

Environmental, Health, and Safety Guidelines for Railways

Introduction

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP)¹. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the **General EHS Guidelines** document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. A complete list of industry-sector guidelines can be found at: www.ifc.org/ifcext/enviro.nsf/Content/EnvironmentalGuidelines

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the

¹ Defined as the exercise of professional skill, diligence, prudence and foresight that would be reasonably expected from skilled and experienced professionals engaged in the same type of undertaking under the same or similar circumstances globally. The circumstances that skilled and experienced professionals may find when evaluating the range of pollution prevention and control techniques available to a project may include, but are not limited to, varying levels of environmental degradation and environmental assimilative capacity as well as varying levels of financial and technical feasibility.

environment, and other project factors, are taken into account. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

Applicability

The EHS Guidelines for Railways are applicable to activities typically conducted by rail infrastructure operators dedicated to passenger and freight transport. The document is organized into two main areas, namely rail operations, covering construction and maintenance of rail infrastructure as well as operation of rolling stock, such as locomotives and rail cars; and, locomotive maintenance activities, including engine services, and other mechanical repair and maintenance of locomotives and railcars. This document is organized according to the following sections:

Section 1.0 — Industry-Specific Impacts and Management
Section 2.0 — Performance Indicators and Monitoring
Section 3.0 — References
Annex A — General Description of Industry Activities

1.0 Industry-Specific Impacts and Management

The following section provides a summary of EHS issues associated with railways that may occur during the construction and operation phases of a project, along with recommendations for their management. Additional recommendations for the management of EHS issues during the decommissioning phase of railways are provided in the **General EHS Guidelines**.

1.1 Environment

1.1.1 Rail Operations

Environmental issues associated with construction and maintenance of rail infrastructure, as well as operation of rolling stock (e.g. locomotives and rail cars), may include the following:

- Habitat alteration and fragmentation
- Emissions to air
- Fuel management
- Wastewater
- Waste
- Noise

Habitat Alteration and Fragmentation

The construction and maintenance of railroad rights-of-way may result in alteration and disruption to terrestrial and aquatic habitats.

Construction of Rail Rights-of-Way²

Right-of-way construction activities along a railway alignment may adversely affect wildlife habitats depending on the characteristics of existing vegetation, topographic features, and waterways. Habitat alteration may include fragmentation of

forested habitat; loss of nesting sites and other wildlife habitat through bush clearing; disruption of watercourses; establishment of non-native invasive plant species; creation of barriers to wildlife movement; and visual and auditory disturbance due to the presence of machinery, construction workers, and associated equipment. In addition, sediment and erosion from construction and stormwater runoff may increase turbidity of surface waters.

Recommended measures to prevent and control impacts to wildlife habitats during construction of rights-of-way include:

- Avoid fragmentation or destruction of critical terrestrial and aquatic habitats³ by siting railways, rail yards, support facilities, and maintenance roads to avoid such locations or by utilizing existing transport corridors whenever possible. Where fragmentation of critical habitats cannot be avoided, maximize the availability of animal crossings (e.g. bridges, culverts, and over-crossings) and provide jointing chambers to allow small animals a means of escape from the railway;
- When rail crossings of watercourses are unavoidable, maintain water flow and fish access by utilizing clear-span bridges, open-bottom culverts, or other appropriate methods. Where sensitive habitats cannot be avoided by rail alignment, construction of bridges should be considered to span at-risk areas (e.g. wetlands);
- Minimize the clearing of riparian vegetation during construction;
- Avoid construction activities during the breeding season and other sensitive seasons or times of day, especially

²Also known as a 'wayleave' or 'easement' in some countries, but referred to in these guidelines as 'right-of-way'.

³The term "critical habitats" is defined in IFC Performance Standard 6: Biodiversity Conservation and Natural Resource Management, along with other terminology related to the preservation of biodiversity. Available at: www.ifc.org/envsocstandards

where critically endangered or endangered species are concerned;

- Avoid the introduction of invasive species during reinstatement activities, preferably through the use of native plant species and, when feasible, clear invasive species during routine vegetation maintenance (see 'Right-of-way maintenance' section below);
- When procuring crossties for rail line construction, consider their source to ensure that it has not originated from unsustainable harvesting of forest products in a critical habitat.
- Additional recommendations on managing construction site activities are described in the **General EHS Guidelines**.

Right-of-Way Maintenance

Regular maintenance of vegetation within railroad rights-of-way is necessary to avoid interference with train operations and track maintenance. Unchecked growth of trees and plants can cover signals, fall onto the tracks and overhead power lines, and prevent workers from getting to places of safety when trains are passing. Regular maintenance of rights-of-way to control vegetation may involve the use of mechanical methods (e.g. mowing), manual methods (e.g. hand pruning), and use of herbicides. Vegetation maintenance beyond that which is necessary for safety may remove unnecessary amounts of vegetation, resulting in the continual replacement of successional species and an increased likelihood of the establishment of invasive species.

Recommended measures to prevent and control impacts from right-of-way vegetation maintenance include:

- Implementation of integrated vegetation management (IVM). The track area should be kept completely clear of vegetation. From the edge of the track area to the boundary of the right-of-way, vegetation should be

structured with smaller plants near the line and larger trees further away from the line to provide habitats for a wide variety of plants and animals;⁴

- Native species should be planted and invasive plant species removed;⁵
- Railways should be designed and maintained to discourage plant growth in the track area (e.g. providing lateral barriers to plant migration and ensuring rapid drainage of the track area);
- Biological, mechanical, and thermal vegetation control measures should be used where practical, and use of chemical herbicides on the bank beyond the transition area should be avoided (approx. 5 meters from the track);
- Maintenance clearing in riparian areas should be avoided or minimized.

An integrated approach to vegetation management may indicate use of herbicides as a preferred approach to control fast-growing vegetation within railway rights-of-way. In this case, the recommended precautions include:

- Personnel should be trained in herbicide application, including applicable certification or equivalent training where such certifications are not required;⁶

⁴ Mowing can be used to control growth of ground covers, minimize propagation of plants in the track area, and prevent the establishment of trees and shrubs in the right-of-way. Herbicides, in combination with mowing, can control fast-growing weedy species that have a potential to mature to heights over those permitted within the right-of-way. Trimming and pruning can be utilized at the boundaries of rights-of-way to maintain corridor breadth and prevent the encroachment of tree branches. Hand removal or removal of vegetation, while labor intensive, can be used in the vicinity of structures, streams, fences, and other obstructions making the use of machinery difficult or dangerous.

⁵ Dense, thorny native shrubs can be used to help deter trespassers. Native plants can also help to stabilize clay soils, reducing the need for ballast maintenance. Leaves of some tree species with invasive root systems can cause traction problems for train wheels. Therefore, such trees are often removed, even if native to the area. Waste from removal of invasive species should be disposed of (e.g. by incineration or at a landfill) to avoid accidental spreading of the weeds to new sites.

⁶ Examples of certification schemes are provided by the United States Environmental Protection Agency (US EPA) (2006), which categorizes pesticides as either "unclassified" or "restricted" and requires workers that apply unclassified pesticides to be trained according to the Worker Protection

- Avoid the use of herbicides that fall under or are listed under:
 - The World Health Organization Recommended Classification of Pesticides by Hazard Classes 1a and 1b
 - Avoid the use of pesticides that fall under the World Health Organization Recommended Classification of Pesticides by Hazard Class II if the project host country lacks restrictions on distribution and use of these chemicals, or if they are likely to be accessible to personnel without proper training, equipment, and facilities to handle, store, apply, and dispose of these products properly;
 - Annexes A and B of the Stockholm Convention, except under the conditions noted in the convention⁷
- Herbicides used should be manufactured under license, registered and approved by an appropriate authority, and in accordance with the Food and Agriculture Organization's (FAO) International Code of Conduct on the Distribution and Use of Pesticides;⁸
- Only herbicides that are labeled in accordance with international standards and norms should be used, such as the FAO Revised Guidelines for Good Labeling Practice for Pesticides;⁹
- Users should review manufacturers' directions on maximum recommended dosage or treatment, as well as published reports on reduced rates of herbicide application without loss of effect,¹⁰ and apply the minimum effective dose;
- Herbicide application should be based on criteria (e.g. field observations, weather data, time of treatment, and dosage) with use of a pesticide logbook to record data;
- Application practices should be designed to reduce unintentional drift or runoff;
- Herbicide application equipment should be maintained and calibrated in accordance with manufacturers' recommendations;
- Untreated buffer zones or strips should be established along water sources, rivers, streams, ponds, lakes, and ditches to help protect water resources;
- Contamination of soils, groundwater, or surface water resources due to accidental spills during transfer, mixing, and storage of herbicides should be prevented by following the hazardous materials storage and handling recommendations presented in the **General EHS Guidelines**.

Forest Fires

If vegetation growth is left unchecked or slash from routine maintenance is left to accumulate within the right-of-way, sufficient fuel can accumulate that may promote forest fires. Recommended measures to prevent and control risk of forest fire include:

- Monitoring of right-of-way vegetation according to fire risk;
- Removal of blowdown and other high-hazard fuel accumulations;
- Timing of thinning, slashing, and other maintenance activities to avoid seasons when the risk of forest fires is high;
- Removal of maintenance slash or management by controlled burning.¹¹ Controlled burning should adhere to

Standard (40 CFR Part 170) for Agricultural Pesticides. It further requires restricted pesticides to be applied by or in the presence of a certified pesticide applicator.

⁷ Stockholm Convention on Persistent Organic Pollutants (2001).

⁸ Food and Agriculture Organization of the United Nations (FAO) (2002)

⁹ FAO (2002)

¹⁰ Danish Agricultural Advisory Service (DAAS), 2000.

¹¹ Controlled burning should only be performed after considering potential impacts to air quality and according to the local air quality management requirements.

applicable burning regulations, fire suppression equipment requirements, and typically should be monitored by a fire watcher;

- Planting and management of fire-resistant species (e.g. hardwoods) within, and adjacent to, rights-of-way.

Emissions to Air

Locomotive engines may be significant contributors to air pollution in urban areas, especially in the vicinity of rail yards. Worldwide, approximately 60 percent of passenger trains and 80 percent of freight trains are powered by diesel locomotives which emit combustion products, including nitrogen oxides (NO_x) and particulate matter (PM), both of which contribute to public health problems, and carbon dioxide (CO₂), a greenhouse gas.¹² Transportation and transfer of dry granular materials (e.g. minerals and grain) may result in dust emissions, while the storage and transfer of fuels or volatile chemicals may result in fugitive emissions. Recommended measures to prevent, minimize, and control air emissions include:

- Reduction of fuel consumption / increase of energy efficiency through:
 - Use of modern, fuel-efficient, low-emission locomotives or scheduled substitution or re-powering of existing fleets
 - Maximizing cargo and passenger space utilization within safety standards to minimize specific fuel consumption
 - Decreasing wind resistance (e.g. by grouping inter-modal loads with rail cars of height similar to the containers and filling empty slots with empty containers, covering of empty freight cars,¹³ installing

¹² Generation of electricity also results in emissions of NO_x, PM, and other air pollutants, and, therefore, electric-powered trains result in indirect air emissions.

¹³ Even at the relatively low speeds of freight trains, a locomotive pulling open, empty cars on level terrain consumes more energy than one pulling a heavy load.

fairings on bogies (also known as trucks) of high-speed trains, and acquisition of new rolling stock with low wind resistance

- Optimizing efficiency of passenger comfort functions during service and while parked (e.g. by installing demand-oriented ventilation controls and automatic control of comfort functions in parked trains);
- Improving driving economy through staff training, incentive programs, driving advice systems, and improved traffic flow to minimize unnecessary acceleration and deceleration
- In electrically powered locomotives, use of regenerative braking systems to recycle energy for use by other locomotives
- Depending on the potential impact of the operation in already degraded airsheds, consider the reduction and control of combustion source emissions through:
 - Use of, or conversion to, alternative fuels (e.g. low-sulfur diesel, bio-diesel)
 - Locomotive re-powering programs
 - Installation of high-efficiency catalytic exhaust emission control systems¹⁴
 - Use of alternative power sources for idling locomotives¹⁵
 - Improvements in ground service and field operations vehicle fleets as described in the **General EHS Guidelines**
- Depending on the potential impact of the operation in already degraded airsheds, considering the reduction and control of fugitive emissions through:

¹⁴ The US EPA is considering requiring such emission controls on new diesel locomotives. See 69 FR 39276 – 39289.

¹⁵ Guidance for Quantifying and Using Long Duration Switch Yard Locomotive Idling Emission Reductions in State Implementation Plans. EPA 20-B-04-002. Office of Transportation and Air Quality, US EPA (2004)

- Use of enclosed cars or covering of open cars used to carry minerals and grains to reduce fugitive dust emissions
- Implementing measures presented in the **General EHS Guidelines** to minimize fugitive air emissions from diesel and other fuel storage and handling activities

Fuel Management

Rail operations with diesel locomotive engines depend on fueling stations strategically situated along the rail network. Fueling stations typically include aboveground storage tanks, piping, and filling equipment with the potential for soil and water resource contamination due to leaks and spills. Storm water falling on fueling areas and secondary containment systems may contain oil residues from incidental releases.

In addition to the recommendations for hazardous materials and oil management in the **General EHS Guidelines**, measures to manage these types of hazards include:

- Storage tanks and components should meet international standards for structural design integrity and operational performance to avoid catastrophic failures during normal operation and during exposure to natural hazards and to prevent fires and explosions;¹⁶
- Storage tanks should have appropriate secondary containment as discussed in the **General EHS Guidelines**, including procedures for the management of containment systems;
- Secondary containment in rail fueling areas should be appropriate for the size of the railcar, level, curbed, sealed,

and draining to a sump connected to a spill retention area. The spill retention area should also be equipped with an oil / water separator to allow the routine discharge of collected rainwater;¹⁷

- Fueling facilities should develop a formal spill prevention and control plan that addresses significant scenarios and magnitude of releases. The plan should be supported by the necessary resources and training. Spill response equipment should be conveniently available to address all types of spills, including small spills.

Wastewater

Rail operations may generate sanitary wastewater primarily from passenger terminals and from passenger rail service. Wastewater from all sources should be managed according to the recommendations provided in the **General EHS Guidelines**.

Waste

Depending on the number of passengers handled and the services provided, trains and passenger train terminals may generate solid, non-hazardous, food waste from food establishments, in addition to packaging materials from retail facilities, and paper, newspaper, and a variety of disposable food containers from trains and common passenger areas. The maintenance and upgrade of rail infrastructure may also result in the generation of non-hazardous and hazardous waste including lubricants from field maintenance equipment and steel and wood from rails and rail ties. Recommended waste management strategies include:

Waste from Passenger Trains and Terminals

- Instituting a solid waste recycling program, depending on the existence of local facilities, involving the placement of

¹⁶ Examples include American Petroleum Institute (API) Standard 620: Design and Construction of Large, Welded, Low-pressure Storage Tanks, 2002; and API Standard 650: Welded Steel Tanks for Oil Storage, 1998; in addition to European Standard (EN) 12285-2 Workshop fabricated steel tanks for the aboveground storage of flammable and non-flammable water polluting liquids, 2005.

labeled waste containers in passenger terminals for metals, glass, paper, and plastics. Food establishments should segregate compostable and other food waste for recycling as agricultural fertilizer and animal feed;

- Passenger train operators and cleaning contractors should be encouraged to segregate waste in the trains by separating the collection of newspapers / papers, plastic, and metallic containers.

Waste from Field Operations

- On-site generation and storage of hazardous wastes and their subsequent treatment and disposal should be managed according to the recommendations provided in the **General EHS Guidelines**;
- Where feasible, avoid use of crossties treated with chromated copper arsenate and consider use of copper azote for wood treatment as a substitute, or using concrete crossties;
- Recycling of crossties may involve crushing for recovery of the steel rebar and use of the crushed material in road construction. Wood crossties may be chipped for reuse, burnt, or disposed of in landfills. Landfill facilities should be capable of handling wastes that may have chemical leaching properties. Disposal of wood crossties by incineration or recycling should take into account associated air emissions and secondary product residues of preservative chemicals.

Noise and Vibrations

Railway noise is generated from a variety of sources, each contributing to the total noise output. Sources include rolling noise generated by the contact between wheel and rail during normal movement and braking; aerodynamic noise generated by the train pushing air (particularly for high speed trains); and

traction noise generated by the engine and cooling fans.¹⁸

Recommended noise management strategies include:¹⁹

- Implementation of noise reduction or prevention measures at the source including, including:
 - Use of modern non-metallic disc brakes, which can reduce rolling noise by 8-10 decibels (dB) compared to cast-iron block tread brakes utilized on older vehicles (non-metallic disc brakes also reduce wearing of wheels and rails)
 - Reducing the roughness of running surfaces through regular maintenance of wheels and tracks, and consideration for replacing traditional jointed track with continuously welded rail
- Installation of noise controls at the source for improved sound-proofing, and other noise reducing features (e.g. engine enclosures and exhaust muffling for diesel engines, and shielding of wheels with vehicle-mounted shrouds);
- Depending on the location of noise-sensitive areas, noise and vibrations should be considered in the design, construction, and operation of railways (e.g. through alignment choice, relocation of nearby buildings, and soundproofing, such as noise barriers, along railways or next to buildings).

1.1.2 Maintenance of Rolling Stock

The main environmental issues typically encountered in locomotive and railcar maintenance activities may include:

Inspection of Terminal & Tank Facilities (2005).

¹⁸ The most significant source of noise is rolling noise from contact between wheel and rail (lateral and longitudinal wheel and track friction from sideways wheel slide and from braking, respectively, including noise from contact between the brake pad and wheel), followed by engine noise and aerodynamic noise.

¹⁹ For additional information, see Dittrich, Michael. 2003. Basic Targets and Conditions for European Railway Noise Abatement Strategies: Analysis of the Current Situation. Working Group (WG) on Railway Noise. European Commission (EC). Also, additional documents published by the WG on Railway Noise. Available at: http://ec.europa.eu/transport/rail/environment/noise_en.htm

¹⁷ API Standard 2610: Design, Construction, Operation, Maintenance, and

- Hazardous materials
- Wastewater
- Waste management

Hazardous Materials

Hazardous materials, including solvents, coolants, acids, and alkalis, may be used in locomotives and rolling stock maintenance operations. Polychlorinated biphenyls (PCB) may be found in older electrical equipment (e.g. transformers and capacitors), and asbestos may be present in older parts such as wheel bearings and seals for steam engines. In addition to the applicable guidance provided in the **General EHS Guidelines**, recommended hazardous materials management strategies include:

- Use of aqueous detergent cleaning solutions or steam cleaning, or use and recycling of aliphatic cleaning solvents (e.g. 140 solvent), for example when removing axle protective coatings or for cleaning of large equipment;
- Use of water-based paints;
- Use of track mats to retain wayside grease and other contaminants;
- Avoiding use of new or replacement parts with asbestos-containing materials.

Wastewater

Rail car maintenance and refurbishment typically involves a high-pressure water wash which may contain residues from transported materials, paint, oil and grease, and other contaminants. Caustic solutions are often used to remove grease and dirt from axles and other metal parts. Acids and caustics may also be used for rust removal. Locomotive coolants are usually water-based with corrosion inhibitor additives. Passenger trains also generate domestic wastewater, which is sometimes discharged directly to the land surface.

Recommended measures to prevent, minimize, or control wastewater effluents include:

- Use of ultrafiltration to extend the life of washing solutions for aqueous parts or use of alternatives to water cleaning (e.g. dry cleaning by wire brush or bake oven);
- Plumbing connection of floor drains, if any, in maintenance areas to the wastewater collection and treatment system;
- Prevention of discharge of industrial wastes to septic systems, drain fields, dry wells, cesspools, pits, or separate storm drains or sewers. Keep wastewater from service bays out of storm drains by constructing berms or other barriers;
- Depending on the volume of contaminants present in the wastewater, and whether the rail facility is discharging into a municipal system or directly to surface waters, pretreatment of effluents may be necessary to reduce contaminant concentrations. Pretreatment systems typically consist of oil / water separators, biological and chemical treatment, and activated carbon systems.

Waste Management

Most wastes from railway operations are generated as a result of maintenance and refurbishment of locomotives and rolling stock and, to a lesser extent, from track maintenance. These wastes typically include solids from mechanical cleaning of rail cars; paint chips and sandblast grit; waste paint; spent solvent and solvent sludges (from painting and cleaning); sludge from cleaning and wastewater treatment; waste oil, hydraulic fluid, and other petroleum-based fluids; petroleum-contaminated solids (e.g. oil filters and saturated spill absorbent material); spent coolant; metal filings and scrap; spent locomotive and signal batteries; and spent brake shoes. These materials should be managed based on their characteristics (e.g. hazardous or non-hazardous) as described in the **General EHS Guidelines**.

1.2 Occupational Health and Safety

1.2.1 Rail Operations

Occupational health and safety hazards during the construction of railway systems are common to those of most large industrial facilities and their prevention and control is discussed in the **General EHS Guidelines**. Additional health and safety issues specific to railway operations include the following:

- Train / worker accidents
- Noise and vibration
- Diesel exhaust
- Fatigue
- Electrical hazards
- Electric and magnetic fields

Train / Worker Accidents

Railway workers in the vicinity of rail lines are exposed to moving trains. Recommended management strategies include:

- Training workers in personal track safety procedures;
- Blocking train traffic on lines where maintenance is occurring (“green zone working”) or, if blocking the line is not feasible, use of an automatic warning system or, as a last resort, human lookouts;
- Design and construction of rail lines with adequate clearance for workers;
- Segregation of stabling, marshalling, and maintenance areas from the running lines.

Noise and Vibration

Crew members may be exposed to noise from locomotives, rolling stock, and machinery, as well as to significant repetitive

mechanical shocks and / or vibrations.²⁰ Recommended management strategies include:

- Use of air conditioning systems to maintain cabin temperature and provide fresh air so that windows can remain closed, limiting wind and outside noise;²¹
- Reduction of internal venting of air brakes to a level that minimizes noise without compromising the crew’s ability to judge brake operation;
- Installation of active noise cancellation systems;
- Use of personal protective equipment (PPE) if engineering controls are not feasible or adequate to reduce noise levels;
- Use of dampers at the seat post to reduce the vibration experienced by the operator;²²
- Installation of active vibration control systems for locomotive suspension, cabs, or seat posts, as needed to comply with applicable international and national standards and guidelines.²³

Diesel Exhaust

Railway workers, including locomotive crews and workers in stations, rail yards, and locomotive and car shops, may be exposed to exhaust from diesel locomotives and other diesel engines. Crew members riding immediately behind the lead engines of trains (e.g. trailing locomotives) and workers in indoor turnaround areas where locomotives are usually left operating, sometimes for prolonged periods, may be exposed to particularly high levels of diesel exhaust.

²⁰ Guidance for the evaluation of mechanical shock and vibration can be found in the International Organization for Standardization (ISO) 2631-1:1997, Mechanical vibration and shock: Evaluation of human exposure to whole-body vibration—Part 1: General requirements.

²¹ Insulation from exterior sound may hinder hearing of exterior noises that provide important cues (e.g. horn loudness, torpedoes). Use of exterior sensors and interior annunciators may be required to compensate.

Measures to control air emissions from locomotives are discussed in Section 1.1 above. In addition, the following measures are recommended to prevent, minimize, and control workers' exposure to diesel exhaust:

- Limiting time locomotives are allowed to run indoors and use of pusher cars to move locomotives in and out of maintenance shops;
- Ventilation of locomotive shops or other enclosed areas where diesel exhaust may accumulate;
- Filtration of air in the train crew cabin;
- Use of PPE where engineering controls are not sufficient to reduce contaminant exposure to acceptable levels (see Section 2.2).

Fatigue

Locomotive engineers and other railway workers are often required to work irregular work hours which may result in fatigue. Fatigue may be affected by the length and time of the shift (e.g. long night shifts, shift start times); the nature of the changes between shifts (shift rotation); the balance in concentration and stimulation in the work activities being undertaken; insufficient rest breaks; and the time of day. Fatigue, particularly of drivers, signallers, maintenance workers, and others whose work is critical to safe operation, can pose a serious safety risk for railway workers and the general public.²⁴

Railway operators should schedule rest periods at regular intervals and during night hours, to the extent feasible, to

maximize the effectiveness of rest breaks, and in accordance with international standards and good practices for work time.²⁵

Electrical Hazards

Electrified railways use either overhead wires or a conductor rail (e.g. third rail) to transmit electrical power to the train locomotive or multiple units. Overhead power lines may also be present near non-electrified rail lines. General electrical safety measures are addressed in the General EHS Guidelines. In addition, workers exposed to electrical hazards from electrified railways should be trained in personal track safety. Only workers who are specifically trained and competent in working with overhead lines and conductor rails should be allowed to approach these systems.

Electric and Magnetic Fields

Railway workers on electric railway systems may have a higher exposure to electric and magnetic fields (EMF) than the general public due to working in proximity to electric power lines.²⁶ Occupational EMF exposure should be prevented or minimized through the preparation and implementation of an EMF safety program including the following components:

- Establishment and identification of safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, and limiting access to properly trained workers;

²² Vibration dampening of the seats can create a difference in relative vibration of the operator and the controls and displays. Operation and legibility problems can result if the difference is large enough.

²³ See International Organization for Standardization (ISO) 2631-1:1997.

²⁴ Office of Rail Regulation.

²⁵ For example, see The Council of the European Union, Council Directive 93/104/EC, of 23 November 1993, concerning certain aspects of the organization of working time, amended by Directive 2000/34/EC of 22 June 2000 of the European Parliament and of the Council; and Transport Canada, Work / Rest Rules for Railway Operating Employees (2005).

²⁶ Detailed studies of workplace exposure to EMF in the United States, Canada, France, England, and several Northern European countries have found no conclusive link or correlation between typical occupational EMF exposure and adverse health effects. However, some studies have identified a possible association between occupational exposure to EMF and cancer, such as brain cancer (U.S. National Institute of Environmental Health Sciences 2002) indicating that there is evidence to warrant limited concern.

- Implementation of an action plan to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP), and the Institute of Electrical and Electronics Engineers (IEEE)²⁷.

1.2.2 Maintenance of Rolling Stock

Occupational hazards typically associated with locomotive and railcar maintenance activities may include physical, chemical, and biological hazards as well as confined space entry hazards. Physical hazards may be associated with work in proximity to moving equipment (e.g. locomotives and other vehicles) and machine safety, including work-portable tools, and electrical safety issues. Chemical hazards may include potential exposures to a variety of hazardous materials (e.g. asbestos, PCB, toxic paint, heavy metals, and VOCs, including those resulting from the use of solvent-based paints and cleaning solvents in enclosed spaces). Other chemical hazards may include the potential for fire and explosion during the conduct of hot work in storage tank systems. Biological hazards may include potential exposures to pathogens present in sewage storage compartments. Confined spaces may include access to railroad tank and grain cars during repair and maintenance. All of these occupational health and safety hazards should be managed based on the recommendations provided in the **General EHS Guidelines**.

1.3 Community Health and Safety

Community health and safety impacts during the construction, rehabilitation, and maintenance of railways are common to those of most infrastructure or large industrial facility

²⁷ The International Commission on Non-Ionizing Radiation Protection

construction projects, and are discussed in the **General EHS Guidelines**. These impacts include, among others, dust, noise, and vibration from construction vehicle transit, and communicable diseases associated with the influx of temporary construction labor.

Health and safety issues specific to railway operations include:

- General rail operational safety
- Transport of dangerous goods
- Level crossings safety
- Pedestrian safety

General Rail Operational Safety

The most significant safety issue potentially affecting both crew and passengers is the threat of serious injury or the potential loss of life due to train collisions with other trains or with road vehicles, as well as the possibility of derailment due to these or other operational causes. Recommended management actions include:

- Implementation of rail operational safety procedures aimed at reducing the likelihood of train collisions such as a positive train control (PTC) system. If a full PTC system is not practical, automatic rail switches should be installed or, where manual switches remain, documenting when a manually operated switch in non-signaled territory is changed from the main track to a siding, and returned back to the normal position for main track movements. This information should be communicated to all crew members and the train dispatcher;²⁸

(ICNIRP) exposure guidelines for Occupational Exposure are listed in Section 2.2 of this Guideline.

²⁸ PTC allows for the coordination of information to ensure proper train movements.

- Regular inspection and maintenance of the rail lines and facilities to ensure track stability and integrity in accordance with national and international track safety standards;²⁹
- Implementation of an overall safety management program that is equivalent to internationally recognized railway safety programs.³⁰

Transport of Dangerous Goods

Dangerous goods are frequently transported in bulk or packaged form by rail, representing a potential risk of release to the environment in the event of accidents on a number of other causes.³¹ Examples include valve leakage or safety valve releases in pressurized and general-service tank cars or other hazardous material containers (e.g. covered hoppers, intermodal trailers and containers, or portable tanks). In intermodal containers, spills and leaks may result from improper packing and resultant load shifting during transport. Additionally, there is a potential for the release of diesel during fueling operations.³²

In addition to guidance on hazardous materials management provided in the **General EHS Guidelines**, recommended measures to prevent, minimize, and control releases of hazardous materials during rail transportation and use include the following:

- Implementation of a system for the proper screening, acceptance, and transport of dangerous goods. Since these materials may be provided by third parties, the

screening and acceptance process should confirm accordance with international standards applicable to packaging, marking, and labeling of containers (or placarding), as well the necessary certificates and manifests from the shipper.³³

- Use of tank cars and other rolling stock that meet national and international standards (e.g. thermal protection and puncture resistance) appropriate for the cargo being carried,³⁴ and implementing a preventive maintenance program;
- Preparation of spill prevention and control, and emergency preparedness and response plans, based on an analysis of hazards, including the nature, consequence, and probability of accidents. Based on result of the hazard analysis, implementation of prevention and control measures which may include:
 - Routing and timing of hazardous materials transport to minimize risk to the community (e.g. restricting transport of hazardous materials on some routes)
 - Limiting train speed in developed areas
 - Construction of protective barriers and other technical measures (e.g. drainage / receptacle provisions) at sensitive locations (e.g. water resources and settlements)
- Dissemination of emergency preparedness and response information to the potentially affected communities (e.g. emergency notification systems and evacuation procedures);

²⁹ See U.S. Department of Transportation. Federal Railroad Administration. Track Safety Standards, Final Rule, 49 CFR Part 213 (1998)

³⁰ Examples include the elements of a safety management system specifically applicable to rail such as provided in the European Union Railway Safety Directive (Directive 2004/49/EC) or the Guidelines for the Safety Management System published by the Safety Management in Railways (SAMRAIL) group of the International Union of Railways (UIC).

³¹ Although hazardous materials are shipped in various kinds of rail cars (e.g. tank cars, covered hoppers, boxcars, intermodal equipment) tank cars carry the major portion of the traffic.

³² Gasoline use is typically limited in railroad operations.

³³ Examples of international standards include the Convention Concerning International Carriage by Rail (COTIF). Transport of dangerous goods is addressed in the Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID). The most recent version of the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID, 2006) came into effect on January 1, 2007. United Kingdom Department for Transport. Statutory Instrument No. 568. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (2004).

³⁴ See, for example, US Department of Transportation, Regulations on Use of Tank Cars, 49 CFR 173.31.

- Implementation of a hazardous material security plan and security awareness training, including provisions for personnel security, prevention of unauthorized access, and measures to reduce risks during storage and transport of hazardous materials;³⁵
- Use of standardized fuel spill prevention system for locomotive fueling, including automatic shut-off systems.³⁶
- Posting of clear and prominent warning signage at potential points of entry to track areas (e.g. stations and level crossings);
- Installation of fencing or other barriers at station ends and other locations to prevent access to tracks by unauthorized persons;
- Local education, especially to young people, regarding the dangers of trespassing;
- Designing stations to ensure the authorized route is safe, clearly indicated, and easy to use;
- Use of closed-circuit television to monitor rail stations and other areas where trespassing occurs frequently, with a voice alarm system to deter trespassers.

Level Crossings Safety

Level crossings (at-grade road / rail intersections) represent high-risk accident locations for railways. On railways with sparse traffic, a flagman may be used to stop all traffic at the crossing and clear the tracks before the approach of a train. Automatic warning lights and bells, and / or closable gates which barricade the roadway are more commonly used. The gates are intended to be complete barriers against intrusion of any road traffic onto the railway. Ungated crossings present the greatest potential risk. Recommendations to prevent, minimize, and control risks associated with level crossings include:

- Use of bridges or tunnels in place of level crossings. The removal of crossings may also improve train performance since most crossings have low speed limits to minimize risks to road traffic;
- Installation of automatic gates at all level crossings, and regular inspection/maintenance to ensure proper operation.

Pedestrian Safety

Trespassers on rail lines and facilities may incur risks from moving trains, electrical lines and equipment, and hazardous substances, among other issues. Measures to minimize, prevent, or control trespassing include:

³⁵ See U.S. Department of Transportation, Security Plans, 49 CFR Part 172, Subpart I.

³⁶ See Association of American Railroads, 2002. Manual of Standards and Recommended Practices Section M—Locomotives and Locomotive Interchange Equipment: RP-5503—Locomotive Fueling Interface.

2.0 Performance Indicators and Monitoring

2.1 Environment

Emissions and Effluent Guidelines

Emissions from new engines used for the propulsion of locomotives and railcars should be consistent with internationally recognized emissions limit values for nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and Total Hydrocarbons (THC).³⁷ Railways operations should also target improvements in the efficient use of energy which may contribute to the overall reduction of polluting emissions.³⁸

Effluents from maintenance facilities should be treated to a level consistent to the requirements of local sewer network operation or, if discharged into surface waters, according to the guideline values provided in the **EHS Guidelines for Metals, Plastics, and Rubber Products Manufacturing**, which provide treated effluent guideline values applicable to metals machining, cleaning, and plating and finishing processes, including painting. Site-specific discharge levels may be established for sewer and process effluents from maintenance facilities and terminals based on the availability of publicly operated sewage collection and treatment systems or, if discharged directly to surface waters, on the receiving water use classification as described in the **General EHS Guidelines**.³⁹

³⁷ Internationally recognized emissions values include the EU Stage III/IV emissions standards for non-road engines (Directive 2004/26/EC) and US Tier 3 / 4 standards (U.S. EPA 40 CFR Part 92). Achieving the most stringent values for NO_x and PM may require the use of secondary controls.

³⁸ As a point of comparison, average energy use by large freight railroads in the United States in 2004 (the most recent year for which data is available) was 245 kilojoules / revenue freight ton-kilometer (US Department of Transportation, Bureau of Transportation Statistics, 2006. National Transportation Statistics, Table 4-25M).

³⁹ Effluent guidelines specifically applicable to rail tank car cleaning activities can be found at US EPA 40 CFR Part 442 Subpart B.

Combustion source emissions guidelines associated with steam- and power-generation activities from sources with a capacity equal to or lower than 50 Megawatt thermal (MWh) are addressed in the **General EHS Guidelines** with larger power source emissions addressed in the **EHS Guidelines for Thermal Power**. Guidance on ambient considerations based on the total load of emissions is provided in the **General EHS Guidelines**.

Environmental Monitoring

Environmental monitoring programs for this sector should be implemented to address all activities that have been identified to have potentially significant impacts on the environment, during normal operations and upset conditions. Environmental monitoring activities should be based on direct or indirect indicators of emissions, effluents, and resource use applicable to the particular project. Monitoring frequency should be sufficient to provide representative data for the parameter being monitored. Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment. Monitoring data should be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Additional guidance on applicable sampling and analytical methods for emissions and effluents is provided in the **General EHS Guidelines**.

2.2 Occupational Health and Safety

Occupational Health and Safety Guidelines

Occupational health and safety performance should be evaluated against internationally published exposure guidelines, of which examples include the Threshold Limit Value (TLV[®]) occupational exposure guidelines and Biological Exposure Indices (BEIs[®]) published by American Conference of

Governmental Industrial Hygienists (ACGIH),⁴⁰ the Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH),⁴¹ Permissible Exposure Limits (PELs) published by the Occupational Safety and Health Administration of the United States (OSHA),⁴² Indicative Occupational Exposure Limit Values published by European Union member states,⁴³ or other similar sources.

Accident and Fatality Rates

Projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. Facility rates may be benchmarked against the performance of facilities in this sector in developed countries through consultation with published sources (e.g. US Bureau of Labor Statistics and UK Health and Safety Executive)⁴⁴.

Occupational Health and Safety Monitoring

The working environment should be occupational hazards relevant to the specific project. Monitoring should be designed and implemented by accredited professionals⁴⁵ as part of an occupational health and safety monitoring program. Facilities should also maintain a record of occupational accidents and diseases and dangerous occurrences and accidents. Additional guidance on occupational health and safety monitoring programs is provided in the **General EHS Guidelines**.

⁴⁰ Available at: <http://www.acgih.org/TLV/> and <http://www.acgih.org/store/>

⁴¹ Available at: <http://www.cdc.gov/niosh/npg/>

⁴² Available at:
http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARD_DS&p_id=9992

⁴³ Available at: http://europe.osha.eu.int/good_practice/risks/ds/oel/

⁴⁴ <http://www.bls.gov/iif/> and <http://www.hse.gov.uk/statistics/index.htm>

⁴⁵ Accredited professionals may include Certified Industrial Hygienists, Registered Occupational Hygienists, or Certified Safety Professionals or their equivalent.

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Annex A: General Description of Industry Activities

Typical railway components include locomotives and railroad cars, known as rolling stock, in addition to fixed infrastructure, including tracks, stations, fueling facilities, and maintenance and repair facilities.

Establishment of railway tracks and infrastructure include the siting of the railway right-of-way. The basic land requirement for a railway right-of-way is approximately 2.5 – 3.0 hectares of land per kilometer of track. Passenger rail systems may require three times this amount of land when including indirect land uses such as stations and parking areas. The land requirement per transport unit (e.g. passenger-km and tonne-km) is about 3.5 times lower for rail than for automobiles.⁴⁶

Project development and construction activities typically include access road construction or upgrade, site preparation and development (e.g. construction of bridges and tunnels), removal of select vegetation, if any, and the grading and excavation of soils for the installation of structural foundations for tracks and site utilities, such as stations, workshop and railway maintenance yards / depots, signaling systems, electricity supplies, and fueling facilities.

Rolling Stock

Locomotives

Passenger and freight railcars are typically pulled or pushed by diesel-powered locomotives. Electric locomotives may be used on rail lines that have electric power supplied by means of overhead lines or a conducting third rail. Modern electrified railway systems typically operate on an alternating current, but many existing direct current (DC) systems are still in use

worldwide. The operating voltage for DC systems is in the range of 750 to 3000 volts (V), while for AC systems 15 to 25 kilovolts (kV) is typical. Locomotives are often subdivided by their usage, namely passenger locomotives, freight locomotives, and switcher (or shunting) locomotives. These categories mainly depend on maneuverability, traction power, and speed. Electrically powered locomotives may be equipped with a regenerative brake system to recapture part of the kinetic energy that would otherwise be lost as heat when braking, transmitting it into the overhead wire for use by other locomotives. The locomotives provide the power to move a number of connected passenger or freight (cargo) railroad cars, and this unit is collectively known as a “train”.

Passenger Cars

Most passenger cars are made of steel, and may consist of double decks to accommodate passengers. Passenger cars may serve multiple functions including dining and baggage storage. Toilet facilities for passenger cars may deposit waste directly onto the tracks or employ retention tanks that are emptied at stations.

Freight / Cargo Cars

There are a number of types of freight cars designed for specific functions. Common types include:

- *Lorries*: Open top railway cars with tipping troughs, often used for transport of ore or minerals
- *Boxcars*: Enclosed railway cars with side doors used for most kinds of cargo
- *Refrigerator cars*: Refrigerated boxcars for the transport of foodstuffs

⁴⁶ European Environment Agency, Spatial and Ecological Assessment of the TEN – demonstration of indicators and GIS methods, 1998.

- *Gondolas*: Railway cars with an open top, enclosed sides and ends, used for bulk commodities and other goods
- *Flatcars*: Open cars for transportation of standard shipping containers and semi-trailers
- *Tank cars*: Tanks for the transport of liquids

Railway Track

The rail track is constructed of two parallel steel rails attached to perpendicular crossties (sleepers) made of timber, concrete or steel. The crossties are mounted in a bed of ballast, with underlying sub-ballast and a fine-grained subgrade foundation. Traditionally, bolted rail joints have been used for all railways. However, continuous-welded rails are now commonly installed when constructing new tracks or replacing rails during track maintenance. Wooden crossties are resilient and tend to give a smooth ride, but require initial chemical treatment to prevent rot and are not structurally suitable for modern high-speed tracks. Ballast generally consists of a 150-225 millimeter (mm) deep layer of stone crushed to a size of 40-65 mm, and provides support for the crossties and promotes drainage.

Railway Operations

The operational activities of rolling stock include all aspects of the movement of locomotives and railcars over a section of track, including passenger and freight transport, loading and unloading of freight at stations, and locomotive fueling. Most modern railways use automatic systems to monitor the location of trains and to operate signal / rail switching infrastructure.⁴⁷ Operational and maintenance activities associated with rail infrastructure include the maintenance and clearance of tracks,

signaling and switching systems, as well as associated roads, tunnels, bridges, and buildings.

Maintenance Activities

In addition to the track and track right-of-way maintenance activities, maintenance activities may consist of routine servicing or heavy mechanical maintenance activities. Routine maintenance activities may include lubricating oil changes and mechanical safety inspections, exterior washing of locomotives and wagons, and interior washing of rail tankers.

Heavy mechanical maintenance may include replacement of rolling and engine components, engine overhauls, mechanical tests and adjustments, among others. Heavy mechanical maintenance may also include parts machining, welding, cleaning (including degreasing), and other types of activities typically conducted in metal mechanics shops. Passenger and cargo wagons may also be cleaned and painted, including touch up painting, during heavy maintenance.

⁴⁷ The flow of train traffic is governed through a system of location and movement signal controls, which are mechanical or electronic and involve the use of time schedules, signs, colored lights, and rail track switching equipment. This system informs train operators regarding the status of the railway line and serves to prevent collisions.