. A New Quiet Zone or New Partial Quiet Zone is being created.
2. A Pre-Rule Quiet Zone or a Pre-Rule Partial Quiet Zone that qualifies for automatic approval under the rule is being established.
3. An Intermediate Quiet Zone or Intermediate Partial Quiet Zone that is creating a New Quiet Zone under the rule. Please note that Notice of Quiet Zone Establishment must be provided by June 3, 2006, in order to prevent the resumption of locomotive horn sounding on June 24, 2006.
4. A Pre-Rule Quiet Zone or a Pre-Rule Partial Quiet Zone that was not established by automatic approval and has since implemented improvements to establish a quiet zone in accordance to the rule.

Each public authority that is establishing a quiet zone under the above circumstances must provide written notice, by certified mail, return receipt requested, to the following:

1. All railroads operating over the public highway-rail grade crossings within the quiet zone;

2. The highway or traffic control or law enforcement authority having jurisdiction over vehicular traffic at grade crossings within the quiet zone;

3. The landowner having control over any private crossings within the quiet zone;

4. The State agency responsible for highway and road safety;

5. The State agency responsible for grade crossing safety; and

6. The Associate Administrator.

The Notice of Quiet Establishment must contain the following information:

1. A list of each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone, identified by both U.S. DOT National Highway-Rail Grade Crossing Inventory Number and street or highway name.

2. A specific reference to the regulatory provision that provides the basis for quiet zone establishment, citing as appropriate, §222.39(a)(1), 222.39(a)(2)(i), 222.39(a)(2)(ii), 222.39(a)(3), 222.39(b), 222.41(a)(1)(i), 222.41(a)(1)(ii), 222.41(a)(1)(iii), 222.41(a)(1)(iv), 222.41(b)(1)(i), 222.41(b)(1)(ii), 222.41(b)(1)(iii), or 222.41(b)(1)(iv).

(a) If the Notice of Quiet Establishment contains a specific reference to §222.39(a)(2)(i), 222.39(a)(2)(ii), 222.39(a)(3), 222.41(a)(1)(ii), 222.41(a)(1)(iii), 222.41(a)(1)(iv), 222.41(b)(1)(ii), 222.41(b)(1)(iii), or 222.41(b)(1)(iv), it shall include a copy of the FRA web page that contains the quiet zone data upon which the public authority is relying.

(b) If the Notice of Quiet Establishment contains a specific reference to §222.39(b), it shall include a copy of FRA's notification of approval.

3. If a diagnostic team review was required under §222.25 (private crossings) or §222.27 (pedestrian crossings), the Notice of Quiet Establishment shall include a statement affirming that the State agency responsible for grade crossing safety and all affected railroads were provided an opportunity to participate in the diagnostic team review. The Notice of Quiet Establishment shall also include a list of recommendations made by the diagnostic team.

4. A statement of the time period within which restrictions on the routine sounding of the locomotive horn will be imposed (i.e., 24 hours or from 10 p.m. until 7 a.m.)

5. An accurate and complete Grade Crossing Inventory Form for each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone that reflects the conditions existing at the crossing before any new SSMs or ASMs were implemented.

6. An accurate, complete and current Grade Crossing Inventory Form for each public highway-rail grade crossing, private highway-rail grade crossing, and pedestrian crossing within the quiet zone that reflects SSMs and ASMs in place upon establishment of the quiet zone. SSMs and ASMs that cannot be fully described on the Inventory Form shall be separately described.

7. If the public authority was required to provide a Notice of Intent:

(a) The Notice of Quiet Zone Establishment shall contain a statement affirming that the Notice of Intent was provided in accordance with the rule. This statement shall also state the date on which the Notice of Intent was mailed.

(b) If the Notice of Quiet Zone Establishment will be mailed less than 60 days after the date on which the Notice of Intent was mailed, the Notice of Quiet Zone Establishment shall also contain a written statement affirming that comments and/or written waiver statements have been received from each railroad operating over public grade crossings within the proposed quiet zone, the State agency responsible for grade crossing safety, and the State agency responsible for highway and road safety.

8. The name and title of the person responsible for monitoring compliance with the requirements of this part and the manner in which that person can be contacted.

9. A list of the names and addresses of each party that is receiving a copy of the Notice of Quiet Establishment.

10. A statement signed by the chief executive officer of each public authority participating in the establishment of the quiet zone, in which the chief executive officer shall certify that the information submitted by the public authority is accurate and complete to the best of his/her knowledge and belief.

SECTION V—EXAMPLES OF QUIET ZONE IMPLEMENTATIONS

Example 1—New Quiet Zone

(a) A public authority wishes to create a New Quiet Zone over four public crossings. All of the crossings are equipped with flashing lights and gates, and the length of the quiet zone is 0.75 mile. There are no private crossings within the proposed zone.

(b) The tables that follow show the street name in the first column, and the existing risk index for each crossing with the horn sounding (''Crossing Risk Index w/ Horns'') in the second. The third column, ''Crossing Risk Index w/o Horns'', is the risk index for each crossing after it has been inflated by 66.8% to account for the lack of train horns.

The fourth column, ''SSM Eff'', is the effectiveness of the SSM at the crossing. A zero indicates that no SSM has been applied. The last column, ''Crossing Risk Index w/o Horns Plus SSM'', is the inflated risk index for the crossing after being reduced by the implementation of the SSM. At the bottom of the table are two values. The first is the Risk Index with Horns (''RIWH'') which represents the average initial amount of risk in the proposed quiet zone with the train horn sounding. The second is the Quiet Zone Risk Index (''QZRI''), which is the average risk in the proposed quiet zone taking into consideration the increased risk caused by the lack of train horns and the reductions in risk attributable to the installation of SSMs. For this example it is assumed that the Nationwide Significant Risk Threshold is 17,030. In order for the proposed quiet zone to qualify under the rule, the Quiet Zone Risk Index must be reduced to a level at, or below, the Nationwide Significant Risk Threshold (17,030) or the Risk Index with Horns.

(c) Table 2 shows the existing conditions in the proposed quiet zone. SSMs have not yet been installed. The Risk Index with Horns for the proposed quiet zone is 11,250. The Quiet Zone Risk Index without any SSMs is 18,765.

TABLE 2

Street	Crossing risk index w/horns	Crossing risk index w/o horns	SSM EFF	Crossing risk index w/o horns plus SSM
A	12000	20016	0	20016
B	10000	16680	0	16680
C	8000	13344	0	13344
D	15000	25020	0	25020
	RIWH			QZRI
	11250			18765

(d) The public authority decides to install traffic channelization devices at D Street. Reducing the risk at the crossing that has the highest severity risk index will provide the greatest reduction in risk. The effectiveness of traffic channelization devices is 0.75. Table 3 shows the changes in the proposed quiet zone corridor that would occur when traffic channelization devices are installed at D Street. The Quiet Zone Risk Index has been reduced to 14,073.75. This reduction in risk would qualify the quiet zone as the risk has been reduced lower than the Nationwide Significant Risk Threshold which is 17,030.

TABLE 3

Street	Crossing risk index w/horns	Crossing risk index w/o horns	SSM EFF	Crossing risk index w/o horns plus SSM
A	12000	20016	0	20016
B	10000	16680	0	16680
C	8000	13344	0	13344
D	15000	25020	0.75	6255
	RIWH			QZRI
	11250			14073.75

(e) The public authority realizes that reducing the Quiet Zone Risk Index to a level below the Nationwide Significant Risk Threshold will result in an annual re-calculation of the Quiet Zone Risk Index and comparison to the Nationwide Significant Risk Threshold. As the Quiet Zone Risk Index is close to the Nationwide Significant Risk Threshold (14,074 to 17,030), there is a reasonable chance that the Quiet Zone Risk Index may some day exceed the Nationwide Significant Risk Threshold. This would result in the quiet zone no longer being qualified and additional steps would have to be taken to keep the quiet zone. Therefore, the public authority decides to reduce the risk further by the use of traffic channelization devices at A Street. Table 4 shows the results of this change. The Quiet Zone Risk Index is now 10,320.75 which is less than the Risk Index with Horns of 11,250. The quiet zone now qualifies by fully compensating for the loss of train horns and will not have to undergo annual reviews of the Quiet Zone Risk Index.

TABLE 4

Street	Crossing risk index w/horns	Crossing risk index w/o horns	SSM EFF	Crossing risk index w/o horns plus SSM
A	12000	20016	0.75	5004
B	10000	16680	0	16680
C	8000	13344	0	13344
D	15000	25020	0.75	6255
	RIWH	.....	.....	QZRI
	11250	.....	.....	10320.75

Example 2—Pre-Rule Quiet Zone

(a) A public authority wishes to qualify a Pre-Rule Quiet Zone which did not meet the requirements for Automatic Approval because the Quiet Zone Risk Index is greater than twice the Nationwide Significant Risk Threshold. There are four public crossings in the Pre-Rule Quiet Zone. Three of the crossings are equipped with flashing lights and gates, and the fourth (Z Street) is passively signed with a STOP sign. The length of the quiet zone is 0.6 mile, and there are no private crossings within the proposed zone.

(b) The tables that follow are very similar to the tables in Example 1. The street name is shown in the first column, and the existing risk index for each crossing (''Crossing Risk Index w/o Horns'') in the second. This is a change from the first example because the risk is calculated without train horns sounding because of the existing ban on whistles. The third column, ''Crossing Risk Index w/ Horns'', is the risk index for each crossing after it has been adjusted to reflect what the risk would have been had train horns been sounding. This is mathematically done by dividing the existing risk index for the three gated crossing by 1.668. The risk at the passive crossing at Z Street is divided by 1.749. (See the above discussion in ''Pre-Rule Quiet Zones—Establishment Overview'' for more information.) The fourth column, ''SSM Eff'', is the effectiveness of the SSM at the crossing. A zero indicates that no SSM has been applied. The last column, ''Crossing Risk Index w/o Horns Plus SSM'', is the risk index without horns for the crossing after being reduced for the implementation of the SSM. At the bottom of the table are two values. The first is the Risk Index with Horns (RIWH), which represents the average initial amount of risk in the proposed quiet zone with the train horn sounding. The second is the Quiet Zone Risk Index (''QZRI''), which is the average risk in the proposed quiet zone taking into consideration the increased risk caused by the lack of train horns and reductions in risk attributable to the installation of SSMs. Once again it is assumed that the Nationwide Significant Risk Threshold is 17,030. The Quiet Zone Risk Index must be reduced to either the Nationwide Significant Risk Threshold (17,030) or to the Risk Index with Horns in order to qualify under the rule.

(c) Table 5 shows the existing conditions in the proposed quiet zone. SSMs have not yet been installed. The Risk Index with Horns for the proposed quiet zone is 18,705.83. The Quiet Zone Risk Index without any SSMs is 31,375. Since the Nationwide Significant Risk Threshold is less than the calculated Risk Index with Horns, the public authority's goal will be to reduce the risk to at least value of the Risk Index with Horns. This will qualify the Pre-Rule Quiet Zone under the rule.

TABLE 5

Street	Crossing risk index w/o horns	Crossing risk index w/ horns	SSM EFF	Crossing risk index w/o horns plus SSM
W	35,000	20,983.21	0	35,000
X	42,000	25,179.86	0	42,000
Y	33,500	20,083.93	0	33,500
Z	15,000	8,576.33	0	15,000
	RIWH	.....	.....	QZRI
	18,705.83	.....	.....	31,375

(d) The Z Street crossing is scheduled to have flashing lights and gates installed as part of the state's highway-rail grade crossing safety improvement plan (Section 130). While this upgrade is not directly a part of the plan to authorize a quiet zone, the public authority may take credit for the risk reduction achieved by the improvement from a

passive STOP sign crossing to a crossing equipped with flashing lights and gates. Unlike New Quiet Zones, upgrades to warning devices in Pre-Rule Quiet Zones do contribute to the risk reduction necessary to qualify under the rule. Table 6 shows the quiet zone corridor after including the warning device upgrade at Z Street. The Quiet Zone Risk Index has been reduced to 29,500.

TABLE 6

Street	Crossing risk index w/o horns	Crossing risk index w/ horns	SSM EFF	Crossing risk index w/o horns plus SSM
W	35,000	20,983.21	0	35,000
X	42,000	25,179.86	0	42,000
Y	33,500	20,083.93	0	33,500
Z	7,500	8,576.33	0	7,500
	RIWH	.....	.....	QZRI
	18,705.83	.....	.....	29,500

(e) The public authority elects to install four-quadrant gates without vehicle presence detection at X Street. As shown in Table 7, this reduces the Quiet Zone Risk Index to 20,890. This risk reduction is not sufficient to quality as quiet zone under the rule.

TABLE 7

Street	Crossing risk index w/o horns	Crossing risk index w/ horns	SSM EFF	Crossing risk index w/o horns plus SSM
W	35,000	20,983.21	0	35,000
X	42,000	25,179.86	0.82	7,560
Y	33,500	20,083.93	0	33,500
Z	7,500	8,576.33	0	7,500
	RIWH	.....	.....	QZRI
	18,705.83	.....	.....	20,890

(f) The public authority next decides to use traffic channelization devices at W Street. Table 8 shows that the Quiet Zone Risk Index is now reduced to 14,327.5. This risk reduction fully compensates for the loss of the train horn as it is less than the Risk Index with Horns. The quiet zone is qualified under the rule.

TABLE 8

Street	Crossing risk index w/o horns	Crossing risk index w/ horns	SSM EFF	Crossing risk index w/o horns plus SSM
W	35000	20983.21	0.75	8750
X	42000	25179.86	0.82	7560
Y	33500	20083.93	0	33500
Z	7500	8576.33	0	7500
	RIWH	.....	.....	QZRI
	18705.83	.....	.....	14327.5

APPENDIX D TO PART 222—DETERMINING RISK LEVELS

INTRODUCTION

The Nationwide Significant Risk Threshold, the Crossing Corridor Risk Index, and the Quiet Zone Risk Index are all measures of collision risk at public highway-rail grade crossings that are weighted by the severity of the associated casualties. Each crossing can be assigned a risk index.

(a) The *Nationwide Significant Risk Threshold* represents the average severity weighted collision risk for all public highway-rail grade crossings equipped with lights and gates nationwide where train horns are routinely sounded. FRA developed this index to serve as a threshold of permissible risk for quiet zones established under this rule.

(b) The *Crossing Corridor Risk Index* represents the average severity weighted collision risk for all public highway-rail grade crossings along a defined rail corridor.

(c) The *Quiet Zone Risk Index* represents the average severity weighted collision risk for all public highway-rail grade crossings that are part of a quiet zone.

THE PREDICTION FORMULAS

(a) The Prediction Formulas were developed by DOT as a guide for allocating scarce traffic safety budgets at the State level. They allow users to rank candidate crossings for safety improvements by collision probability. There are three formulas, one for each warning device category:

1. automatic gates with flashing lights;
2. flashing lights with no gates; and
3. passive warning devices.

(b) The prediction formulas can be used to derive the following for each crossing:

1. the predicted collisions (PC)
2. the probability of a fatal collision given that a collision occurs (P(FC|C))
3. the probability of a casualty collision given that a collision occurs (P(CC|C))

(c) The following factors are the determinants of the number of predicted collisions per year:

1. average annual daily traffic
2. total number of trains per day
3. number of highway lanes
4. number of main tracks
5. maximum timetable train speed
6. whether the highway is paved or not
7. number of through trains per day during daylight hours

(d) The resulting basic prediction is improved in two ways. It is enriched by the particular crossing's collision history for the previous five years and it is calibrated by resetting normalizing constants. The normalizing constants are reset so that the sum of the predicted accidents in each warning device group (passive, flashing lights, gates) for the top twenty percent most hazardous crossings exactly equals the number of accidents which occurred in a recent period for the top twenty percent of that group. This adjustment factor allows the formulas to stay current with collision trends. The calibration also corrects for errors such as data entry errors. The final output is the predicted number of collisions (PC).

(e) The severity formulas answer the question, ''What is the chance that a fatality (or casualty) will happen, given that a collision has occurred?'' The fatality formula calculates the probability of a fatal collision given that a collision occurs (*i.e.*, the probability of a collision in which a fatality occurs) P(FC|C). Similarly, the casualty formula calculates the probability of a casualty collision given that a collision occurs P(CC|C). As casualties consist of both fatalities and injuries, the probability of a non-fatal injury collision is found by subtracting the probability of a fatal collision from the probability of a casualty collision. To convert the probability of a fatal or casualty collision to the number of expected fatal or casualty collisions, that probability is multiplied by the number of predicted collisions (PC).

(f) For the prediction and severity index formulas, please see the following DOT publications: *Summary of the DOT Rail-Highway Crossings Resource Allocation Procedure—Revised*, June 1987, and the *Rail-Highway Crossing Resource Allocation Procedure: User's Guide, Third Edition*, August 1987. Both documents are in the docket for this rulemaking and also available through the National Technical Information Service located in Springfield, Virginia 22161.

RISK INDEX

(a) The risk index is basically the predicted cost to society of the casualties that are expected to result from the predicted collisions at a crossing. It incorporates three outputs of the DOT prediction formulas. The two components of a risk index are:

1. Predicted Cost of Fatalities = PC × P(FC|C) × (Average Number of Fatalities Observed In Fatal Collisions) × $3 million
2. Predicted Cost of Injuries = PC × (P(CC|C)—P(FC|C)) × (Average Number of Injuries in Collisions Involving Injuries) × $1,167,000

PC, P(CC|C), and P(FC|C) are direct outputs of the DOT prediction formulas.

(b) The average number of fatalities observed in fatal collisions and the average number of injuries in collisions involving injuries were calculated by FRA as follows.

(c) The highway-rail incident files from 1999 through 2003 were matched against a data file containing the list of whistle ban crossings in existence from January 1, 1999 through December 31, 2003 to identify two types of collisions involving trains and motor vehicles: (1) Those that occurred at crossings where a whistle ban was in place during the period, and (2) those that occurred at crossings equipped with automatic gates where a whistle ban was not in place. Certain records were excluded. These were incidents where the driver was not in the motor vehicle, or the motor vehicle struck the train beyond the 4th locomotive or rail car that entered the crossing. FRA believes that sounding the train horn would not be very effective at preventing such incidents.[2]

[2]The data used to make these exclusions is contained in blocks 18—Position of Car Unit in Train; 19—Circumstance: Rail Equipment Struck/Struck By Highway User; 28—Number of Locomotive Units; and 29—Number of Cars of the current FRA Form 6180–57 Highway-

(d) Collisions in the group containing the gated crossings nationwide where horns are routinely sounded were then identified as either fatal, injury only, or no casualty. Collisions were identified as fatal if one or more deaths occurred, regardless of whether or not injuries were also sustained. Collisions were identified as injury only when injuries, but no fatalities, resulted.

(e) The collisions (incidents) selected were summarized by year from 1999 through 2003. The total number of collisions for the period was 2,161. The fatality rate for each year was calculated by dividing the number of fatalities (''Deaths'') by the number of fatal incidents (''Number''). The injury rates were calculated by dividing the number of injuries in injury only incidents (''Injured'') by the number of injury only incidents (''Number''). There were 274 fatal incidents resulting in 324 fatalities and yielding a fatality rate 1.1825 for the period. There were 551 injury-only incidents resulting in 733 injuries and yielding an injury rate 1.3303 for the period.

(f) Per guidance from DOT, $3 million is the value placed on preventing a fatality. The Abbreviated Injury Scale (AIS) developed by the Association for the Advancement of Automotive Medicine categorizes injuries into six levels of severity. Each AIS level is assigned a value of injury avoidance as a fraction of the value of avoiding a fatality . FRA rates collisions that occur at train speeds in excess of 25 mph as an AIS level 5 ($2,287,500) and injuries that result from collisions involving trains traveling under 25 mph as an AIS level 2 ($46,500). About half of grade crossing collisions occur at speeds greater than 25 mph. Therefore, FRA estimates that the value of preventing the average injury resulting from a grade crossing collision is $1,167,000 (the average of an AIS–5 injury and an AIS–2 injury).

(g) Notice that the quantity [PC*P(FC|C)] represents the expected number of fatal collisions. Similarly, {PC*[P(CC|C)–P(FC|C)]} represents the expected number of injury collisions. These are then multiplied by their respective average number of fatalities and injuries (from the table above) to develop the number of expected casualties. The final parts of the expressions attach the dollar values for these casualties.

(h) The Risk Index for a Crossing is the integer sum of the Predicted Cost of Fatalities and the Predicted Cost of Injuries.

NATIONWIDE SIGNIFICANT RISK THRESHOLD

The Nationwide Significant Risk Threshold is simply an average of the risk indexes for all of the gated crossings nationwide where train horns are routinely sounded. FRA identified 35,803 gated non-whistle ban crossings for input to the Nationwide Significant Risk Threshold.

The Nationwide Significant Risk Threshold rounds to 17,030. This value is recalculated annually.

CROSSING CORRIDOR RISK INDEX

The Crossing Corridor Risk Index is the average of the risk indexes of all the crossings in a defined rail corridor. Communities seeking to establish ''Quiet Zones'' should initially calculate this average for potential corridors.

QUIET ZONE RISK INDEX

The Quiet Zone Risk Index is the average of the risk indexes of all the public crossings in a Quiet Zone. It takes into consideration the absence of the horn sound and any safety measures that may have been installed.

EFFECTIVE DATE NOTE: At 72 FR 44792, Aug. 9, 2007, appendix D was amended by revising paragraphs (b) through (e) in the section titled ''RISK INDEX,'' the section titled, ''Nationwide Significant Risk Threshold,'' and the section titled, ''Crossing Corridor Risk Index'', effective Oct. 9, 2007. For the convenience of the user, the revised text is set forth as follows:

APPENDIX D TO PART 222—DETERMINING RISK LEVELS

* * * * *

Risk Index

* * * * *

(b) The average number of fatalities observed in fatal collisions and the average number of injuries in collisions involving injuries are calculated by FRA as described in paragraphs (c) through (e).

(c) FRA will match the highway-rail incident files for the past five years against a data file containing the list of grade crossings where the train horn was not routinely sounded over that five-year period to identify two types of collisions involving trains and motor vehicles: (1) Those that occurred at crossings where the train horn was not routinely sounded during the period, and (2) those that occurred at crossings equipped with automatic gates where the train horn was routinely sounded. Certain records will be excluded, including records pertaining to incidents where the driver was not in the motor vehicle or where the motor vehicle struck the train beyond the fourth locomotive or rail car that entered the crossing. FRA believes that sounding the train horn

Rail Grade Crossing Accident/Incident Report.

would not be very effective at preventing such incidents.[1]

(d) Collisions in the group containing the gated crossings nationwide where horns were routinely sounded will then be identified as fatal, injury only or no casualty. Collisions will be identified as fatal if one or more deaths occurred, regardless of whether injuries were also sustained. Collisions will be identified as injury only when injuries, but no fatalities, resulted.

(e) The collisions (incidents) will be summarized by year for the five-year period preceding the year in which the risk index is being updated. The fatality rate for each year will be calculated by dividing the number of fatalities by the number of fatal incidents. The injury rate will be calculated by dividing the number of injuries in injury only incidents by the number of injury only incidents. FRA will publish updated fatality and injury rates on an annual basis in the FEDERAL REGISTER.

* * * * *

Nationwide Significant Risk Threshold

The Nationwide Significant Risk Threshold is simply an average of the risk indexes for all of the gated public crossings nationwide where train horns are routinely sounded. This value will be recalculated annually and published in a notice in the FEDERAL REGISTER. For the most recent value of the Nationwide Significant Risk Threshold, please visit FRA's public Web site at *http://www.fra.dot.gov*.

Crossing Corridor Risk Index

The Crossing Corridor Risk Index is the average of the risk indexes of all the public crossings in a defined rail corridor.

APPENDIX E TO PART 222—REQUIREMENTS FOR WAYSIDE HORNS

This appendix sets forth the following minimum requirements for wayside horn use at highway-rail grade crossings:

1. Highway-rail crossing must be equipped with constant warning time device, if reasonably practical, and power-out indicator;

2. Horn system must be equipped with an indicator or other system to notify the locomotive engineer as to whether the wayside horn is operating as intended in sufficient time to enable the locomotive engineer to sound the locomotive horn for at least 15 seconds prior to arrival at the crossing in the event the wayside horn is not operating as intended;

3. The railroad must adopt an operating rule, bulletin or special instruction requiring that the train horn be sounded if the wayside horn indicator is not visible approaching the crossing or if the wayside horn indicator, or an equivalent system, indicates that the system is not operating as intended;

4. Horn system must provide a minimum sound level of 92 dB(A) and a maximum of 110 dB(A) when measured 100 feet from the centerline of the nearest track;

5. Horn system must sound at a minimum of 15 seconds prior to the train's arrival at the crossing and while the lead locomotive is traveling across the crossing. It is permissible for the horn system to begin to sound simultaneously with activation of the flashing lights or descent of the crossing arm; arm

6. Horn shall be directed toward approaching traffic.

APPENDIX F TO PART 222—DIAGNOSTIC TEAM CONSIDERATIONS

For purposes of this part, a diagnostic team is a group of knowledgeable representatives of parties of interest in a highway-rail grade crossing, organized by the public authority responsible for that crossing who, using crossing safety management principles, evaluate conditions at a grade crossing to make determinations or recommendations for the public authority concerning the safety needs at that crossing. Crossings proposed for inclusion in a quiet zone should be reviewed in the field by a diagnostic team composed of railroad personnel, public safety or law enforcement, engineering personnel from the State agency responsible for grade crossing safety, and other concerned parties.

This diagnostic team, using crossing safety management principles, should evaluate conditions at a grade crossing to make determinations and recommendations concerning safety needs at that crossing. The diagnostic team can evaluate a crossing from many perspectives and can make recommendations as to what safety measures authorized by this part might be utilized to compensate for the silencing of the train horns within the proposed quiet zone.

ALL CROSSINGS WITHIN A PROPOSED QUIET ZONE

The diagnostic team should obtain and review the following information about each crossing within the proposed quiet zone:

1. Current highway traffic volumes and percent of trucks;

2. Posted speed limits on all highway approaches;

[1] The data used to make these exclusions is contained in blocks 18—Position of Car Unit in Train; 19—Circumstance: Rail Equipment Struck/Struck by Highway User; 28—Number of Locomotive Units; and 29—Number of Cars on the current FRA Form 6180–57 Highway-Rail Grade Crossing Accident/Incident Report.

3. Maximum allowable train speeds, both passenger and freight;
4. Accident history for each crossing under consideration;
5. School bus or transit bus use at the crossing; and
6. Presence of U.S. DOT grade crossing inventory numbers clearly posted at each of the crossings in question.

The diagnostic team should obtain all inventory information for each crossing and should check, while in the field, to see that inventory information is up-to-date and accurate. Outdated inventory information should be updated as part of the quiet zone development process.

When in the field, the diagnostic team should take note of the physical characteristics of each crossing, including the following items:

1. Can any of the crossings within the proposed quiet zone be closed or consolidated with another adjacent crossing? Crossing elimination should always be the preferred alternative and it should be explored for crossings within the proposed quiet zone.
2. What is the number of lanes on each highway approach? Note the pavement condition on each approach, as well as the condition of the crossing itself.
3. Is the grade crossing surface smooth, well graded and free draining?
4. Does the alignment of the railroad tracks at the crossing create any problems for road users on the crossing? Are the tracks in superelevation (are they banked on a curve?) and does this create a conflict with the vertical alignment of the crossing roadway?
5. Note the distance to the nearest intersection or traffic signal on each approach (if within 500 feet or so of the crossing or if the signal or intersection is determined to have a potential impact on highway traffic at the crossing because of queuing or other special problems).
6. If a roadway that runs parallel to the railroad tracks is within 100 feet of the railroad tracks when it crosses an intersecting road that also crosses the tracks, the appropriate advance warning signs should be posted as shown in the MUTCD.
7. Is the posted highway speed (on each approach to the crossing) appropriate for the alignment of the roadway and the configuration of the crossing?
8. Does the vertical alignment of the crossing create the potential for a ''hump crossing'' where long, low-clearance vehicles might get stuck on the crossing?
9. What are the grade crossing warning devices in place at each crossing? Flashing lights and gates are required for each public crossing in a New Quiet Zone. Are all required warning devices, signals, pavement markings and advance signing in place, visible and in good condition for both day and night time visibility?
10. What kind of train detection is in place at each crossing? Are these systems old or outmoded; are they in need of replacement, upgrading, or refurbishment?
11. Are there sidings or other tracks adjacent to the crossing that are often used to store railroad cars, locomotives, or other equipment that could obscure the vision of road users as they approach the crossings in the quiet zone? Clear visibility may help to reduce automatic warning device violations.
12. Are motorists currently violating the warning devices at any of the crossings at an excessive rate?
13. Do collision statistics for the corridor indicate any potential problems at any of the crossings?
14. If school buses or transit buses use crossings within the proposed quiet zone corridor, can they be rerouted to use a single crossing within or outside of the quiet zone?

Private Crossings Within a Proposed Quiet Zone

In addition to the items discussed above, a diagnostic team should note the following issues when examining any private crossings within a proposed quiet zone:

1. How often is the private crossing used?
2. What kind of signing or pavement markings are in place at the private crossing?
3. What types of vehicles use the private crossing?
   School buses
   Large trucks
   Hazmat carriers
   Farm equipment
4. What is the volume, speed and type of train traffic over the crossing?
5. Do passenger trains use the crossing?
6. Do approaching trains sound the horn at the private crossing?
   State or local law requires it?
   Railroad safety rule requires it?
7. Are there any nearby crossings where train horns sound that might also provide some warning if train horns were not sounded at the private crossing?
8. What are the approach (corner) sight distances?
9. What is the clearing sight distance for all approaches?
10. What are the private roadway approach grades?
11. What are the private roadway pavement surfaces?

Pedestrian Crossings Within a Proposed Quiet Zone

In addition to the items discussed in the section titled, ''All crossings within a proposed quiet zone'', a diagnostic team should note the following issues when examining any pedestrian crossings within a proposed quiet zone:

1. How often is the pedestrian crossing used?
2. What kind of signing or pavement markings are in place at the pedestrian crossing?
3. What is the volume, speed, and type of train traffic over the crossing?
4. Do approaching trains sound the horn at the pedestrian crossing?
State or local law requires it?
Railroad safety rule requires it?
5. Are there any crossings where train horns sound that might also provide some warning if train horns were not sounded at the pedestrian crossing?
6. What are the approach sight distances?
7. What is the clearing sight distance for all approaches?

APPENDIX G TO PART 222—SCHEDULE OF CIVIL PENALTIES[1]

Section	Violation	Willful violation
Subpart B—Use of Locomotive Horns		
§222.21 Use of locomotive horn		
(a) Failure to sound horn at grade crossing	$5,000	$7,500
Failure to sound horn in proper pattern	1,000	3,000
(b) Failure to sound horn at least 15 seconds and less than ¼-mile before crossing	5,000	7,500
Sounding the locomotive horn more than 25 seconds before crossing	1,000	2,000
Sounding the locomotive horn more than ¼-mile in advance of crossing	1,000	2,000
§222.33 Failure to sound horn when conditions of §222.33 are not met	5,000	7,500
§222.45 Routine sounding of the locomotive horn at quiet zone crossing	5,000	7,500
§222.49 (b) Failure to provide Grade Crossing Inventory Form information	2,500	5,000
§222.59 (d) Routine sounding of the locomotive horn at a grade crossing equipped with wayside horn	5,000	7,500

PART 223—SAFETY GLAZING STANDARDS—LOCOMOTIVES, PASSENGER CARS AND CABOOSES

Subpart A—General

Sec.
223.1 Scope.
223.3 Application.
223.5 Definitions.
223.7 Responsibility.

Subpart B—Specific Requirements

223.8 Additional requirements for passenger equipment.
223.9 Requirements for new or rebuilt equipment.
223.11 Requirements for existing locomotives.
223.13 Requirements for existing cabooses.
223.15 Requirements for existing passenger cars.
223.17 Identification of equipped locomotives, passenger cars and cabooses.

APPENDIX A TO PART 223—CERTIFICATION OF GLAZING MATERIALS
APPENDIX B TO PART 223—SCHEDULE OF CIVIL PENALTIES

AUTHORITY: 49 U.S.C. 20102–03, 20133, 20701–20702, 21301–02, 21304; 28 U.S.C. 2461, note; and 49 CFR 1.49.

Subpart A—General

§223.1 Scope.

This part provides minimum requirements for glazing materials in order to protect railroad employees and railroad passengers from injury as a result of objects striking the windows of locomotives, caboose and passenger cars.

[44 FR 77352, Dec. 31, 1979]

§223.3 Application.

(a) This part applies to railroads that operate rolling equipment on standard gauge track that is a part of the general railroad system of transportation.
(b) This part does not apply to—
(1) Locomotives, cabooses, and passenger cars that operate only on track inside an installation that is not part of the general railroad system of transportation;
(2) Rapid transit operations in an urban area that are not connected with the general railroad system of transportation.
(3) Locomotives, passenger cars and cabooses that are historical or antiquated equipment and are used only for excursion, educational, recreational

[1] A penalty may be assessed against an individual only for a willful violation. The Administrator reserves the right to assess a penalty of up to $27,000 for any violation where circumstances warrant. See 49 CFR Part 209, appendix A.

equipment component is a difference of two percentages which must be divided by 100 to present it in a consistent fractional form. After performing the calculation, the result is rounded to the nearest $100.

7. The weightings result from using STB wage data and BLS equipment cost data to produce a reasonable estimation of the reporting threshold that was calculated using the threshold formula in effect immediately before calendar year 2006, a formula that assumed damage repair costs, at levels at or near the threshold, were split approximately evenly between labor and materials.

8. Formula:

New Threshold = Prior Threshold × [1 + 0.4(Wnew—Wprior)/Wprior + 0.6(Enew − Eprior)/100]

Where:

Wnew = New average hourly wage rate ($).
Wprior = Prior average hourly wage rate ($).
Enew = New equipment average PPI value.
Eprior = Prior equipment average PPI value.

[70 FR 75417, Dec. 20, 2005]

PART 227—OCCUPATIONAL NOISE EXPOSURE

Subpart A—General

Subpart B—Occupational Noise Exposure for Railroad Operating Employees

AUTHORITY: 49 U.S.C. 20103, 20103 (note), 20701–20702; 49 CFR 1.49.

SOURCE: 71 FR 63123, Oct. 27, 2006, unless otherwise noted.

Subpart A—General

§ 227.1 Purpose and scope.

(a) The purpose of this part is to protect the occupational health and safety of employees whose predominant noise exposure occurs in the locomotive cab.

(b) This part prescribes minimum Federal health and safety noise standards for locomotive cab occupants. This part does not restrict a railroad or railroad contractor from adopting and enforcing additional or more stringent requirements.

§ 227.3 Application.

(a) Except as provided in paragraph (b) of this section, this part applies to all railroads and contractors to railroads.

(b) This part does not apply to—

(1) A railroad that operates only on track inside an installation that is not part of the general railroad system of transportation;

(2) A rapid transit operation in an urban area that is not connected to the general railroad system of transportation;

(3) A rapid transit operation in an urban area that is connected to the general system and operates under a shared use waiver;

(4) A railroad that operates tourist, scenic, historic, or excursion operations, whether on or off the general railroad system of transportation; or

(5) Foreign railroad operations that meet the following conditions: Employees of the foreign railroad have a primary reporting point outside of the U.S. but are operating trains or conducting switching operations in the U.S.; and the government of that foreign railroad has implemented requirements for hearing conservation for railroad employees; the foreign railroad undertakes to comply with those requirements while operating within

the U.S.; and FRA's Associate Administrator for Safety determines that the foreign requirements are consistent with the purpose and scope of this part. A ''foreign railroad'' refers to a railroad that is incorporated in a place outside the U.S. and is operated out of a foreign country but operates for some distance in the U.S.

§ 227.5 Definitions.

As used in this part—

Action level means an eight-hour time-weighted-average sound level (TWA) of 85 dB(A), or, equivalently, a dose of 50 percent, integrating all sound levels from 80 dB(A) to 140 dB(A).

Administrator means the Administrator of the Federal Railroad Administration or the Administrator's delegate.

Artifact means any signal received or recorded by a noise measuring instrument that is not related to occupational noise exposure and may adversely impact the accuracy of the occupational noise measurement.

Audiogram means a record of audiometric testing, showing the thresholds of hearing sensitivity measured at discrete frequencies, as well as other recordkeeping information.

Audiologist means a professional, who provides comprehensive diagnostic and treatment/rehabilitative services for auditory, vestibular, and related impairments and who

(1) Has a Master's degree or doctoral degree in audiology and

(2) Is licensed as an audiologist by a State; or in the case of an individual who furnishes services in a State which does not license audiologists, has successfully completed 350 clock hours of supervised clinical practicum (or is in the process of accumulating such supervised clinical experience), performed not less than 9 months of supervised full-time audiology services after obtaining a master's or doctoral degree in audiology or a related field, and successfully completed a national examination in audiology approved by the Secretary of the U.S. Department of Health and Human Services.

Audiometry means the act or process of measuring hearing sensitivity at discrete frequencies. Audiometry can also be referred to as audiometric testing.

Baseline audiogram means an audiogram, recorded in accordance with §227.109, against which subsequent audiograms are compared to determine the extent of change of hearing level.

Class I, Class II, and Class III railroads have the meaning assigned by the regulations of the Surface Transportation Board (49 CFR part 120; General Instructions 1–1).

Continuous noise means variations in sound level that involve maxima at intervals of 1 second or less.

Decibel (dB) means a unit of measurement of sound pressure levels.

dB(A) means the sound pressure level in decibels measured on the A-weighted scale.

Employee means any individual who is engaged or compensated by a railroad or by a contractor to a railroad to perform any of the duties defined in this part.

Exchange rate means the change in sound level, in decibels, which would require halving or doubling of the allowable exposure time to maintain the same noise dose. For purposes of this part, the exchange rate is 5 decibels.

FRA means the Federal Railroad Administration.

Hearing protector means any device or material, which is capable of being worn on the head, covering the ear canal or inserted in the ear canal; is designed wholly or in part to reduce the level of sound entering the ear; and has a scientifically accepted indicator of its noise reduction value.

Hertz (Hz) means a unit of measurement of frequency numerically equal to cycles per second.

Medical pathology means a condition or disease affecting the ear which is medically or surgically treatable.

Noise operational controls means a method used to reduce noise exposure, other than hearing protectors or equipment modifications, by reducing the time a person is exposed to excessive noise.

Occasional service means service of not more than a total of 20 days in a calendar year.

Otolaryngologist means a physician specializing in diagnosis and treatment of disorders of the ear, nose, and throat.

Periodic audiogram is a record of follow-up audiometric testing conducted at regular intervals after the baseline audiometric test.

Person means an entity of any type covered under 1 U.S.C. 1, including but not limited to the following: a railroad; a manager, supervisor, official, or other employee or agent of a railroad; an owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; an independent contractor providing goods or services to a railroad; and any employee of such owner, manufacturer, lessor, lessee, or independent contractor.

Professional Supervisor of the Audiometric Monitoring Program in a hearing conservation program means an audiologist, otolaryngologist, or a physician with experience and expertise in hearing and hearing loss.

Qualified Technician is a person who is certified by the Council for Accreditation in Occupational Hearing Conservation or equivalent organization; or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining, and checking calibration and proper functioning of the audiometers used; and is responsible to the Professional Supervisor of the Audiometric Testing Program.

Railroad means any form of non-highway ground transportation that runs on rails or electromagnetic guide-ways and any entity providing such transportation, including:

(1) Commuter or other short-haul railroad passenger service in a metropolitan or suburban area and commuter railroad service that was operated by the Consolidated Rail Corporation on January 1, 1979; and

(2) High speed ground transportation systems that connect metropolitan areas, without regard to whether those systems use new technologies not associated with traditional railroads. The term ''railroad'' is also intended to mean a person that provides transportation by railroad, whether directly or by contracting out operation of the railroad to another person. The term does not include rapid transit operations in an urban area that are not connected to the general railroad system of transportation.

Representative personal sampling means measurement of an employee's noise exposure that is representative of the exposures of other employees who operate similar equipment under similar conditions.

Sound level or Sound pressure level means ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of twenty micropascals, measured in decibels. For purposes of this regulation, SLOW time response, in accordance with ANSI S1.43–1997 (Reaffirmed 2002), ''Specifications for Integrating-Averaging Sound Level Meters,'' is required. The Director of the Federal Register approves this incorporation by reference of this standard in this section in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated standard from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036 or *http://www.ansi.org*. You may inspect a copy of the incorporated standard at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., NW., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

Standard threshold shift (STS) means a change in hearing sensitivity for the worse, relative to the baseline audiogram, or relative to the most recent revised baseline (where one has been established), of an average of 10 dB or more at 2000, 3000, and 4000 Hz in either ear.

Time-weighted-average eight-hour (or 8-hour TWA) means the sound level, which, if constant over 8 hours, would result in the same noise dose as is measured. For purposes of this part, the exchange rate is 5 decibels.

Tourist, scenic, historic, or excursion operations means railroad operations that carry passengers, often using antiquated equipment, with the conveyance of the passengers to a particular

destination not being the principal purpose.

§ 227.7 Preemptive effect.

Under 49 U.S.C. 20106, issuance of these regulations preempts any State law, regulation, or order covering the same subject matter, except an additional or more stringent law, regulation, or order that is necessary to eliminate or reduce an essentially local safety hazard; is not incompatible with a law, regulation, or order of the United States Government; and does not impose an unreasonable burden on interstate commerce.

§ 227.9 Penalties.

(a) Any person who violates any requirement of this part or causes the violation of any such requirement is subject to a civil penalty of at least $550 and not more than $11,000 per violation, except that: penalties may be assessed against individuals only for willful violations, and, where a grossly negligent violation or a pattern of repeated violations has created an imminent hazard of death or injury to persons, or has caused death or injury, a penalty not to exceed $27,000 per violation may be assessed. Each day a violation continues shall constitute a separate offense. See appendix H to this part for a statement of agency civil penalty policy.

(b) Any person who knowingly and willfully falsifies a record or report required by this part may be subject to criminal penalties under 49 U.S.C. 21311.

§ 227.11 Responsibility for compliance.

Although the duties imposed by this part are generally stated in terms of the duty of a railroad, any person, including a contractor for a railroad, who performs any function covered by this part must perform that function in accordance with this part.

§ 227.13 Waivers.

(a) A person subject to a requirement of this part may petition the Administrator for a waiver of compliance with such requirement. The filing of such a petition does not affect that person's responsibility for compliance with that requirement while the petition is being considered.

(b) Each petition for waiver under this section must be filed in the manner and contain the information required by part 211 of this chapter.

(c) If the Administrator finds that a waiver of compliance is in the public interest and is consistent with railroad safety, the Administrator may grant the waiver subject to any conditions the Administrator deems necessary.

§ 227.15 Information collection.

(a) The information collection requirements of this part were reviewed by the Office of Management and Budget pursuant to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.) and are assigned OMB control number 2130–NEW.

(b) The information collection requirements are found in the following sections: §§ 227.13, 227.103, 227.107, 227.109, 227.111, 227.117, 227.119, and 227.121.

Subpart B—Occupational Noise Exposure for Railroad Operating Employees.

§ 227.101 Scope and applicability.

(a) This subpart shall apply to the noise-related working conditions of—

(1) Any person who regularly performs service subject to the provisions of the hours of service laws governing ''train employees'' (see 49 U.S.C. 21101(5) and 21103), but, subject to a railroad's election in paragraph (a)(3) of this section, does not apply to:

(i) Employees who move locomotives only within the confines of locomotive repair or servicing areas, as provided in §§ 218.5 and 218.29(a) of this chapter, or

(ii) Employees who move a locomotive or group of locomotives for distances of less than 100 feet and this incidental movement of a locomotive or locomotives is for inspection or maintenance purposes, or

(iii) Contractors who operate historic equipment in occasional service, provided that the contractors have been provided with hearing protectors and, where necessary, are required to use the hearing protectors while operating the historic equipment;

(2) Any direct supervisor of the persons described in paragraph (a)(1) of this section whose duties require frequent work in the locomotive cab; and

(3) At the election of the railroad, any other person (including a person excluded by paragraph (a)(1) of this section) whose duties require frequent work in the locomotive cab and whose primary noise exposure is reasonably expected to be experienced in the cab, if the position occupied by such person is designated in writing by the railroad, as required by §227.121(d).

(b) Occupational noise exposure and hearing conservation for employees not covered by this subpart is governed by the appropriate occupational noise exposure regulation of the U.S. Department of Labor, Occupational Safety and Health Administration located at 29 CFR 1910.95.

§227.103 Noise monitoring program.

(a) *Schedule.* A railroad shall develop and implement a noise monitoring program to determine whether any employee covered by the scope of this subpart may be exposed to noise that may equal or exceed an 8-hour TWA of 85 dB(A), in accordance with the following schedule:

(1) Class 1, passenger, and commuter railroads no later than February 26, 2008.

(2) Railroads with 400,000 or more annual employee hours that are not Class 1, passenger, or commuter railroads no later than August 26, 2008.

(3) Railroads with fewer than 400,000 annual employee hours no later than August 26, 2009.

(b) *Sampling strategy.*

(1) In its monitoring program, the railroad shall use a sampling strategy that is designed to identify employees for inclusion in the hearing conservation program and to enable the proper selection of hearing protection.

(2) Where circumstances such as high worker mobility, significant variations in sound level, or a significant component of impulse noise make area monitoring generally inappropriate, the railroad shall use representative personal sampling to comply with the monitoring requirements of this section, unless the railroad can show that area sampling produces equivalent results.

(c) *Noise measurements.*

(1) All continuous, intermittent, and impulse sound levels from 80 decibels to 140 decibels shall be integrated into the noise measurements.

(2) Noise measurements shall be made under typical operating conditions using:

(i) A sound level meter conforming, at a minimum, to the requirements of ANSI S1.4–1983 (Reaffirmed 2001) (incorporated by reference, see §227.103(h)), Type 2, and set to an A-weighted SLOW response;

(ii) An integrated sound level meter conforming, at a minimum, to the requirements of ANSI S1.43–1997 (Reaffirmed 2002) (incorporated by reference, see §227.103(h)), Type 2, and set to an A-weighted slow response ; or

(iii) A noise dosimeter conforming, at a minimum, to the requirements of ANSI S1.25–1991 (Reaffirmed 2002) (incorporated by reference, see §227.103(h)) and set to an A-weighted SLOW response.

(3) All instruments used to measure employee noise exposure shall be calibrated to ensure accurate measurements.

(d) The railroad shall repeat noise monitoring, consistent with the requirements of this section, whenever a change in operations, process, equipment, or controls increases noise exposures to the extent that:

(1) Additional employees may be exposed at or above the action level; or

(2) The attenuation provided by hearing protectors being used by employees may be inadequate to meet the requirements of §227.103.

(e) In administering the monitoring program, the railroad shall take into consideration the identification of work environments where the use of hearing protectors may be omitted.

(f) *Observation of monitoring.* The railroad shall provide affected employees or their representatives with an opportunity to observe any noise dose measurements conducted pursuant to this section.

(g) *Reporting of monitoring results.*

(1) The railroad shall notify each monitored employee of the results of the monitoring.

(2) The railroad shall post the monitoring results at the appropriate crew origination point for a minimum of 30 days. The posting should include sufficient information to permit other crews to understand the meaning of the results in the context of the operations monitored.

(h) *Incorporation by reference.* The materials listed in this section are incorporated by reference in the corresponding sections noted. These incorporations by reference were approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated materials from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036 or *http://www.ansi.org.* You may inspect a copy of the incorporated standards at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., NW., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(1) ANSI S1.4–1983 (Reaffirmed 2001), Specification for Sound Level Meters, incorporation by reference (IBR) approved for §227.103(c)(2)(i).

(2) ANSI S1.43–1997 (Reaffirmed 2002), Specifications for Integrating-Averaging Sound Level Meters, IBR approved for §227.103(c)(2)(ii).

(3) ANSI S1.25–1991 (Reaffirmed 2002), Specification for Personal Noise Dosimeters, IBR approved for §227.103(c)(2)(iii).

§227.105 Protection of employees.

(a) A railroad shall provide appropriate protection for its employees who are exposed to noise, as measured according to §227.103, that exceeds the limits specified in appendix A of this part.

(b) In assessing whether exposures exceed 115 dB(A), as set forth in paragraph (a) of this section and appendix A to this part, the apparent source of the noise exposures shall be observed and documented and measurement artifacts may be removed.

(c) Except as set forth in paragraph (d) of this section, exposure to continuous noise shall not exceed 115dB(A).

(d) Exposures to continuous noise greater than 115 dB(A) and equal to or less than 120 dB(A) are permissible, provided that the total daily duration does not exceed 5 seconds.

§227.107 Hearing conservation program.

(a) Consistent with the requirements of the noise monitoring program required by §227.103, the railroad shall administer a continuing, effective hearing conservation program, as set forth in §§227.109 through 227.121, for all employees exposed to noise at or above the action level.

(b) For purposes of the hearing conservation program, employee noise exposure shall be computed in accordance with the tables in appendix A of this part, and without regard to any attenuation provided by the use of hearing protectors.

§227.109 Audiometric testing program.

(a) Each railroad shall establish and maintain an audiometric testing program as set forth in this section and include employees who are required to be included in a hearing conservation program pursuant to §227.107.

(b) *Cost.* The audiometric tests shall be provided at no cost to employees.

(c) *Tests.* Audiometric tests shall be performed by:

(1) An audiologist, otolaryngologist, or other physician who has experience and expertise in hearing and hearing loss; or

(2) A qualified technician.

(d) [Reserved]

(e) *Baseline audiogram.* This paragraph (e) applies to employees who are required by §227.107 to be included in a hearing conservation program.

(1) *New employees.*

(i) Except as provided in paragraph (e)(1)(ii), for employees hired after February 26, 2007, the railroad shall establish a valid baseline audiogram within 6 months of the new employee's first tour of duty.

(ii) Where mobile test vans are used to meet the requirement in paragraph (e)(1)(i), the railroad shall establish a valid baseline audiogram within one

year of the new employee's first tour of duty.

(2) *Existing employees.*

(i) For all employees without a baseline audiogram as of February 26, 2007, Class 1, passenger, and commuter railroads, and railroads with 400,000 or more annual employee hours shall establish a valid baseline audiogram by February 26, 2009; and railroads with less than 400,000 annual employee hours shall establish a valid baseline audiogram by February 26, 2010.

(ii) If an employee has had a baseline audiogram as of February 26, 2007, and it was obtained under conditions that satisfy the requirements found in 29 CFR 1910.95(h), the railroad must use that baseline audiogram.

(iii) If the employee has had a baseline audiogram as of February 26, 2007, and it was obtained under conditions that satisfy the requirements in 29 CFR 1910.95(h)(1), but not the requirements found in 29 CFR 1910.95(h)(2) through (5), the railroad may elect to use that baseline audiogram provided that the Professional Supervisor of the Audiometric Monitoring Program makes a reasonable determination that the baseline audiogram is valid and is clinically consistent with other materials in the employee's medical file.

(3) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to occupational noise in excess of the action level. Hearing protectors may be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to occupational noise.

(4) The railroad shall notify its employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(f) *Periodic audiogram.*

(1) The railroad shall offer an audiometric test to each employee included in the hearing conservation program at least once each calendar year. The interval between the date offered to any employee for a test in a calendar year and the date offered in the subsequent calendar year shall be no more than 450 days and no less than 280 days.

(2) The railroad shall require each employee included in the hearing conservation program to take an audiometric test at least once every 1095 days.

(g) *Evaluation of audiogram.*

(1) Each employee's periodic audiogram shall be compared to that employee's baseline audiogram to determine if the audiogram is valid and to determine if a standard threshold shift has occurred. This comparison may be done by a qualified technician.

(2) If the periodic audiogram demonstrates a standard threshold shift, a railroad may obtain a retest within 90 days. The railroad may consider the results of the retest as the periodic audiogram.

(3) The audiologist, otolaryngologist, or physician shall review problem audiograms and shall determine whether there is a need for further evaluation. A railroad shall provide all of the following information to the person performing this review:

(i) The baseline audiogram of the employee to be evaluated;

(ii) The most recent audiogram of the employee to be evaluated;

(iii) Measurements of background sound pressure levels in the audiometric test room as required in appendix D of this part: Audiometric Test Rooms; and

(iv) Records of audiometer calibrations required by § 227.111.

(h) *Follow-up procedures.*

(1) If a comparison of the periodic audiogram to the baseline audiogram indicates that a standard threshold shift has occurred, the railroad shall inform the employee in writing within 30 days of the determination.

(2) Unless a physician or audiologist determines that the standard threshold shift is not work-related or aggravated by occupational noise exposure, the railroad shall ensure that the following steps are taken:

(i) Employees not using hearing protectors shall be fitted with hearing protectors, shall be trained in their use and care, and shall be required to use them.

(ii) Employees already provided with hearing protectors shall be refitted, shall be retrained in the use of hearing

protectors offering greater attenuation, if necessary, and shall be required to use them.

(iii) If subsequent audiometric testing is necessary or if the railroad suspects that a medical pathology of the ear is caused or aggravated by the wearing of hearing protectors, the railroad shall refer the employee for a clinical audiological evaluation or an otological examination.

(iv) If the railroad suspects that a medical pathology of the ear unrelated to the use of hearing protectors is present, the railroad shall inform the employee of the need for an otological examination.

(3) If subsequent audiometric testing of an employee, whose exposure to noise is less than an 8-hour TWA of 90 dB, indicates that a standard threshold shift is not persistent, the railroad shall inform the employee of the new audiometric interpretation and may discontinue the required use of hearing protectors for that employee.

(i) *Revised baseline.* A railroad shall use the following methods for revising baseline audiograms:

(1) Periodic audiograms from audiometric tests conducted through February 26, 2009, may be substituted for the baseline measurement by the Professional Supervisor of the Audiometric Monitoring Program who is evaluating the audiogram if:

(i) The standard threshold shift revealed by the audiogram is persistent; or

(ii) The hearing threshold shown in the periodic audiogram indicates significant improvement over the baseline audiogram.

(2) Baseline audiograms from audiometric tests conducted after February 26, 2009, shall be revised in accordance with the method specified in appendix C of this part: Audiometric Baseline Revision.

(j) *Standard threshold shift.* In determining whether a standard threshold shift has occurred, allowance may be made for the contribution of aging (presbycusis) to the change in hearing level by correcting the annual audiogram according to the procedure described in appendix F of this part: Calculation and Application of Age Correction to Audiograms.

§ 227.111 Audiometric test requirements.

(a) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz. Tests at each frequency shall be taken separately for each ear.

(b) Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of and are maintained and used in accordance with ANSI S3.6–2004 ''Specification for Audiometers.'' The Director of the Federal Register approves the incorporation by reference of this standard in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated standard from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036 or *http://www.ansi.org*. You may inspect a copy of the incorporated standard at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., NW., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For more information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(1) Pulsed-tone audiometers should be used with the following on and off times: F–J and J–K shall each have values of 225 ± 35 milliseconds (ms).

(2) Use of insert earphones shall be consistent with the requirements listed in appendix E of this part: Use of Insert Earphones for Audiometric Testing.

(c) Audiometric examinations shall be administered in a room meeting the requirements listed in appendix D of this part: Audiometric Test Rooms.

(d) *Audiometer calibration.*

(1) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds or by appropriate calibration device, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 decibels or greater require an acoustic calibration.

(2) Audiometer calibration shall be checked acoustically at least annually according to the procedures described in ANSI S3.6–2004. Frequencies below 500 Hz and above 8000 Hz may be omitted from this check. The audiometer must meet the sound pressure accuracy requirements of section 7.2 of ANSI S3.6–2004 of 3 dB at any test frequency between 500 and 5000 Hz and 5 dB at any test frequency 6000 Hz and higher for the specific type of transducer used. For air-conduction supra-aural earphones, the specifications in Table 6 of ANSI S3.6–2004 shall apply. For air-conduction insert earphones, the specifications in Table 7 of ANSI S3.6–2004 shall apply. Audiometers that do not meet these requirements must undergo an exhaustive calibration.

(3) Exhaustive Calibration. An exhaustive calibration shall be performed in accordance with ANSI S3.6–2004, according to the following schedule:

(i) At least once every two years on audiometers not used in mobile test vans. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(ii) At least annually on audiometers used in mobile test vans.

§ 227.113 Noise operational controls.

(a) Railroads may use noise operational controls at any sound level to reduce exposures to levels below those required by Table A–1 of appendix A of this part.

(b) Railroads are encouraged to use noise operational controls when employees are exposed to sound exceeding an 8-hour TWA of 90 dB(A).

§ 227.115 Hearing protectors.

(a) *General requirements for hearing protectors.*

(1) The railroad shall provide hearing protectors to employees at no cost to the employee.

(2) The railroad shall replace hearing protectors as necessary.

(3) When offering hearing protectors, a railroad shall consider an employee's ability to understand and respond to voice radio communications and audible warnings.

(4) The railroad shall give employees the opportunity to select their hearing protectors from a variety of suitable hearing protectors. The selection shall include devices with a range of attenuation levels.

(5) The railroad shall provide training in the use and care of all hearing protectors provided to employees.

(6) The railroad shall ensure proper initial fitting and supervise the correct use of all hearing protectors.

(b) *Availability of hearing protectors.* A railroad shall make hearing protectors available to all employees exposed to sound levels that meet or exceed the action level.

(c) *Required use at action level.* A railroad shall require the use of hearing protectors when an employee is exposed to sound levels that meet or exceed the action level, and the employee has:

(1) Not yet had a baseline audiogram established pursuant to § 227.109; or

(2) Experienced a standard threshold shift and is required to use hearing protectors under § 227.109(h).

(d) *Required use for TWA of 90 dB(A).* The railroad shall require the use of hearing protectors when an employee is exposed to sound levels equivalent to an 8-hour TWA of 90 dB(A) or greater. The hearing protectors should be used to reduce sound levels to within those levels required by appendix A of this part.

§ 227.117 Hearing protector attenuation.

(a) A railroad shall evaluate hearing protector attenuation for the specific noise environments in which the protector will be used. The railroad shall use one of the evaluation methods described in appendix B of this part; ''Methods for Estimating the Adequacy of Hearing Protector Attenuation.''

(b) Hearing protectors shall attenuate employee exposure to an 8-hour TWA of 90 decibels or lower, as required by § 227.115.

(c) For employees who have experienced a standard threshold shift, hearing protectors must attenuate employee exposure to an 8-hour time-weighted average of 85 decibels or lower.

(d) The adequacy of hearing protector attenuation shall be re-evaluated whenever employee noise exposures increase to the extent that the hearing

protectors provided may no longer provide adequate attenuation. A railroad shall provide more effective hearing protectors where necessary.

§ 227.119 Training program.

(a) The railroad shall institute an occupational noise and hearing conservation training program for all employees included in the hearing conservation program.

(1) The railroad shall offer the training program to each employee included in the hearing conservation program at least once each calendar year. The interval between the date offered to any employee for the training in a calendar year and the date offered in the subsequent calendar year shall be no more than 450 days and no less than 280 days.

(2) The railroad shall require each employee included in the hearing conservation program to complete the training at least once every 1095 days.

(b) The railroad shall provide the training required by paragraph (a) of this section in accordance with the following:

(1) For employees hired after February 26, 2007, within six months of the employee's first tour of duty in a position identified within the scope of this part.

(2) For employees hired on or before February 26, 2007, by Class 1, passenger, and commuter railroads, and railroads with 400,000 or more annual employee hours, by no later than February 26, 2009;

(3) For employees hired on or before February 26, 2007, by railroads with fewer than 400,000 annual employee hours, by no later than February 26, 2010.

(c) The training program shall include and the training materials shall reflect, at a minimum, information on all of the following:

(1) The effects of noise on hearing;

(2) The purpose of hearing protectors;

(3) The advantages, disadvantages, and attenuation of various types of hearing protectors;

(4) Instructions on selection, fitting, use, and care of hearing protectors;

(5) The purpose of audiometric testing, and an explanation of the test procedures;

(6) An explanation of noise operational controls, where used;

(7) General information concerning the expected range of workplace noise exposure levels associated with major categories of railroad equipment and operations (*e.g.*, switching and road assignments, hump yards near retarders, etc.) and appropriate reference to requirements of the railroad concerning use of hearing protectors;

(8) The purpose of noise monitoring and a general description of monitoring procedures;

(9) The availability of a copy of this part, an explanation of the requirements of this part as they affect the responsibilities of employees, and employees' rights to access records under this part;

(10) How to determine what can trigger an excessive noise report, pursuant to § 229.121(b); and

(11) How to file an excessive noise report, pursuant to § 229.121(b).

§ 227.121 Recordkeeping.

(a) *General requirements.*

(1) *Availability of records.* Each railroad required to maintain and retain records under this part shall:

(i) Make all records available for inspection and copying/photocopying to representatives of the FRA, upon request;

(ii) Make an employee's records available for inspection and copying/photocopying to that employee, former employee, or such person's representative upon written authorization by such employee;

(iii) Make exposure measurement records for a given run or yard available for inspection and copying/photocopying to all employees who were present in the locomotive cab during the given run and/or who work in the same yard; and

(iv) Make exposure measurement records for specific locations available to regional or national labor representatives, upon request. These reports shall not contain identifying information of an employee unless an employee authorizes the release of such information in writing.

(2) *Electronic records.* All records required by this part may be kept in electronic form by the railroad. A railroad

may maintain and transfer records through electronic transmission, storage, and retrieval provided that:

(i) The electronic system be designed so that the integrity of each record is maintained through appropriate levels of security such as recognition of an electronic signature, or other means, which uniquely identify the initiating person as the author of that record. No two persons shall have the same electronic identity;

(ii) The electronic system shall ensure that each record cannot be modified in any way, or replaced, once the record is transmitted and stored;

(iii) Any amendment to a record shall be electronically stored apart from the record which it amends. Each amendment to a record shall be uniquely identified as to the person making the amendment;

(iv) The electronic system shall provide for the maintenance of records as originally submitted without corruption or loss of data; and

(v) Paper copies of electronic records and amendments to those records, that may be necessary to document compliance with this part shall be made available for inspection and copying/photocopying by representatives of the FRA.

(3) *Transfer of records.* If a railroad ceases to do business, it shall transfer to the successor employer all records required to be maintained under this subpart, and the successor employer shall retain them for the remainder of the period prescribed in this part.

(b) *Exposure measurements records.* The railroad shall:

(1) Maintain an accurate record of all employee exposure measurements required by §227.103; and

(2) Retain these records for the duration of the covered employee's employment plus thirty years.

(c) *Audiometric test records.* The railroad shall:

(1) Maintain employee audiometric test records required by §227.109, including:

(i) The name and job classification of the employee;

(ii) The date of the audiogram;

(iii) The examiner's name;

(iv) The date of the last acoustic or exhaustive calibration of the audiometer;

(v) Accurate records of the measurements of the background sound pressure levels in audiometric test rooms;

(vi) The model and serial number of the audiometer used for testing; and

(2) Retain the records required by §227.107 for the duration of the covered employee's employment plus thirty years.

(d) *Positions and persons designated records.* The railroad shall:

(1) Maintain a record of all positions or persons or both designated by the railroad to be placed in a Hearing Conservation Program pursuant to §227.107; and

(2) Retain these records for the duration of the designation.

(e) *Training program materials records.* The railroad shall:

(1) Maintain copies of all training program materials used to comply with §227.119(c) and a record of employees trained; and

(2) Retain these copies and records for three years.

(f) *Standard threshold shift records.* The railroad shall:

(1) Maintain a record of all employees who have been found to have experienced a standard threshold shift within the prior calendar year and include all of the following information for each employee on the record:

(i) Date of the employee's baseline audiogram;

(ii) Date of the employee's most recent audiogram;

(iii) Date of the establishment of a standard threshold shift;

(iv) The employee's job code; and

(v) An indication of how many standard threshold shifts the employee has experienced in the past, if any; and

(2) Retain these records for five years.

APPENDIX A TO PART 227—NOISE EXPOSURE COMPUTATION

This appendix is mandatory.

I. COMPUTATION OF EMPLOYEE NOISE EXPOSURE

A. Noise dose is computed using Table A–1 as follows:

1. When the sound level, L, is constant over the entire work day, the noise dose, D, in

percent, is given by: D = 100 C/T, where C is the total length of the work day, in hours, and T is the duration permitted corresponding to the measured sound level, L, as given in Table A–1.

2. When the work day noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

D = 100 (C1/T1 + C2/T2 + . . . + Cn/Tn), where Cn indicates the total time of exposure at a specific noise level, and Tn indicates the duration permitted for that level as given by Table A–1.

B. The eight-hour TWA in dB may be computed from the dose, in percent, by means of the formula: TWA = 16.61 log10 (D/100) + 90. For an eight-hour work day with the noise level constant over the entire day, the TWA is equal to the measured sound level.

C. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

D. Any time that an employee spends deadheading shall be included in the calculation of the noise dose.

E. A table relating dose and TWA is given in Section II of this Appendix.

TABLE A–1[1]

A-weighted sound level, L (decibel)	Duration permitted T (hour)
80	32
81	27.9
82	24.3
83	21.1
84	18.4
85	16
86	13.9
87	12.1
88	10.6
89	9.2
90	8
91	7.0
92	6.1
93	5.3
94	4.6
95	4
96	3.5
97	3.0
98	2.6
99	2.3
100	2
101	1.7
102	1.5
103	1.3
104	1.1
105	1
106	0.87
107	0.76
108	0.66
109	0.57
110	0.5
111	0.44
112	0.38
113	0.33
114	0.29
115	0.25

TABLE A–1[1]—Continued

A-weighted sound level, L (decibel)	Duration permitted T (hour)
116	*0.22*
117	*0.19*
118	*0.16*
119	*0.14*
120	*0.125*
121	*0.11*
122	*0.095*
123	*0.082*
124	*0.072*
125	*0.063*
126	*0.054*
127	*0.047*
128	*0.041*
129	*0.036*
130	*0.031*
140	*0.078*

[1] Numbers above 115 dB(A) are italicized to indicate that they are noise levels that are not permitted. The italicized numbers are included only because they are sometimes necessary for the computation of noise dose.

In the above table the duration permitted, T, is computed by

$$T = \frac{8}{2^{(L-90)/5}}$$

where L is the measured A-weighted sound level.

II. CONVERSION BETWEEN "DOSE" AND "8-HOUR TIME-WEIGHTED AVERAGE" SOUND LEVEL

A. Compliance with subpart B of part 227 is determined by the amount of exposure to noise in the workplace. The amount of such exposure is usually measured with a dosimeter which gives a readout in terms of "dose." In order to better understand the requirements of the regulation, dosimeter readings can be converted to an "8-hour TWA."

B. In order to convert the reading of a dosimeter into TWA, see Table A–2, below. This table applies to dosimeters that are set by the manufacturer to calculate dose or percent exposure according to the relationships in Table A–1. So, for example, a dose of 91 percent over an eight-hour day results in a TWA of 89.3 dB, and a dose of 50 percent corresponds to a TWA of 85 dB.

C. If the dose as read on the dosimeter is less than or greater than the values found in Table A–2, the TWA may be calculated by using the formula: TWA = 16.61 log10 (D/100) + 90 where TWA = 8-hour time-weighted average sound level and D = accumulated dose in percent exposure.

TABLE A–2—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)

Dose or percent noise exposure	TWA
10	73.4
15	76.3
20	78.4
25	80.0
30	81.3
35	82.4
40	83.4
45	84.2
50	85.0
55	85.7
60	86.3
65	86.9
70	87.4
75	87.9
80	88.4
81	88.5
82	88.6
83	88.7
84	88.7
85	88.8
86	88.9
87	89.0
88	89.1
89	89.2
90	89.2
91	89.3
92	89.4
93	89.5
94	89.6
95	89.6
96	89.7
97	89.8
98	89.9
99	89.9
100	90.0
101	90.1
102	90.1
103	90.2
104	90.3
105	90.4
106	90.4
107	90.5
108	90.6
109	90.6
110	90.7
111	90.8
112	90.8
113	90.9
114	90.9
115	91.1
116	91.1
117	91.1
118	91.2
119	91.3
120	91.3
125	91.6
130	91.9
135	92.2
140	92.4
145	92.7
150	92.9
155	93.2
160	93.4
165	93.6
170	93.8
175	94.0
180	94.2

TABLE A–2—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
185	94.4
190	94.6
195	94.8
200	95.0
210	95.4
220	95.7
230	96.0
240	96.3
250	96.6
260	96.9
270	97.2
280	97.4
290	97.7
300	97.9
310	98.2
320	98.4
330	98.6
340	98.8
350	99.0
360	99.2
370	99.4
380	99.6
390	99.8
400	100.0
410	100.2
420	100.4
430	100.5
440	100.7
450	100.8
460	101.0
470	101.2
480	101.3
490	101.5
500	101.6
510	101.8
520	101.9
530	102.0
540	102.2
550	102.3
560	102.4
570	102.6
580	102.7
590	102.8
600	102.9
610	103.0
620	103.2
630	103.3
640	103.4
650	103.5
660	103.6
670	103.7
680	103.8
690	103.9
700	104.0
710	104.1
720	104.2
730	104.3
740	104.4
750	104.5
760	104.6
770	104.7
780	104.8
790	104.9
800	105.0
810	105.1
820	105.2
830	105.3

TABLE A–2—CONVERSION FROM "PERCENT NOISE EXPOSURE" OR "DOSE" TO "8-HOUR TIME-WEIGHTED AVERAGE SOUND LEVEL" (TWA)—Continued

Dose or percent noise exposure	TWA
840	105.4
850	105.4
860	105.5
870	105.6
880	105.7
890	105.8
900	105.8
910	105.9
920	106.0
930	106.1
940	106.2
950	106.2
960	106.3
970	106.4
980	106.5
990	106.5
999	106.6

APPENDIX B TO PART 227—METHODS FOR ESTIMATING THE ADEQUACY OF HEARING PROTECTOR ATTENUATION

This appendix is mandatory.

Employers must select one of the following three methods by which to estimate the adequacy of hearing protector attenuation.

I. DERATE BY TYPE

Derate the hearing protector attenuation by type using the following requirements:

A. Subtract 7 dB from the published Noise Reduction Rating (NRR).

B. Reduce the resulting amount by:

1. 20% for earmuffs,
2. 40% for form-able earplugs, or
3. 60% for all other earplugs.

C. Subtract the remaining amount from the A-weighted TWA. You will have the estimated A-weighted TWA for that hearing protector.

II. METHOD B FROM ANSI S12.6–1997 (REAFFIRMED 2002)

Use Method B, which is found in ANSI S12.6–1997 (Reaffirmed 2002) ''Methods for Measuring the Real-Ear Attenuation of Hearing Protectors.'' The Director of the Federal Register approves the incorporation by reference of this standard in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated standard from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036, or *http://www.ansi.org*. You may inspect a copy of the incorporated standard at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

III. OBJECTIVE MEASUREMENT

Use actual measurements of the level of noise exposure (as an A-weighted SLOW response dose) inside the hearing protector when the employee wears the hearing protector in the actual work environment.

APPENDIX C TO PART 227—AUDIOMETRIC BASELINE REVISION

This appendix is mandatory beginning on February 26, 2009.

I. GENERAL

A. A professional reviewer (audiologist, otolaryngologist, or physician) shall use these procedures when revising baseline audiograms.

B. Although these procedures can be programmed by a computer to identify records for potential revision, the final decision for revision rests with a human being. Because the goal of the guidelines is to foster consistency among different professional reviewers, human override of the guidelines must be justified by specific concrete reasons.

C. These procedures do not apply to: The identification of standard threshold shifts (STS) other than an FRA STS[1] or to the calculation of the 25-dB average shifts that are reportable on the Form FRA F 6180.55a.

D. Initially, the baseline is the latest audiogram obtained before entry into the hearing conservation program. If no appropriate pre-entry audiogram exists, the baseline is the first audiogram obtained after entry into the hearing conservation program. Each subsequent audiogram is reviewed to detect improvement in the average (average of thresholds at 2, 3, and 4 kHz) and to detect an FRA STS. The two ears are examined separately and independently for improvement and for worsening. If one ear meets the criteria for revision of baseline, then the baseline is revised for that ear only. Therefore, if the two ears show different hearing trends, the baseline for the left ear may be from one test date, while the baseline for the right ear may be from a different test date.

E. Age corrections do not apply in considering revisions for improvement (Rule 1). The FRA-allowed age corrections from appendix F of Part 227[2] may be used, if desired,

[1] OSHA and FRA use the same definition for Standard Threshold Shift (STS). FRA's definition is located in §227.5. OSHA's definition is located in 29 CFR 1910.95(g)(10)(i).

[2] FRA and OSHA use the same age-correction provisions. FRA's is found in appendix F

before considering revision for persistent STS. Rule 2 operates in the same way, whether age corrections are used or not.

II. Rule 1: Revision for Persistent Improvement

If the average of the thresholds for 2, 3, and 4 kHz for either ear shows an improvement of 5 dB or more from the baseline value, and the improvement is present on one test and persistent on the next test, then the record should be identified for review by the audiologist, otolaryngologist, or physician for potential revision of the baseline for persistent improvement. The baseline for that ear should be revised to the test which shows the lower (more sensitive) value for the average of thresholds at 2, 3, and 4 kHz unless the audiologist, otolaryngologist, or physician determines and documents specific reasons for not revising. If the values of the three-frequency average are identical for the two tests, then the earlier test becomes the revised baseline.

III. Rule 2: Revision for Persistent Standard Threshold Shift

A. If the average of thresholds for 2, 3, and 4 kHz for either ear shows a worsening of 10 dB or more from the baseline value, and the STS persists on the next periodic test (or the next test given at least 6 months later), then the record should be identified for review by the audiologist, otolaryngologist, or physician for potential revision of the baseline for persistent worsening. Unless the audiologist, otolaryngologist, or physician determines and documents specific reasons for not revising, the baseline for that ear should be revised to the test which shows the lower (more sensitive) value for the average of thresholds at 2, 3, and 4 kHz. If both tests show the same numerical value for the average of 2, 3, and 4 kHz, then the audiologist, otolaryngologist, or physician should revise the baseline to the earlier of the two tests, unless the later test shows better (more sensitive) thresholds for other test frequencies.

B. Following an STS, a retest within 90 days of the periodic test may be substituted for the periodic test if the retest shows better (more sensitive) results for the average threshold at 2, 3, and 4 kHz.

C. If the retest is used in place of the periodic test, then the periodic test is retained in the record, but it is marked in such a way that it is no longer considered in baseline revision evaluations. If a retest within 90 days of periodic test confirms an FRA STS shown on the periodic test, the baseline will not be revised at that point because the required six-month interval between tests showing STS persistence has not been met. The purpose of the six-month requirement is to prevent premature baseline revision when STS is the result of temporary medical conditions affecting hearing.

D. Although a special retest after six months could be given, if desired, to assess whether the STS is persistent, in most cases, the next annual audiogram would be used to evaluate persistence of the STS.

Appendix D to Part 227—Audiometric Test Rooms

This appendix is mandatory.

A. Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table D–1 when measured by equipment conforming at least to the Type 2 requirements of ANSI S1.4–1983 (Reaffirmed 2001) and to the Class 2 requirements of ANSI S1.11–2004, ''Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters.''

B. The Director of the Federal Register approves the incorporation by reference of ANSI S1.4–1983 (Reaffirmed 2001) and S.1.11–2004 in this section in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated standard from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036 or *http://www.ansi.org*. You may inspect a copy of the incorporated standard at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., NW., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

Table D–1—Maximum Allowable Octave-Band Sound Pressure Levels for Audiometric Test Rooms

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure levels—supra-aural earphones	40	40	47	57	62
Sound pressure levels—insert earphones	50	47	49	50	56

of part 227 and OSHA's in appendix F of 29 CFR 1910.95.

APPENDIX E TO PART 227—USE OF INSERT EARPHONES FOR AUDIOMETRIC TESTING

This appendix is mandatory.

Section 227.111(d) allows railroads to use insert earphones for audiometric testing. Railroads are not required to use insert earphones, however, where they elect to use insert earphones, they must comply with the requirements of this appendix.

I. ACCEPTABLE FIT

A. The audiologist, otolaryngologist, or other physician responsible for conducting the audiometric testing, shall identify ear canals that prevent achievement of an acceptable fit with insert earphones, or shall assure that any technician under his/her authority who conducts audiometric testing with insert earphones has the ability to identify such ear canals.

B. Technicians who conduct audiometric tests must be trained to insert the earphones correctly into the ear canals of test subjects and to recognize conditions where ear canal size prevents achievement of an acceptable insertion depth (fit).

C. Insert earphones shall not be used for audiometric testing of employees with ear canal sizes that prevent achievement of an acceptable insertion depth (fit).

II. PROPER USE

The manufacturer's guidelines for proper use of insert earphones must be followed.

III. AUDIOMETER CALIBRATION

A. Audiometers used with insert earphones must be calibrated in accordance with ANSI S3.6–2004, ''Specification for Audiometers.'' The Director of the Federal Register approves the incorporation by reference of this standard in this section in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. You may obtain a copy of the incorporated standard from the American National Standards Institute at 1819 L Street, NW., Washington, DC 20036 or *http://www.ansi.org*. You may inspect a copy of the incorporated standard at the Federal Railroad Administration, Docket Room, 1120 Vermont Ave., NW., Suite 700, Washington, DC 20005, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

B. Audiometers used with insert earphones must be calibrated using one of the couplers listed in Table 7 of ANSI S3.6–2004.

C. The acoustical calibration shall be conducted annually.

D. The functional calibration must be conducted before each day's use of the audiometer.

IV. BACKGROUND NOISE LEVELS

Testing shall be conducted in a room where the background ambient noise octave-band sound pressures levels meet appendix D to this part.

V. CONVERSION FROM SUPRA AURAL EARPHONES

At the time of conversion from supra-aural to insert earphones, testing must be performed with both types of earphones.

A. The test subject must have a quiet period of at least 14 hours before testing. Hearing protectors may be used as a substitute for the quiet period.

B. The supra-aural earphone audiogram shall be compared to the baseline audiogram, or the revised baseline audiogram if appropriate, to check for a Standard Threshold Shift (STS). In accordance with §227.109(f)(2), if the audiogram shows an STS, retesting with supra-aural earphones must be performed within 90 days. If the resulting audiogram confirms the STS, then it is adopted as the current test instead of the prior one.

C. If retesting with supra-aural earphones is performed, then retesting with insert earphones must be performed at that time to establish the baseline for future audiometric tests using the insert earphones.

VI. REVISED BASELINE AUDIOGRAMS

A. If an STS is confirmed by the re-test with supra-aural earphones, the audiogram may become the revised baseline audiogram per the requirements of §227.109(i) for all future hearing tests with supra-aural earphones. The insert-earphone audiogram will become the new reference baseline audiogram for all future hearing tests performed with insert earphones.

B. If an STS is not indicated by the test with supra-aural earphones, the baseline audiogram remains the reference baseline audiogram for all future supra-aural earphone tests, until such time as an STS is observed. In this case, the insert-earphone audiogram taken at the same time will become the new reference baseline audiogram for all future hearing tests performed with insert earphones.

C. Transitioning Employees with Partial Shifts. Employers must account for the workers who are in the process of developing an STS (e.g., demonstrate a 7 dB average shift), but who at the time of the conversion to insert earphones do not have a 10 dB average shift. Employers who want to use insert earphones must enter the 7 dB shift information in the employee's audiometric test records although it is not an ''STS''. When

the next annual audiogram using insert earphones shows an average threshold shift at 2000, 3000 and 4000 Hz of 3 dB, completing the full shift (7 dB + 3 dB), employers must then label that average shift as an STS. This triggers the follow-up procedures at §227.109(h).

VII. Records

All audiograms (including both those produced through the use of insert earphones and supra-aural headsets), calculations, pure-tone individual and average threshold shifts, full STS migrations, and audiometric acoustical calibration records, are to be preserved as records and maintained according to §227.121(c).

Appendix F to Part 227—Calculations and Application of Age Corrections to Audiograms

This appendix is non-mandatory.

In determining whether a standard threshold shift (STS) has occurred, allowance may be made for the contribution of aging to the change in hearing level by adjusting the most recent audiogram. If the employer chooses to adjust the audiogram, the employer shall follow the procedure described below. This procedure and the age correction tables were developed by the National Institute for Occupational Safety and Health in a criteria document. See "Criteria for a Recommended Standard: Occupational Exposure to Noise," Department of Health and Human Services (NIOSH) Publication No. 98–126. For each audiometric test frequency:

I. Determine from Tables F–1 or F–2 the age correction values for the employee by:

A. Finding the age at which the most recent audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz;

B. Finding the age at which the baseline audiogram was taken and recording the corresponding values of age corrections at 1000 Hz through 6000 Hz.

II. Subtract the values found in step (I)(B) from the value found in step (I)(A).

III. The differences calculated in step (II) represented that portion of the change in hearing that may be due to aging.

Example: Employee is a 32-year-old male. The audiometric history for his right ear is shown in decibels below.

Employee's age	Audiometric test frequency (Hz)				
	1000	2000	3000	4000	6000
26	10	5	5	10	5
27*	0	0	0	5	5
28	0	0	0	10	5
29	5	0	5	15	5
30	0	5	10	20	10
31	5	10	20	15	15
32*	5	10	10	25	20

a. The audiogram at age 27 is considered the baseline since it shows the best hearing threshold levels. Asterisks have been used to identify the baseline and most recent audiogram. A threshold shift of 20 dB exists at 4000 Hz between the audiograms taken at ages 27 and 32.

b. (The threshold shift is computed by subtracting the hearing threshold at age 27, which was 5, from the hearing threshold at age 32, which is 25). A retest audiogram has confirmed this shift. The contribution of aging to this change in hearing may be estimated in the following manner:

c. Go to Table F–1 and find the age correction values (in dB) for 4000 Hz at age 27 and age 32.

	Frequency (Hz)				
	1000	2000	3000	4000	6000
Age 32	6	5	7	10	14
Age 27	5	4	6	7	11
Difference	1	1	1	3	3

d. The difference represents the amount of hearing loss that may be attributed to aging in the time period between the baseline audiogram and the most recent audiogram. In this example, the difference at 4000 Hz is 3 dB. This value is subtracted from the hearing level at 4000 Hz, which in the most recent

audiogram is 25, yielding 22 after adjustment. Then the hearing threshold in the baseline audiogram at 4000 Hz (5) is subtracted from the adjusted annual audiogram hearing threshold at 4000 Hz (22). Thus the age-corrected threshold shift would be 17 dB (as opposed to a threshold shift of 20 dB without age correction).

TABLE F–1—AGE CORRECTION VALUES IN DECIBELS FOR MALES

Years	Audiometric test frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	5	3	4	5	8
21	5	3	4	5	8
22	5	3	4	5	8
23	5	3	4	6	9
24	5	3	5	6	9
25	5	3	5	7	10
26	5	4	5	7	10
27	5	4	6	7	11
28	6	4	6	8	11
29	6	4	6	8	12
30	6	4	6	9	12
31	6	4	7	9	13
32	6	5	7	10	14
33	6	5	7	10	14
34	6	5	8	11	15
35	7	5	8	11	15
36	7	5	9	12	16
37	7	6	9	12	17
38	7	6	9	13	17
39	7	6	10	14	18
40	7	6	10	14	19
41	7	6	10	14	20
42	8	7	11	16	20
43	8	7	12	16	21
44	8	7	12	17	22
45	8	7	13	18	23
46	8	8	13	19	24
47	8	8	14	19	24
48	9	8	14	20	25
49	9	9	15	21	26
50	9	9	16	22	27
51	9	9	16	23	28
52	9	10	17	24	29
53	9	10	18	25	30
54	10	10	18	26	31
55	10	11	19	27	32
56	10	11	20	28	34
57	10	11	21	29	35
58	10	12	22	31	36
59	11	12	22	32	37
60 or older	11	13	23	33	38

TABLE F–2—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES

Years	Audiometric test frequencies (Hz)				
	1000	2000	3000	4000	6000
20 or younger	7	4	3	3	6
21	7	4	4	3	6
22	7	4	4	4	6
23	7	5	4	4	7
24	7	5	4	4	7
25	8	5	4	4	7
26	8	5	5	4	8
27	8	5	5	5	8
28	8	5	5	5	8
29	8	5	5	5	9
30	8	6	5	5	9
31	8	6	6	5	9
32	9	6	6	6	10
33	9	6	6	6	10
34	9	6	6	6	10

TABLE F–2—AGE CORRECTION VALUES IN DECIBELS FOR FEMALES—Continued

Years	Audiometric test frequencies (Hz)				
	1000	2000	3000	4000	6000
35	9	6	7	7	11
36	9	7	7	7	11
37	9	7	7	7	12
38	10	7	7	7	12
39	10	7	8	8	12
40	10	7	8	8	13
41	10	8	8	8	13
42	10	8	9	9	13
43	11	8	9	9	14
44	11	8	9	9	14
45	11	8	10	10	15
46	11	9	10	10	15
47	11	9	10	11	16
48	12	9	11	11	16
49	12	9	11	11	16
50	12	10	11	12	17
51	12	10	12	12	17
52	12	10	12	13	18
53	13	10	13	13	18
54	13	11	13	14	19
55	13	11	14	14	19
56	13	11	14	15	20
57	13	11	15	15	20
58	14	12	15	16	21
59	14	12	16	16	21
60 or older	14	12	16	17	22

APPENDIX G TO PART 227—SCHEDULE OF CIVIL PENALTIES

Section	Violation	Willful violation
Subpart A—General		
227.3 Application:		
(b)(4) Failure to meet the required conditions for foreign railroad operations	$2,500	$5,000
Subpart B—General Requirements		
227.103 Noise monitoring program:		
(a) Failure to develop and/or implement a noise monitoring program	7,500	10,000
(b) Failure to use sampling as required	2,500	5,000
(c) Failure to integrate sound levels and/or make noise measurements as required	2,500	5,000
(d) Failure to repeat noise monitoring where required	2,500	5,000
(e) Failure to consider work environments where hearing protectors may be omitted	2,500	5,000
(f) Failure to provide opportunity to observe monitoring	2,000	4,000
(g) Reporting of Monitoring Results:		
(1) Failure to notify monitored employee	2,500	5,000
(2) Failure to post results as required	2,500	5,000
227.105 Protection of employees:		
(a) Failure to provide appropriate protection to exposed employee	7,500	10,000
(b) Failure to observe and document source(s) of noise exposures	2,500	5,000
(c)–(d) Failure to protect employee from impermissible continuous noise	5,000	7,500
227.107 Hearing conservation program:		
(a) Failure to administer a HCP	7,500	10,000
(b) Failure to compute noise exposure as required	3,500	7,000
227.109 Audiometric testing program:		
(a) Failure to establish and/or maintain an audiometric testing program	7,500	10,000
(b) Failure to provide audiometric test at no cost to employee	2,500	5,000
(c) Failure to have qualified person perform audiometric test	2,500	5,000
(d) [Reserved]		
(e) Failure to establish baseline audiogram as required	3,500	7,000
(f) Failure to offer and/or require periodic audiograms as required	2,500	5,000
(g) Failure to evaluate audiogram as required	2,500	5,000
(h) Failure to comply with follow-up procedures as required	2,500	5,000
(i) Failure to use required method for revising baseline audiograms	2,500	5,000
227.111 Audiometric test requirements:		
(a) Failure to conduct test as required	2,500	5,000

Section	Violation	Willful violation
(b) Failure to use required equipment	2,500	5,000
(c) Failure to administer test in room that meets requirements	2,500	5,000
(d) Complete failure to calibrate	5,000	7,500
(1) Failure to perform daily calibration as required	2,000	4,000
(2) Failure to perform annual calibration as required	2,000	4,000
(3) Failure to perform exhaustive calibration as required	2,000	4,000
227.115 Hearing protectors (HP):		
(a) Failure to comply with general requirements	3,000	6,000
(b) Failure to make HP available as required	2,500	5,000
(c) Failure to require use of HP at action level	5,000	7,500
(d) Failure to require use of HP at TWA of 90 dB(A)	5,000	7,500
227.117 Hearing protector attenuation:		
(a) Failure to evaluate attenuation as required	2,500	5,000
(b)–(c) Failure to attenuate to required level	2,500	5,000
(d) Failure to re-evaluate attenuation	2,500	5,000
227.119 Training program:		
(a) Failure to institute a training program as required	5,000	7,500
(b) Failure to provide training within required time frame	2,500	5,000
(c) Failure of program and/or training materials to include required information	2,500	5,000
227.121 Recordkeeping:		
(a) General Requirements:		
(1) Failure to make record available as required	2,500	5,000
(3) Failure to transfer or retain records as required	2,000	4,000
(b)–(f) Records:		
(1) Failure to maintain record or failure to maintain record with required information	2,000	4,000
(2) Failure to retain records for required time period	2,000	4,000

PART 228—HOURS OF SERVICE OF RAILROAD EMPLOYEES

Subpart A—General

Subpart B—Records and Reporting

Subpart C—Construction of Employee Sleeping Quarters

AUTHORITY: 49 U.S.C. 20103, 20107, 21101–21108; 28 U.S.C. 2461, note and 49 CFR 1.49.

SOURCE: 37 FR 12234, June 21, 1972, unless otherwise noted.

Subpart A—General

§ 228.1 Scope.

This part—

(a) Prescribes reporting and record keeping requirements with respect to the hours of service of certain railroad employees; and

(b) Establishes standards and procedures concerning the construction or reconstruction of employee sleeping quarters.

[43 FR 31012, July 19, 1978]

§ 228.3 Application.

(a) Except as provided in paragraph (b), this part applies to all railroads.

(b) This part does not apply to:

(1) A railroad that operates only on track inside an installation which is not part of the general railroad system of transportation; or

(2) Rapid transit operations in an urban area that are not connected with

Section	Violation	Willful violation
(b) Failure to use required equipment	2,500	5,000
(c) Failure to administer test in room that meets requirements	2,500	5,000
(d) Complete failure to calibrate	5,000	7,500
(1) Failure to perform daily calibration as required	2,000	4,000
(2) Failure to perform annual calibration as required	2,000	4,000
(3) Failure to perform exhaustive calibration as required	2,000	4,000
227.115 Hearing protectors (HP):		
(a) Failure to comply with general requirements	3,000	6,000
(b) Failure to make HP available as required	2,500	5,000
(c) Failure to require use of HP at action level	5,000	7,500
(d) Failure to require use of HP at TWA of 90 dB(A)	5,000	7,500
227.117 Hearing protector attenuation:		
(a) Failure to evaluate attenuation as required	2,500	5,000
(b)–(c) Failure to attenuate to required level	2,500	5,000
(d) Failure to re-evaluate attenuation	2,500	5,000
227.119 Training program:		
(a) Failure to institute a training program as required	5,000	7,500
(b) Failure to provide training within required time frame	2,500	5,000
(c) Failure of program and/or training materials to include required information	2,500	5,000
227.121 Recordkeeping:		
(a) General Requirements:		
(1) Failure to make record available as required	2,500	5,000
(3) Failure to transfer or retain records as required	2,000	4,000
(b)–(f) Records:		
(1) Failure to maintain record or failure to maintain record with required information	2,000	4,000
(2) Failure to retain records for required time period	2,000	4,000

PART 228—HOURS OF SERVICE OF RAILROAD EMPLOYEES

Subpart A—General

Subpart B—Records and Reporting

Subpart C—Construction of Employee Sleeping Quarters

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[43 FR 31012, July 19, 1978]

§ 228.3 Application.

(a) Except as provided in paragraph (b), this part applies to all railroads.

(b) This part does not apply to:

(1) A railroad that operates only on track inside an installation which is not part of the general railroad system of transportation; or

(2) Rapid transit operations in an urban area that are not connected with

the general railroad system of transportation.

[54 FR 33229, Aug. 14, 1989]

§ 228.5 Definitions.

As used in this part:

(a) *Administrator* means the Administrator of the Federal Railroad Administrator or any person to whom he delegated authority in the matter concerned.

(b) *Carrier*, *common carrier*, and *common carrier engaged in interstate or foreign commerce by railroad* mean *railroad* as that term is defined below.

(c) *Employee* means an individual employed by the common carrier who (1) is actually engaged in or connected with the movement of any train, including a person who performs the duties of a hostler, (2) dispatches, reports, transmits, receives, or delivers orders pertaining to train movements by the use of telegraph, telephone, radio, or any other electrical or mechanical device, or (3) is engaged in installing, repairing or maintaining signal systems.

(d) *Railroad* means all forms of nonhighway ground transportation that run on rails or electromagnetic guideways, including (1) commuter or other short-haul rail passenger service in a metropolitan or suburban area, and (2) high speed ground transportation systems that connect metropolitan areas, without regard to whether they use new technologies not associated with traditional railroads. Such term does not include rapid transit operations within an urban area that are not connected to the general railroad system of transportation.

[54 FR 33229, Aug. 14, 1989]

Subpart B—Records and Reporting

§ 228.7 Hours of duty.

(a) For purposes of this part, time on duty of an employee actually engaged in or connected with the movement of any train, including a hostler, begins when he reports for duty and ends when he is finally released from duty, and includes—

(1) Time engaged in or connected with the movement of any train;

(2) Any interim period available for rest at a location that is not a designated terminal;

(3) Any interim period of less than 4 hours available for rest at a designated terminal;

(4) Time spent in deadhead transportation en route to a duty assignment; and

(5) Time engaged in any other service for the carrier.

Time spent in deadhead transportation by an employee returning from duty to his point of final release may not be counted in computing time off duty or time on duty.

(b) For purposes of this part, time on duty of an employee who dispatches, reports, transmits, receives, or delivers orders pertaining to train movements by use of telegraph, telephone, radio, or any other electrical or mechanical device includes all time on duty in other service performed for the common carrier during the 24-hour period involved.

(c) For purposes of this part, time on duty of an employee who is engaged in installing, repairing or maintaining signal systems includes all time on duty in other service performed for a common carrier during the 24-hour period involved.

[37 FR 12234, June 21, 1972, as amended at 43 FR 3124, Jan. 23, 1978]

§ 228.9 Railroad records; general.

(a) Records maintained under this part shall be—

(1) Signed by the employee whose time on duty is being recorded or, in the case of train and engine crews, signed by the ranking crew member;

(2) Retained for 2 years; and

(3) Available for inspection and copying by the Administrator during regular business hours.

(b) [Reserved]

§ 228.11 Hours of duty records.

(a) Each carrier shall keep a record of the following information concerning the hours of duty of each employee:

(1) Identification of employee.

(2) Place, date, and beginning and ending times for hours of duty in each occupation.

(3) Total time on duty in all occupations.
(4) Number of consecutive hours off duty prior to going on duty.
(5) Beginning and ending times of periods spent in transportation, other than personal commuting, to or from a duty assignment and mode of transportation (train, track car, carrier motor vehicle, personal automobile, etc.).
(b) [Reserved]

[37 FR 12234, June 21, 1972, as amended at 43 FR 3124, Jan. 23, 1978]

§ 228.17 Dispatcher's record of train movements.

(a) Each carrier shall keep, for each dispatching district, a record of train movements made under the direction and control of a dispatcher who uses telegraph, telephone, radio, or any other electrical or mechanical device to dispatch, report, transmit, receive, or deliver orders pertaining to train movements. The following information shall be included in the record:
(1) Identification of timetable in effect.
(2) Location and date.
(3) Identification of dispatchers and their times on duty.
(4) Weather conditions at 6-hour intervals.
(5) Identification of enginemen and conductors and their times on duty.
(6) Identification of trains and engines.
(7) Station names and office designations.
(8) Distances between stations.
(9) Direction of movement and the time each train passes all reporting stations.
(10) Arrival and departure times of trains at all reporting stations.
(11) Unusual events affecting movement of trains and identification of trains affected.
(b) [Reserved]

§ 228.19 Monthly reports of excess service.

(a) Each carrier shall report to the Associate Administrator for Safety, (RRS–1), Federal Railroad Administration, Washington, DC 20590, each of the following instances within 30 days after the calendar month in which the instance occurs:

(1) A member of a train or engine crew or other employee engaged in or connected with the movement of any train, including a hostler, is on duty for more than 12 consecutive hours.
(2) A member of a train or engine crew or other employee engaged in or connected with the movement of any train, including a hostler, returns to duty after 12 hours of continuous service without at least 10 consecutive hours off duty.
(3) A member of a train or engine crew or other employee engaged in or connected with the movement of any train, including a hostler, continues on duty without at least 8 consecutive hours off duty during the preceding 24 hours. [1]
(4) A member of a train or engine crew or other employee engaged in or connected with the movement of any train, including a hostler, returns to duty without at least 8 consecutive hours off duty during the preceding 24 hours. [1]
(5) An employee who transmits, receives, or delivers orders affecting train movements is on duty for more than 9 hours in any 24-hour period at an office where two or more shifts are employed.
(6) An employee who transmits, receives, or delivers orders affecting train movements is on duty for more than 12 hours in any 24-hour period at any office where one shift is employed.
(7) An employee engaged in installing, repairing or maintaining signal systems is on duty for more than 12 hours in a twenty-four hour period.
(8) An employee engaged in installing, repairing or maintaining signal systems returns to duty after 12 hours of continuous service without at least 10 consecutive hours off duty.

[1] Instances involving tours of duty that are broken by four or more consecutive hours off duty time at a designated terminal which do not constitute more than a total of 12 hours time on duty are not required to be reported, provided such tours of duty are immediately preceded by 8 or more consecutive hours off-duty time. Instances involving tours of duty that are broken by less than 8 consecutive hours off duty which constitute more than a total of 12 hours time on duty must be reported.

(9) An employee engaged in installing, repairing or maintaining signal systems continues on duty without at least 8 consecutive hours off duty during the preceding 24 hours.

(10) An employee engaged in installing, repairing or maintaining signal systems returns to duty without at least 8 consecutive hours off duty during the preceding 24 hours.

(b) Reports required by paragraph (a) of this section shall be filed in writing on FRA Form F–6180–3[2] with the Office of Safety, Federal Railroad Administration, Washington, DC 20590. A separate form shall be used for each instance reported.

[37 FR 12234, June 21, 1972, as amended at 43 FR 3124, Jan. 23, 1978]

§ 228.21 Civil penalty.

Any person (an entity of any type covered under 1 U.S.C. 1, including but not limited to the following: a railroad; a manager, supervisor, official, or other employee or agent of a railroad; any owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; any independent contractor providing goods or services to a railroad; and any employee of such owner, manufacturer, lessor, lessee, or independent contractor) who violates any requirement of this part or causes the violation of any such requirement is subject to a civil penalty of at least $550 and not more than $11,000 per violation, except that: Penalties may be assessed against individuals only for willful violations, and, where a grossly negligent violation or a pattern of repeated violations has created an imminent hazard of death or injury to persons, or has caused death or injury, a penalty not to exceed $27,000 per violation may be assessed. Each day a violation continues shall constitute a separate offense. See appendix B to this part for a statement of agency civil penalty policy. Violations of the Hours of Service Act itself (*e.g.*, requiring an employee to work excessive hours or beginning construction of a sleeping quarters subject to approval under subpart C of this part without prior approval) are subject to penalty under that Act's penalty provision, 45 U.S.C. 64a.

[53 FR 52931, Dec. 29, 1988, as amended at 63 FR 11622, Mar. 10, 1998; 69 FR 30594, May 28, 2004]

EFFECTIVE DATE NOTE: At 72 FR 51197, Sept. 6, 2007, § 228.21 was amended by removing the numerical amount "$11,000" and adding in its place the numerical amount "$16,000", effective October 9, 2007.

§ 228.23 Criminal penalty.

Any person who knowingly and willfully falsifies a report or record required to be kept under this part or otherwise knowingly and willfully violates any requirement of this part may be liable for criminal penalties of a fine up to $5,000, imprisonment for up to two years, or both, in accordance with 45 U.S.C. 438(e).

[53 FR 52931, Dec. 29, 1988]

Subpart C—Construction of Employee Sleeping Quarters

SOURCE: 43 FR 31012, July 19, 1978, unless otherwise noted.

§ 228.101 Distance requirement; definitions.

(a) The Hours of Service Act, as amended (45 U.S.C. 61–64b), makes it unlawful for any common carrier engaged in interstate or foreign commerce by railroad to begin, on or after July 8, 1976, the construction or reconstruction of sleeping quarters for employees who perform duties covered by the act "within or in the immediate vicinity (as determined in accordance with rules prescribed by the Secretary of Transportation) of any area where railroad switching or humping operations are performed." 45 U.S.C. 62(a)(4). This subpart sets forth (1) a general definition of "immediate vicinity" (§ 228.101(b)), (2) procedures under which a carrier may request a determination by the Federal Railroad Administration that a particular proposed site is not within the "immediate vicinity" of railroad switching or humping operations (§§ 228.103 and 228.105), and (3) the basic criteria utilized in evaluating proposed sites (§ 228.107).

[2] Form may be obtained from the Office of Safety, Federal Railroad Administration, Washington, DC 20590. Reproduction is authorized.

(b) Except as determined in accordance with the provisions of this subpart. ''The immediate vicinity'' shall mean the area within one-half mile (2,640 feet) (804 meters) of switching or humping operations as measured from the nearest rail of the nearest trackage where switching or humping operations are performed to the point on the site where the carrier proposes to construct or reconstruct the exterior wall of the structure, or portion of such wall, which is closest to such operations.

(c) As used in this subpart—

(1) *Construction* shall refer to the—

(i) Creation of a new facility;

(ii) Expansion of an existing facility;

(iii) Placement of a mobile or modular facility; or

(iv) Acquisition and use of an existing building.

(2) *Reconstruction* shall refer to the—

(i) Replacement of an existing facility with a new facility on the same site; or

(ii) Rehabilitation or improvement of an existing facility (normal periodic maintenance excepted) involving the expenditure of an amount representing more than 50 percent of the cost of replacing such facility on the same site at the time the work of rehabilitation or improvement began, the replacement cost to be estimated on the basis of contemporary construction methods and materials.

(3) *Switching or humping operations* includes the classification of placarded railroad cars according to commodity or destination, assembling of placarded cars for train movements, changing the position of placarded cars for purposes of loading, unloading, or weighing, and the placing of placarded cars for repair. However, the term does not include the moving of rail equipment in connection with work service, the moving of a train or part of a train within yard limits by a road locomotive or placing locomotives or cars in a train or removing them from a train by a road locomotive while en route to the train's destination. The term does include operations within this definition which are conducted by any railroad; it is not limited to the operations of the carrier contemplating construction or reconstruction of railroad employee sleeping quarters.

(4) *Placarded car* shall mean a railroad car required to be placarded by the Department of Transportation hazardous materials regulations (49 CFR 172.504).

(5) The term L_{eq} (8) shall mean the equivalent steady state sound level which in 8 hours would contain the same acoustic energy as the time-varying sound level during the same time period.

§ 228.103 Approval procedure: construction within one-half mile (2,640 feet) (804 meters).

(a) A common carrier that has developed plans for the construction or reconstruction of sleeping quarters subject to this subpart and which is considering a site less than one-half mile (2,640 feet) (804 meters) from any area where switching or humping operations are performed, measured from the nearest rail of the nearest trackage utilized on a regular or intermittent basis for switching or humping operations to the point on the site where the carrier proposes to construct or reconstruct the exterior wall of the structure, or portion of such wall, which is closest to such operations, must obtain the approval of the Federal Railroad Administration before commencing construction or reconstruction on that site. Approval may be requested by filing a petition conforming to the requirements of this subpart.

(b) A carrier is deemed to have conducted switching or humping operations on particular trackage within the meaning of this subpart if placarded cars are subjected to the operations described in §228.101(c)(3) within the 365-day period immediately preceding the date construction or reconstruction is commenced or if such operations are to be permitted on such trackage after such date. If the carrier does not have reliable records concerning the traffic handled on the trackage within the specified period, it shall be presumed that switching of placarded cars is conducted at the location and construction or reconstruction of sleeping quarters within one-half mile shall be subject to the approval procedures of this subpart.

(c) A petition shall be filed in triplicate with the Secretary, Railroad Safety Board, Federal Railroad Administration, Washington, DC 20590 and shall contain the following:

(1) A brief description of the type of construction planned, including materials to be employed, means of egress from the quarters, and actual and projected exterior noise levels and projected interior noise levels;

(2) The number of employees expected to utilize the quarters at full capacity;

(3) A brief description of the site, including:

(i) Distance from trackage where switching or humping operations are performed, specifying distances from particular functions such as classification, repair, assembling of trains from large groups of cars, etc. cetera;

(ii) Topography within a general area consisting of the site and all of the rail facilities close to the site;

(iii) Location of other physical improvements situated between the site and areas where railroad operations are conducted;

(4) A blueprint or other drawing showing the relationship of the site to trackage and other planned and existing facilities;

(5) The proposed or estimated date for commencement of construction;

(6) A description of the average number and variety of rail operations in the areas within one-half mile (2,640 feet) (804 meters) of the site (e.g., number of cars classified in 24-hour period; number of train movements);

(7) An estimate of the average daily number of placarded rail cars transporting hazardous materials through the railroad facility (where practicable, based on a 365-day period sample, that period not having ended more than 120 days prior to the date of filing the petition), specifying the—

(i) Number of such cars transporting class A explosives and poison gases; and

(ii) Number of DOT Specification 112A and 114A tank cars transporting flammable gas subject to FRA emergency order No. 5;

(8) A statement certified by a corporate officer of the carrier possessing authority over the subject matter explaining any plans of that carrier for utilization of existing trackage, or for the construction of new trackage, which may impact on the location of switching or humping operations within one-half mile of the proposed site (if there are no plans, the carrier official must so certify); and

(9) Any further information which is necessary for evaluation of the site.

(d) A petition filed under this section must contain a statement that the petition has been served on the recognized representatives of the railroad employees who will be utilizing the proposed sleeping quarters, together with a list of the employee representatives served.

§ 228.105 Additional requirements; construction within one-third mile (1,760 feet) (536 meters) of certain switching.

(a) In addition to providing the information specified by § 228.103, a carrier seeking approval of a site located within one-third mile (1,760 feet) (536 meters) of any area where railroad switching or humping operations are performed involving any cars required to be placarded ''EXPLOSIVES A'' or ''POISON GAS'' or any DOT Specification 112A or 114A tank cars transporting flammable gas subject to FRA emergency order No. 5 shall establish by a supplementary statement certified by a corporate officer possessing authority over the subject matter that—

(1) No feasible alternate site located at or beyond one-third mile from switching or humping operations is either presently available to the railroad or is obtainable within 3 miles (15,840 feet) (4,827 meters) of the reporting point for the employees who are to be housed in the sleeping quarters;

(2) Natural or other barriers exist or will be created prior to occupancy of the proposed facility between the proposed site and any areas in which switching or humping operations are performed which will be adequate to shield the facility from the direct and severe effects of a hazardous materials accident/incident arising in an area of switching or humping operations;

(3) The topography of the property is such as most likely to cause any hazardous materials unintentionally released during switching or humping to flow away from the proposed site; and

(4) Precautions for ensuring employee safety from toxic gases or explosions such as employee training and evacuation plans, availability of appropriate respiratory protection, and measures for fire protection, have been considered.

(b) In the absence of reliable records concerning traffic handled on trackage within the one-third mile area, it shall be presumed that the types of cars enumerated in paragraph (a) of this section are switched on that trackage; and the additional requirements of this section shall be met by the petitioning carrier, unless the carrier establishes that the switching of the enumerated cars will be effectively barred from the trackage if the petition is approved.

§ 228.107 Action on petition.

(a) Each petition for approval filed under § 228.103 is referred to the Railroad Safety Board for action in accordance with the provisions of part 211, title 49, CFR, concerning the processing of requests for special approvals.

(b) In considering a petition for approval filed under this subpart, the Railroad Safety Board evaluates the material factors bearing on—

(1) The safety of employees utilizing the proposed facility in the event of a hazardous materials accident/incident and in light of other relevant safety factors; and

(2) Interior noise levels in the facility.

(c) The Railroad Safety Board will not approve an application submitted under this subpart if it appears from the available information that the proposed sleeping quarters will be so situated and constructed as to permit interior noise levels due to noise under the control of the railroad to exceed an $L_{eq}(8)$ value of 55dB(A). If individual air conditioning and heating systems are to be utilized, projections may relate to noise levels with such units turned off.

(d) Approval of a petition filed under this subpart may be withdrawn or modified at any time if it is ascertained, after opportunity for a hearing, that any representation of fact or intent made by a carrier in materials submitted in support of a petition was not accurate or truthful at the time such representation was made.

APPENDIX A TO PART 228—REQUIREMENTS OF THE HOURS OF SERVICE ACT: STATEMENT OF AGENCY POLICY AND INTERPRETATION

First enacted in 1907, the Hours of Service Act was substantially revised in 1969 by Public Law 91–169. Further amendments were enacted as part of the Federal Railroad Safety Authorization Act of 1976, Public Law 94–348 and by the Rail Safety Improvement Act of 1988, Public Law 100–342. The purpose of the law is "to promote the safety of employees and travelers upon railroads by limiting the hours of service of employees * * *." This appendix is designed to explain the effect of the law in commonly-encountered situations.

The Act governs the maximum work hours of employees engaged in one or more of the basic categories of covered service treated below. If an individual performs more than one kind of covered service during a tour of duty, then the most restrictive of the applicable limitations control.

The act applies to any railroad, as that term is defined in 45 U.S.C. 431(e). It governs the carrier's operations over its own railroad and all lines of road which it uses.

TRAIN AND ENGINE SERVICE

Covered Service. Train or engine service refers to the actual assembling or operation of trains. Employees who perform this type of service commonly include locomotive engineers, firemen, conductors, trainmen, switchmen, switchtenders (unless their duties come under the provisions of section 3) and hostlers. With the passage of the 1976 amendments, both inside and outside hostlers are considered to be connected with the movement of trains. Previously, only outside hostlers were covered. Any other employee who is actually engaged in or connected with the movement of any train is also covered, regardless of his job title.

Limitations on Hours. The Act establishes two limitations on hours of service. First, no employee engaged in train or engine service may be required or permitted to work in excess of twelve consecutive hours. After working a full twelve consecutive hours, an employee must be given at least ten consecutive hours off duty before being permitted to return to work.

Second, no employee engaged in train or engine service may be required or permitted to continue on duty or go on duty unless he has had at least eight consecutive hours off

duty within the preceding twenty-four hours. This latter limitation, when read in conjunction with the requirements with respect to computation of duty time (discussed below) results in several conclusions:

(1) When an employee's work tour is broken or interrupted by a valid period of interim release (4 hours or more at a designated terminal), he may return to duty for the balance of the total 12-hour work tour during a 24-hour period.

(2) After completing the 12 hours of broken duty, or at the end of the 24-hour period, whichever occurs first, the employee may not be required or permitted to continue on duty or to go on duty until he has had at least 8 consecutive hours off duty.

(3) The 24-hour period referred to in paragraphs 1 and 2 above shall begin upon the commencement of a work tour by the employee immediately after his having received a statutory off-duty period of 8 or 10 hours as appropriate.

Duty time and effective periods of release. On-duty time commences when an employee reports at the time and place specified by the railroad and terminates when the employee is finally released of all responsibilities. (Time spent in deadhead transportation to a duty assignment is also counted as time on duty. See discussion below.) Any period available for rest that is of four or more hours and is at a designated terminal is off-duty time. All other periods available for rest must be counted as time on duty under the law, regardless of their duration.

The term ''designated terminal'' means a terminal (1) which is designated in or under a collective bargaining agreement as the ''home'' or ''away-from-home'' terminal for a particular crew assignment and (2) which has suitable facilities for food and lodging. Carrier and union representatives may agree to establish additional designated terminals having such facilities as points of effective release under the Act. Agreements to designate additional terminals for purposes of release under the Act should be reduced to writing and should make reference to the particular assignments affected and to the Hours of Service Act. The following are common situations illustrating the designated terminal concept:

(1) A freight or passenger road crew operates a train from home terminal ''A'' to away-from-home terminal ''B'' (or the reverse). Terminals ''A'' and ''B'' would normally be the designated terminals for this specific crew assignment. However, carrier and employee representatives may agree to designate additional terminals having suitable facilities for food and lodging as appropriate points of release under the Hours of Service Act.

(2) A road crew operates a train in turn-around service from home terminal ''A'' to turn-around point ''B'' and back to ''A''. Terminal ''A'' is the only designated terminal for this specific crew assignment, unless carrier and employee representatives have agreed to designate additional terminals having suitable facilities for food and lodging.

(3) A crew is assigned to operate a maintenance-of-way work train from home terminal ''A'', work on line of road and tie up for rest along the line of road at point ''B''. Home terminal ''A'' and tie-up point ''B'' both qualify as designated terminals for this specific work train crew assignment. Of course, suitable facilities for food and lodging must be available at tie-up point ''B''.

Deadheading. Under the Act time spent in deadhead transportation receives special treatment. Time spent in deadhead transportation to a duty assignment by a train or engine service employee is considered on-duty time. Time spent in deadhead transportation from the final duty assignment of the work tour to the point of final release is not computed as either time on duty or time off duty. Thus, the period of deadhead transportation to point of final release may not be included in the required 8- or 10-hour off-duty period. Time spent in deadhead transportation to a duty assignment is calculated from the time the employee reports for deadhead until he reaches his duty assignment.

All time spent awaiting the arrival of a deadhead vehicle for transportation from the final duty assignment of the work tour to the point of final release is considered limbo time, *i.e.*, neither time on duty nor time off duty, provided that the employee is given no specific responsibilities to perform during this time. However, if an employee is required to perform service of any kind during that period (*e.g.*, protecting the train against vandalism, observing passing trains for any defects or unsafe conditions, flagging, shutting down locomotives, checking fluid levels, or communicating train consist information via radio), he or she will be considered as on duty until all such service is completed. Of course, where a railroad carrier's operating rules clearly relieve the employee of all duties during the waiting period and no duties are specifically assigned, the waiting time is not computed as either time on duty or time off duty.

Transit time from the employee's residence to his regular reporting point is not considered deadhead time.

If an employee utilizes personal automobile transportation to a point of duty assignment other than the regular reporting point in lieu of deadhead transportation provided by the carrier, such actual travel time is considered as deadheading time. However, if the actual travel time from his home to the point of duty assignment exceeds a reasonable travel time from the regular reporting point to the point of duty assignment,

then only the latter period is counted. Of course, actual travel time must be reasonable and must not include diversions for personal reasons.

Example: Employee A receives an assignment from an ''extra board'' located at his home terminal to protect a job one hour's drive from the home terminal. In lieu of transporting the employee by carrier conveyance, the railroad pays the employee a fixed amount to provide his own transportation to and from the outlying point. The employee is permitted to go directly from his home to the outlying point, a drive which takes 40 minutes. The normal driving time between his regular reporting point at his home terminal and the outlying point is 60 minutes. The actual driving time, 40 minutes is considered deadhead time and is counted as time on duty under the Act.

Employee A performs local switching service at the outlying point. When the employee returns from the outlying point that evening, and receives an ''arbitrary'' payment for his making the return trip by private automobile, 40 minutes of his time in transportation home is considered deadheading to point of final release and is not counted as either time on duty or time off duty.

Wreck and relief trains. Prior to the 1976 amendments, crews of wreck and relief trains were exempted entirely from the limitations on hours of service. Under present law that is no longer the case. The crew of a wreck or relief train may be permitted to be on duty for not to exceed 4 additional hours in any period of 24 consecutive hours whenever an actual emergency exists and the work of the crew is related to that emergency. Thus, a crew could work up to 16 hours, rather than 12. The Act specifies that an emergency ceases to exist for purposes of this provision when the track is cleared and the line is open for traffic. An ''emergency'' for purposes of wreck or relief service may be a less extraordinary or catastrophic event than an ''unavoidable accident or Act of God'' under section 5(d) of the Act.

Example: The crew of a wreck train is dispatched to clear the site of a derailment which has just occurred on a main line. The wreck crew re-rails or clears the last car and the maintenance of way department releases the track to the operating department 14 hours and 30 minutes into the duty tour. Since the line is not clear until the wreck train is itself out of the way, the crew may operate the wreck train to its terminal, provided this can be accomplished within the total of 16 hours on duty.

Emergencies. The Act contains no general exception using the term ''emergency'' with respect to train or engine service or related work. See ''casualties,'' etc., under ''General Provisions''.

COMMUNICATION OF TRAIN ORDERS

Covered Service. The handling of orders governing the movement of trains is the second type of covered service. This provision of the Act applies to any operator, train dispatcher or other employee who by the use of the telegraph, telephone, radio, or any other electical or mechanical device dispatches, reports, transmits, receives, or delivers orders pertaining to or affecting train movements.

The approach of the law is functional. Thus, though a yardmaster normally is not covered by this provision, a yardmaster or other employee who performs any of the specified service during a duty tour is subject to the limitations on service for that entire tour.

Limitations on hours. No employee who performs covered service involving communication of train orders may be required or permitted to remain on duty for more than nine hours, whether consecutive or in the aggregate, in any 24-hour period in any office, tower, station or place where two or more shifts are employed. Where only one shift is employed, the employee is restricted to 12 hours consecutively or in the aggregate during any 24-hour period.

The provision on emergencies, discussed below, may extend the permissible hours of employees performing this type of service.

Shifts. The term ''shift'' is not defined by the Act, but the legislative history of the 1969 amendments indicates that it means a tour of duty constituting a day's work for one or more employee performing the same class of work at the same station who are scheduled to begin and end work at the same time. The following are examples of this principle:

Scheduled Hours	Classification
7 a.m. to 3 p.m	1 shift.
7 a.m. to 12:30 p.m. 1:30 p.m. to 8 p.m. (Schedule for one employee including one hour lunch period).	Do.
7 a.m. to 3 p.m. 7 a.m. to 3 p.m. (Two employees scheduled).	Do.
7 a.m. to 3 p.m. 8 a.m. to 4 p.m. (Two employees scheduled).	2 shifts.

Duty time and effective periods of release. If, after reporting to his place of duty, an employee is required to perform duties at other places during this same tour of duty, the time spent traveling between such places is considered as time on duty. Under the traditional administrative interpretation of section 3, other periods of transportation are viewed as personal commuting and, thus, off-duty time.

A release period is considered off-duty time if it provides a meaningful period of relaxation and if the employee is free of all responsibilities to the carrier. One hour is the

minimum acceptable release period for this type of covered service.

Emergencies. The section of the Act dealing with dispatchers, operators, and others who transmit or receive train orders contains its own emergency provision. In case of emergency, an employee subject to the 9 or 12-hour limitation is permitted to work an additional four hours in any 24-hour period, but only for a maximum of three days in any period of seven consecutive days. However, even in an emergency situation the carrier must make reasonable efforts to relieve the employee.

GENERAL PROVISIONS

(APPLICABLE TO ALL COVERED SERVICE)

Commingled Service. All duty time for a railroad even though not otherwise subject to the Act must be included when computing total on-duty time of an individual who performs one or more of the type of service covered by the Act. This is known as the principle of ''commingled service''.

For example, if an employee performs duty for 8 hours as a trainman and then is used as a trackman (not covered by the law) in the same 24-hour period, total on-duty time is determined by adding the duty time as trackman to that as trainman. The law does not distinguish treatment of situations in which non-covered service follows, rather than precedes, covered service. The limitations on total hours apply on both cases. It should be remembered that attendance at required rules classes is duty time subject to the provisions on ''commingling''. Similarly, where a carrier compels attendance at a disciplinary proceeding, time spent in attendance is subject to the provisions on commingling.

When an employee performs service covered by more than one restrictive provision, the most restrictive provision determines the total lawful on-duty time. Thus, when an employee performs duty in train or engine service and also as an operator, the provisions of the law applicable to operators apply to all on-duty and off-duty periods during such aggregate time. However, an employee subject to the 12 hour provision of section 2 of the law does not become subject to the 9 or 12-hour provisions of section 3 merely because he receives, transmits or delivers orders pertaining to or affecting the movement of his train in the course of his duties as a trainman.

Casualties, Unavoidable Accidents, Acts of God. Section 5(d) of the Act states the following: ''The provisions of this Act shall not apply in any case of casualty or unavoidable accident or the Act of God; nor where the delay was the result of a cause not known to the carrier or its officer or agent in charge of the employee at the time said employee left a terminal, and which could not have been foreseen.'' This passage is commonly referred to as the ''emergency provision''. Judicial construction of this sentence has limited the relief which it grants to situations which are truly unusual and exceptional. The courts have recognized that delays and operational difficulties are common in the industry and must be regarded as entirely foreseeable; otherwise, the Act will provide no protection whatsoever. Common operational difficulties which do not provide relief from the Act include, but are not limited to, broken draw bars, locomotive malfunctions, equipment failures, brake system failures, hot boxes, unexpected switching, doubling hills and meeting trains. Nor does the need to clear a main line or cut a crossing justify disregard of the limitations of the Act. Such contingencies must normally be anticipated and met within the 12 hours. Even where an extraordinary event or combination of events occurs which, by itself, would be sufficient to permit excess service, the carrier must still employ due diligence to avoid or limit such excess service. The burden of proof rests with the carrier to establish that excess service could not have been avoided.

Sleeping Quarters. Under the 1976 amendments to the Act it is unlawful for any common carrier to provide sleeping quarters for persons covered by the Hours of Service Act which do not afford such persons an opportunity for rest, free from interruptions caused by noise under the control of the railroad, in clean, safe, and sanitary quarters. Such sleeping quarters include crew quarters, camp or bunk cars, and trailers.

Sleeping quarters are not considered to be ''free from interruptions caused by noise under the control of the railroad'' if noise levels attributable to noise sources under the control of the railroad exceed an $L_{eq}(8)$ value of 55dB(A).

FRA recognizes that camp cars, either because of express limitations of local codes or by virtue of their physical mobility, cannot, for practical purposes, be subject to state or local housing, sanitation, health, electrical, or fire codes. Therefore, FRA is unable to rely upon state or local authorities to ensure that persons covered by the Act who reside in railroad-provided camp cars are afforded an opportunity for rest in ''clean, safe, and sanitary'' conditions. Accordingly, the guidelines in appendix C to this part 228 will be considered by FRA as factors to be used in applying the concepts of ''clean,'' ''safe,'' and ''sanitary'' to camp cars provided by railroads for the use of employees covered by section 2(a)(3) of the Act. Failure to adhere to these guidelines might interfere with the ordinary person's ability to rest.

Collective Bargaining. The Hours of Service Act prescribes the maximum permissible hours of service consistent with safety. However, the Act does not prohibit collective

bargaining for shorter hours of service and time on duty.

Penalty. As amended by the Rail Safety Improvement Act of 1988 and the Rail Safety Enforcement and Review Act of 1992, the penalty provisions of the law apply to any person (an entity of any type covered under 1 U.S.C. 1, including but not limited to the following: a railroad; a manager, supervisor, official, or other employee or agent of a railroad; any owner, manufacturer, lessor, or lessee of railroad equipment, track, or facilities; any independent contractor providing goods or services to a railroad; and any employee of such owner, manufacturer, lessor, lessee, or independent contractor), except that a penalty may be assessed against an individual only for a willful violation. See appendix A to 49 CFR part 209. For violations that occurred on September 3, 1992, a person who violates the Act is liable for a civil penalty, as the Secretary of Transportation deems reasonable, in an amount not less than $500 nor more than $11,000, except that where a grossly negligent violation or a pattern of repeated violations has created an imminent hazard of death or injury to persons, or has caused death or injury, a penalty not to exceed $22,000 may be assessed. The Federal Civil Penalties Inflation Adjustment Act of 1990 as amended by the Debt Collection Improvement Act of 1996 required agencies to increase the maximum civil monetary penalty for inflation. The amounts increased from $10,000 to $11,000 and from $20,000 to $22,000 respectively. According to the same law, in 2004, the minimum penalty of $500 was raised to $550, and the maximum penalty for a grossly negligent violation or a pattern of repeated violations that has caused an imminent hazard of death or injury to individuals or has caused death or injury, was increased from $22,000 to $27,000. The $11,000 maximum penalty was not adjusted.

Each employee who is required or permitted to be on duty for a longer period than prescribed by law or who does not receive a required period of rest represents a separate and distinct violation and subjects the railroad to a separate civil penalty. In the case of a violation of section 2(a)(3) or (a)(4) of the Act, each day a facility is in noncompliance constitutes a separate offense and subjects the railroad to a separate civil penalty.

In compromising a civil penalty assessed under the Act, FRA takes into account the nature, circumstances, extent, and gravity of the violation committed, and, with respect to the person found to have committed such violation, the degree of culpability, any history of prior or subsequent offenses, ability to pay, effect on ability to continue to do business and such other matters as justice may require.

Statute of limitations. No suit may be brought after the expiration of two years from the date of violation unless administrative notification of the violation has been provided to the person to be charged within that two year period. In no event may a suit be brought after expiration of the period specified in 28 U.S.C. 2462.

Exemptions. A railroad which employs not more than 15 persons covered by the Hours of Service Act (including signalmen and hostlers) may be exempted from the law's requirements by the FRA after hearing and for good cause shown. The exemption must be supported by a finding that it is in the public interest and will not adversely affect safety. The exemption need not relate to all carrier employees. In no event may any employee of an exempt railroad be required or permitted to work beyond 16 hours continuously or in the aggregate within any 24-hour period. Any exemption is subject to review at least annually.

[42 FR 27596, May 31, 1977, as amended at 43 FR 30804, July 18, 1978; 53 FR 28601, July 28, 1988; 55 FR 30893, July 27, 1990; 58 FR 18165, Apr. 8, 1993; 61 FR 20495, May 7, 1996; 63 FR 11622, Mar. 10, 1998; 69 FR 30594, May 28, 2004]

EFFECTIVE DATE NOTE: At 72 FR 51197, Sept. 6, 2007, the ninth paragraph below the heading ''General Provisions,'' which is entitled ''Penalty'' in appendix A to part 228 was amended adding a sentence to end, effective October 9, 2007. For the convenience of the user, the added text is set forth as follows:

APPENDIX A TO PART 228—REQUIREMENTS OF THE HOURS OF SERVICE ACT: STATEMENT OF AGENCY POLICY AND INTERPRETATION

* * * * *

Penalty. * * * Effective October 9, 2007, the ordinary maximum penalty of $11,000 was raised to $16,000 as required under the law; however, the minimum penalty and the maximum penalty for a grossly negligent violation did not need to be adjusted.

APPENDIX B TO PART 228—SCHEDULE OF CIVIL PENALTIES [1]

Section	Violation	Willful violation
Subpart B—Records and Reporting:		
228.9 Railroad records	$500	$1,000
228.11 Hours of duty records	500	1,000
228.17 Dispatcher's record	500	1,000
228.19 Monthly reports of excess service	1,000	2,000

[1] A penalty may be assessed against an individual only for a willful violation. The Administrator reserves the right to assess a penalty of up to $27,000 for any violation where circumstances warrant. See 49 CFR part 209, appendix A.

[53 FR 52931, Dec. 29, 1988, as amended at 69 FR 30594, May 28, 2004]

APPENDIX C TO PART 228—GUIDELINES FOR CLEAN, SAFE, AND SANITARY RAILROAD PROVIDED CAMP CARS

1. *Definitions applicable to these Guidelines.*

(a) *Camp Cars* mean trailers and on-track vehicles, including outfit, camp, or bunk cars or modular homes mounted on flat cars, used to house or accommodate railroad employees. Wreck trains are not included.

(b) *Employee* means any worker whose service is covered by the Hours of Service Act or who is defined as an employee for purposes of section 2(a)(3) of that Act.

(c) *Lavatory* means a basin or similar vessel used primarily for washing of the hands, arms, face, and head.

(d) *Nonwater carriage toilet facility* means a toilet facility not connected to a sewer.

(e) *Number of employees* means the number of employees assigned to occupy the camp cars.

(f) *Personal service room* means a room used for activities not directly connected with the production or service function performed by the carrier establishment. Such activities include, but are not limited to, first-aid, medical services, dressing, showering, toilet use, washing, and eating.

(g) *Potable water* means water that meets the quality standards prescribed in the U.S. Public Health Service Drinking Water Standards, published at 42 CFR part 72, or is approved for drinking purposes by the State or local authority having jurisdiction.

(h) *Toilet facility* means a fixture maintained within a toilet room for the purpose of defecation or urination, or both.

(i) *Toilet room* means a room maintained within or on the premises containing toilet facilities for use by employees.

(j) *Toxic material* means a material in concentration or amount of such toxicity as to constitute a recognized hazard that is causing or is likely to cause death or serious physical harm.

(k) *Urinal* means a toilet facility maintained within a toilet room for the sole purpose of urination.

(l) *Water closet* means a toilet facility maintained within a toilet room for the purpose of both defecation and urination and which is flushed with water.

(m) *Leq* (8) means the equivalent steady sound level which in 8 hours would contain the same acoustic energy as the time-varying sound level during the same time period.

2. *Housekeeping.*

(a) All camp cars should be kept clean to the extent that the nature of the work allows.

(b) To facilitate cleaning, every floor, working place, and passageway should be kept free from protruding nails, splinters, loose boards, and unnecessary holes and openings.

3. *Waste Disposal.*

(a) Any exterior receptacle used for putrescible solid or liquid waste or refuse should be so constructed that it does not leak and may be thoroughly cleaned and maintained in a sanitary condition. Such a receptacle should be equipped with a solid tight-fitting cover, unless it can be maintained in a sanitary condition without a cover. This requirement does not prohibit the use of receptacles designed to permit the maintenance of a sanitary condition without regard to the aforementioned requirements.

(b) All sweepings, solid or liquid wastes, refuse, and garbage should be removed in such a manner as to avoid creating a menace to health and as often as necessary or appropriate to maintain a sanitary condition.

4. *Vermin Control.*

(a) Camp cars should be so constructed, equipped, and maintained, so far as reasonably practicable, as to prevent the entrance or harborage of rodents, insects, or other vermin. A continuing and effective extermination program should be instituted where their presence is detected.

5. *Water Supply.*

(a) Potable water. (1) Potable water should be adequately and conveniently provided to all employees in camp cars for drinking, washing of the person, cooking, washing of foods, washing of cooking or eating utensils, washing of food preparation or processing premises, and personal service rooms where such facilities are provided.

(2) Potable drinking water dispensers should be designed, constructed, and serviced so that sanitary conditions are maintained, should be capable of being closed, and should be equipped with a tap.

(3) Open containers such as barrels, pails, or tanks for drinking water from which the water must be dipped or poured, whether or not they are fitted with a cover, should not be used.

(4) A common drinking cup and other common utensils should not be used.

(b) The distribution lines should be capable of supplying water at sufficient operating pressures to all taps for normal simultaneous operation.

6. *Toilet facilities.*

(a) Toilet facilities. (1) Toilet facilities adequate for the number of employees housed in the camp car should be provided in convenient and safe location(s), and separate toilet rooms for each sex should be provided in accordance with table 1 of this paragraph. The number of facilities to be provided for each sex should be based on the number of employees of that sex for whom the facilities are furnished. Where toilet rooms will be occupied by no more than one person at a time, can be locked from the inside, and contain at least one water closet or nonwater carriage

toilet facility, separate toilet rooms for each sex need not be provided. Where such single-occupancy rooms have more than one toilet facility, only one such facility in each toilet room should be counted for the purpose of table 1.

TABLE 1

No. of employees	Minimum No. of toilet facilities [1]
1 to 10	1
11 to 25	2
26 to 49	3
50 to 100	5
Over 100	[2]

[1] Where toilet facilities will not be used by women, urinals may be provided instead of water closets or nonwater carriage toilet facilities, except that the number of water closets or facilities in such cases should not be reduced to less than ⅔ of the minimum specified.

[2] One additional fixture for each additional 25 employees.

(2) When toilet facilities are provided in separate cars, toilet rooms should have a window space of not less than 6 square feet in area opening directly to the outside area or otherwise be satisfactorily ventilated. All outside openings should be screened with material that is equivalent to or better than 16-mesh. No fixture, water closet, nonwater carriage toilet facility or urinal should be located in a compartment used for other than toilet purposes.

(3) The sewage disposal method should not endanger the health of employees.

(b) *Construction of toilet rooms.* (1) Each water closet should occupy a separate compartment with a door and walls or partitions between fixtures sufficiently high to assure privacy.

(2) Nonwater carriage toilet facilities should be located within 50 feet, but as far as practical on the same side of the track on which camp cars are sited.

(3) Each toilet facility should be lighted naturally, or artificially by a safe type of lighting available at all hours of the day and night. Flashlights can be substituted by the railroad when nonwater carriage toilet facilities are used.

(4) An adequate supply of toilet paper should be provided in each water closet, or nonwater carriage toilet facility, unless provided to the employees individually.

(5) Toilet facilities should be kept in a clean and sanitary condition. They should be cleaned regularly when occupied. In the case of nonwater carriage toilet facilities, they should be cleaned and changed regularly.

7. *Lavatories.*

(a) Lavatories should be made available to all rail employees housed in camp cars.

(b) Each lavatory should be provided with either hot and cold running water or tepid running water.

(c) Unless otherwise provided by agreement, hand soap or similar cleansing agents should be provided.

(d) Unless otherwise provided by agreement, individual hand towels or sections thereof, of cloth or paper, warm air blowers or clean individual sections of continuous cloth toweling, convenient to the lavatories, should be provided.

(e) One lavatory basin per six employees should be provided in shared facilities.

8. *Showering facilities.*

(a) Showering facilities should be provided in the following ratio: one shower should be provided for each 10 employees of each sex, or numerical fraction thereof, who are required to shower during the same shift.

(b) Shower floors should be constructed of non-slippery materials. Floor drains should be provided in all shower baths and shower rooms to remove waste water and facilitate cleaning. All junctions of the curbing and the floor should be sealed. The walls and partitions of shower rooms should be smooth and impervious to the height of splash.

(c) An adequate supply of hot and cold running water should be provided for showering purposes. Facilities for heating water should be provided.

(d) *Showers.* 1. Unless otherwise provided by agreement, body soap or other appropriate cleansing agent convenient to the showers should be provided.

2. Showers should be provided with hot and cold water feeding a common discharge line.

3. Unless otherwise provided by agreement, employees who use showers should be provided with individual clean towels.

9. *Kitchens, dining hall and feeding facilities.*

(a) In all camp cars where central dining operations are provided, the food handling facilities should be clean and sanitary.

(b) When separate kitchen and dining hall cars are provided, there should be a closable door between the living or sleeping quarters into a kitchen or dining hall car.

10. *Consumption of food and beverages on the premises.*

(a) *Application.* This paragraph should apply only where employees are permitted to consume food or beverages, or both, on the premises.

(b) *Eating and drinking areas.* No employee should be allowed to consume food or beverages in a toilet room or in any area exposed to a toxic material.

(c) *Sewage disposal facilities.* All sewer lines and floor drains from camp cars should be connected to public sewers where available and practical, unless the cars are equipped with holding tanks that are emptied in a sanitary manner.

(d) *Waste disposal containers provided for the interior of camp cars.* An adequate number of receptacles constructed of smooth, corrosion resistant, easily cleanable, or disposable materials, should be provided and used for the

disposal of waste food. Receptacles should be provided with a solid tightfitting cover unless sanitary conditions can be maintained without use of a cover. The number, size and location of such receptacles should encourage their use and not result in overfilling. They should be emptied regularly and maintained in a clean and sanitary condition.

(e) *Sanitary storage.* No food or beverages should be stored in toilet rooms or in an area exposed to a toxic material.

(f) *Food handling.* (1) All employee food service facilities and operations should be carried out in accordance with sound hygienic principles. In all places of employment where all or part of the food service is provided, the food dispensed should be wholesome, free from spoilage, and should be processed, prepared, handled, and stored in such a manner as to be protected against contamination.

(2) No person with any disease communicable through contact with food or food preparation items should be employed or permitted to work in the preparation, cooking, serving, or other handling of food, foodstuffs, or materials used therein, in a kitchen or dining facility operated in or in connection with camp cars.

11. *Lighting.* Each habitable room in a camp car should be provided with adequate lighting.

12. *First Aid.* Adequate first aid kits should be maintained and made available for railway employees housed in camp cars for the emergency treatment of injured persons.

13. *Shelter.*

(a) Every camp car should be constructed in a manner that will provide protection against the elements.

(b) All steps, entry ways, passageways and corridors providing normal entry to or between camp cars should be constructed of durable weather resistant material and properly maintained. Any broken or unsafe fixtures or components in need of repair should be repaired or replaced promptly.

(c) Each camp car used for sleeping purposes should contain at least 48 square feet of floor space for each occupant. At least a 7-foot ceiling measured at the entrance to the car should be provided.

(d) Beds, cots, or bunks and suitable storage facilities such as wall lockers or space for foot lockers for clothing and personal articles should be provided in every room used for sleeping purposes. Except where partitions are provided, such beds or similar facilities should be spaced not closer than 36 inches laterally (except in modular units which cannot be spaced closer than 30 inches) and 30 inches end to end, and should be elevated at least 12 inches from the floor. If double-deck bunks are used, they should be spaced not less than 48 inches both laterally and end to end. The minimum clear space between the lower and upper bunk should be not less than 27 inches. Triple-deck bunks should not be used.

(e) Floors should be of smooth and tight construction and should be kept in good repair.

(f) All living quarters should be provided with windows the total of which should be not less than 10 percent of the floor area. At least one-half of each window designed to be opened should be so constructed that it can be opened for purposes of ventilation. Durable opaque window coverings should be provided to reduce the entrance of light during sleeping hours.

(g) All exterior openings should be effectively screened with 16-mesh material. All screen doors should be equipped with self-closing devices.

(h) In a facility where workers cook, live, and sleep, a minimum of 90 square feet per person should be provided. Sanitary facilities should be provided for storing and preparing food.

(i) In camp cars where meals are provided, adequate facilities to feed employees within a 60-minute period should be provided.

(j) All heating, cooking, ventilation, air conditioning and water heating equipment should be installed in accordance with applicable local regulations governing such installations.

(k) Every camp car should be provided with equipment capable of maintaining a temperature of at least 68 degrees F. during normal cold weather and no greater than 78 degrees F., or 20 degrees below ambient, whichever is warmer, during normal hot weather.

(l) Existing camp cars may be grandfathered so as to only be subject to subparagraphs (c), (d), (f), (h), and (k), in accordance with the following as recommended maximums:

13 (c), (d), and (h)—by January 1, 1994.

13(f)—Indefinitely insofar as the ten percent (10%) requirement for window spacing is concerned.

13(k)—by January 1, 1992.

14. *Location.* Camp cars occupied exclusively by individuals employed for the purpose of maintaining the right-of-way of a railroad should be located as far as practical from where ''switching or humping operations'' of ''placarded cars'' occur, as defined in 49 CFR 228.101 (c)(3) and (c)(4), respectively. Every reasonable effort should be made to locate these camp cars at least one-half mile (2,640 feet) from where such switching or humping occurs. In the event employees housed in camp cars located closer than one-half mile (2,640 feet) from where such switching or humping of cars takes place are exposed to an unusual hazard at such location, the employees involved should be housed in other suitable accommodations.

An unusual hazard means an unsafe condition created by an occurrence other than normal switching or humping.

15. *General provisions.* (a) Sleeping quarters are not considered to be ''free of interruptions caused by noise under the control of the railroad'' if noise levels attributable to noise sources under the control of the railroad exceed an Leq (8) value of 55 dB(A), with windows closed and exclusive of cooling, heating, and ventilating equipment.

(b) A railroad should, within 48 hours after notice of noncompliance with these recommendations, fix the deficient condition(s). Where holidays or weekends intervene, the railroad should fix the condition within 8 hours after the employees return to work. In the event such condition(s) affects the safety or health of the employees, such as water, cooling, heating or eating facilities, the railroad should provide alternative arrangements for housing and eating until the noncomplying condition is fixed.

[55 FR 30893, July 27, 1990]

PART 229—RAILROAD LOCOMOTIVE SAFETY STANDARDS

Subpart A—General

Subpart B—Inspections and Tests

Subpart C—Safety Requirements

the next place where repairs can be made. This movement must be consistent with § 229.9.

(h) Any locomotive subject to Part 229, that was built before December 31, 1948, and that is not used regularly in commuter or intercity passenger service, shall be considered historic equipment and excepted from the requirements of paragraphs (d) through (h) of this section.

[45 FR 21109, Mar. 31, 1980, as amended at 61 FR 8887, Mar. 6, 1996; 68 FR 49717, Aug. 19, 2003; 69 FR 12537, Mar. 16, 2004]

§ 229.127 Cab lights.

(a) Each locomotive shall have cab lights which will provide sufficient illumination for the control instruments, meters, and gauges to enable the engine crew to make accurate readings from their normal positions in the cab. These lights shall be located, constructed, and maintained so that light shines only on those parts requiring illumination and does not interfere with the crew's vision of the track and signals. Each controlling locomotive shall also have a conveniently located light that can be readily turned on and off by the persons operating the locomotive and that provides sufficient illumination for them to read train orders and timetables.

(b) Cab passageways and compartments shall have adequate illumination.

§ 229.129 Locomotive horn.

(a) Each lead locomotive shall be equipped with a locomotive horn that produces a minimum sound level of 96 dB(A) and a maximum sound level of 110 dB(A) at 100 feet forward of the locomotive in its direction of travel. The locomotive horn shall be arranged so that it can be conveniently operated from the engineer's usual position during operation of the locomotive.

(b)(1) Each locomotive built on or after September 18, 2006 shall be tested in accordance with this section to ensure that the horn installed on such locomotive is in compliance with paragraph (a) of this section. Locomotives built on or after September 18, 2006 may, however, be tested in accordance with an acceptance sampling scheme such that there is a probability of .05 or less of rejecting a lot with a proportion of defectives equal to an AQL of 1% or less, as set forth in 7 CFR part 43.

(2) Each locomotive built before September 18, 2006 shall be tested in accordance with this section before June 24, 2010 to ensure that the horn installed on such locomotive is in compliance with paragraph (a) of this section.

(3) Each remanufactured locomotive, as determined pursuant to § 229.5 of this part, shall be tested in accordance with this section to ensure that the horn installed on such locomotive is in compliance with paragraph (a).

(4)(i) Except as provided in paragraph (b)(4)(ii) of this section, each locomotive equipped with a replacement locomotive horn shall be tested, in accordance with paragraph (c) of this section, before the next two annual tests required by § 229.27 of this part are completed.

(ii) Locomotives that have already been tested individually or through acceptance sampling, in accordance with paragraphs (b)(1), (b)(2), or (b)(3) of this section, shall not be required to undergo sound level testing when equipped with a replacement locomotive horn, provided the replacement locomotive horn is of the same model as the locomotive horn that was replaced and the mounting location and type of mounting are the same.

(c) Testing of the locomotive horn sound level shall be in accordance with the following requirements:

(1) A properly calibrated sound level meter shall be used that, at a minimum, complies with the requirements of International Electrotechnical Commission (IEC) Standard 61672–1 (2002–05) for a Class 2 instrument.

(2) An acoustic calibrator shall be used that, at a minimum, complies with the requirements of IEC standard 60942 (1997–11) for a Class 2 instrument.

(3) The manufacturer's instructions pertaining to mounting and orienting the microphone; positioning of the observer; and periodic factory recalibration shall be followed.

(4) A microphone windscreen shall be used and tripods or similar microphone mountings shall be used that minimize

interference with the sound being measured.

(5) The test site shall be free of large reflective structures, such as barriers, hills, billboards, tractor trailers or other large vehicles, locomotives or rail cars on adjacent tracks, bridges or buildings, within 200 feet to the front and sides of the locomotive. The locomotive shall be positioned on straight, level track.

(6) Measurements shall be taken only when ambient air temperature is between 32 degrees and 104 degrees Fahrenheit inclusively; relative humidity is between 20 percent and 95 percent inclusively; wind velocity is not more than 12 miles per hour and there is no precipitation.

(7) With the exception of cab-mounted or low-mounted horns, the microphone shall be located 100 feet forward of the front knuckle of the locomotive, 15 feet above the top of the rail, at an angle no greater than 20 degrees from the center line of the track, and oriented with respect to the sound source according to the manufacturer's recommendations. For cab-mounted and low-mounted horns, the microphone shall be located 100 feet forward of the front knuckle of the locomotive, four feet above the top of the rail, at an angle no greater than 20 degrees from the center line of the track, and oriented with respect to the sound source according to the manufacturer's recommendations. The observer shall not stand between the microphone and the horn.

(8) Background noise shall be minimal: the sound level at the test site immediately before and after each horn sounding event shall be at least 10 dB(A) below the level measured during the horn sounding.

(9) *Measurement procedures.* The sound level meter shall be set for A-weighting with slow exponential response and shall be calibrated with the acoustic calibrator immediately before and after compliance tests. Any change in the before and after calibration levels shall be less than 0.5 dB. After the output from the locomotive horn system has reached a stable level, the A-weighted equivalent sound level (slow response) for a 10-second duration (LAeq, 10s) shall be obtained either directly using an integrating-averaging sound level meter, or recorded once per second and calculated indirectly. The arithmetic-average of a series of at least six such 10-second duration readings shall be used to determine compliance. The standard deviation of the readings shall be less than 1.5 dB.

(10) Written reports of locomotive horn testing required by this part shall be made and shall reflect horn type; the date, place, and manner of testing; and sound level measurements. These reports, which shall be signed by the person who performs the test, shall be retained by the railroad, at a location of its choice, until a subsequent locomotive horn test is completed and shall be made available, upon request, to FRA as provided by 49 U.S.C. 20107.

(d) This section does not apply to locomotives of rapid transit operations which are otherwise subject to this part.

[71 FR 47666, Aug. 17, 2006]

§ 229.131 Sanders.

Except for MU locomotives, each locomotive shall be equipped with operable sanders that deposit sand on each rail in front of the first power operated wheel set in the direction of movement.

§ 229.133 Interim locomotive conspicuity measures—auxiliary external lights.

(a) A locomotive at the head of a train or other movement is authorized to be equipped with auxiliary external lights, additional to the headlight required by § 229.125, for the purpose of improved conspicuity. A locomotive that is equipped with auxiliary external lights in conformance with the specifications or performance standards set forth in paragraph (b) of this section on the date of issuance of a final rule that requires additional or other external lights on locomotives for improved conspicuity, as required by section 202(u) of the Federal Railroad Safety Act of 1970, shall be deemed to conform to the requirements of the final rule for four years following the date of issuance of that final rule.

Appendix E: References

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2. Transit Noise and Vibration Impact Assessment. FTA Report No. FTA-VA-90-1003-06. Burlington, MA: Harris, Miller, Miller, and Hanson Inc., May 2006.

3. High-Speed Ground Transportation Noise and Vibration Impact Assessment. HMMH Report No. 293630-4. Burlington, MA: Harris Miller Miller & Hanson Inc., October 2005.

4. Noise Control Act of 1972: 42 U.S.C. 4901

5. "Noise Emission Standards for Transportation Equipment; Interstate Rail Carriers." Federal Register. Environmental Protection Agency, Code of Federal Regulations, Title 40, Chapter 1, Part 201. July 2006.

6. "Railroad Noise Emission Compliance Regulations." Federal Register. U.S. Department of Transportation, Federal Railroad Administration, Code of Federal Regulations, Title 49, Chapter 2, Part 210. October 2007.

7. "Use of Locomotive Horns at Public Highway-Rail Grade Crossings." Federal Register. U.S. Department of Transportation, Federal Railroad Administration, Code of Federal Regulations, Title 49, Chapter 2, Part 222. August 2006.

8. "Occupational Noise Exposure." Federal Register. U.S. Department of Transportation, Federal Railroad Administration, Code of Federal Regulations, Title 49, Chapter 2, Part 227. October 2007.

9. "Hours of Service of Railroad Employees." Federal Register. U.S. Department of Transportation, Federal Railroad Administration, Code of Federal Regulations, Title 49, Chapter 2, Part 228. October 2007.

10. "Railroad Locomotive Safety Standards." Federal Register. U.S. Department of Transportation, Federal Railroad Administration, Code of Federal Regulations, Title 49, Chapter 2, Part 229. October 2007.

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