CHAPTER 12

RAIL TRANSIT

Part Section Article

# 7 Maintenance of Way Considerations

## 7.1 GENERAL INFORMATION

Maintenance of Passenger Rail Transit systems whether publicly or privately owned, starts immediately at turnover from the builders. There are a series of both regularly scheduled and emergency response actions that a system needs to be ready to perform to keep the system safe and operational. There are many ways of preparing for these actions in use globally and across North America. This section discusses some of the considerations that the system owner, operator, designer, and/or contractor should consider during the planning, construction, and revenue service operations of the system to provide continuity of safe operations. The AREMA Manual of Railway Engineering (MRE) Chapters 2, 10, and 16 contain additional information on maintenance planning and activities.

### 7.1.1 SAFETY/SECURITY (2023)

Safety and security of the riders using the rail system, and of the employees providing the service, are the goals of safety, security, and operating plans.

Safety is the first and foremost concern when working on and around the railroad Right-of-Way (ROW). Safety is everyone's responsibility; it is important to be prepared when arriving on a railroad work site with all Personal Protective Equipment (PPE) required and established by the operating railroad. In the event of doubt or uncertainty, the safe course must be taken.

Security of stations, rail facilities, equipment, equipment yards, materials, and material yards all could pose a risk to train operations and is required for safety of the railroad ROW.

## 7.2 MAINTENANCE PHILOSOPHY

The most desirable maintenance philosophy is to maintain the railroad ROW in excellent operating condition for the reliable and safe passage of trains. The maintenance philosophy of a system covers organizational, contractual, and operational aspects.

### 7.2.1 GENERAL(2023)

Organizationally, an early decision about how the system will be maintained must be made. The first organizational decision is whether the railroad owner will use its own internal forces to perform the maintenance or will contract with a third party for those responsibilities, or will there be some combination of both options.

Contractually, the decision is how to structure the contract maintenance agreement(s). The maintenance contract can be a standalone contract or combined as part of a larger contract that includes other services (i.e., rail operations, dispatch, customer service, etc.) in addition to the maintenance.

Rail systems will continually undergo wear and degradation due to frequency of use and tonnage of loads traversing the track. The contract maintenance terms should contain assigned totals of track remediation that has been calculated as required to maintain track conditions for the reliable and safe passage of trains according to the owner's standards. These remediation items include for rehabilitation and/or replacement totals for rail, ties, ballast, welding of special trackwork (frogs and crossing diamonds), surfacing of the track, and other items as appropriate based on time frequencies and degradation limits.

Operationally, there are a range of decisions about how the system will be maintained. Maintenance is always linked to safety, and the railroad owner's/operator's maintenance decisions always are made to protect the safety of the system, its users, and the employees. The railroad owner could perform minimum maintenance and only repair an asset when it fails or reaches its condemnable or unsafe condition regardless of how it affects the reliability of the system. Alternately, the owner can undertake maintenance based on ensuring the reliability and make maintenance repairs based on failure metrics where repairs are scheduled for minimal disruptions and are made before the asset fails, a system that is sometimes referred to a reliability based maintenance (RBM). A third option is to perform maintenance protect the asset, to achieve reliability and to maximize the useful life of the asset.

### 7.2.2 RELIABILITY UNDER ADVERSE CONDITIONS (2023)

Reliability under adverse conditions and events covers a wide range and types of maintenance requirements. These events and conditions are not predictable in their timing but are predictable in their likelihood of occurrence. Some of these conditions vary by region while other conditions are common to all systems.

Adverse conditions and events include recurring weather patterns like large temperature swings affecting track stability (buckling and pull aparts), and specific regional weather events like hurricanes, tornadoes, blizzards, sandstorms, and floods. Other events and conditions to be considered include earthquakes, wildfires, rockslides, salt air, and tsunamis.

### 7.2.3 PROGRAM MAINTENANCE AND SPOT REPAIRS (2023)

Spot repairs are generally simple repairs that result from wear, degradation, or asset failure. Spot repairs are a mix of scheduled and unscheduled actions in response to asset failures or conditions identified during inspections. Typical unscheduled spot repairs could include culvert cleaning, broken rails, individual defective components like ties, fasteners, gate arms, lights, rail joints, downed trees, and more. Scheduled spot repairs could include switch lubrication, track circuit adjustments, spot tamping, ditching, and general preventive maintenance activities.

Programmatic Maintenance and cyclical maintenance involves planned work that is generally broader in scope or larger in scale than spot repairs. Programmatic and cyclical activities include out of face work where specific types of repairs are performed on segments of the system like surfacing, rail or tie replacement, rail grinding, ballast cleaning/undercutting, Bridge repairs and replacements, vegetation control, upgrades at crossing or signal locations, and more.

### 7.2.4 EFFECTS ON REVENUE OPERATIONS AND CUSTOMERS (2023)

To provide for the safety of the maintenance crews, maintenance is typically performed in work windows where trains are not operated on specific tracks during the maintenance activities. Work windows often result in detrimental effects to the operations where train schedules are temporarily suspended or modified creating issues for the system customers.

The design of the system can mitigate the operational effects by providing double tracks and frequent crossovers that allow work to be performed on one track while the adjacent track carries some of the scheduled trains. There is a system cost related to double track with frequent crossovers both at the initial construction phase and for the life of the system where additional tracks and crossovers require more maintenance than a minimum operable system with fewer tracks, switches and service recovery options. Determining the proper balance during planning and design is key to a reliable system.

Most systems have an established procedure for scheduling work windows and strive to accomplish the greatest number of activities under each work window while minimizing the number of work windows in effect across their system.

### 7.2.5 EFFECTS ON ADJACENT PROPERTIES (2023)

Maintenance activities may have impacts on adjacent properties. Systems often schedule work windows when the fewest trains are running. The low traffic periods used for the work windows are often late at night and/or on weekends. Lights used to illuminate the work area to provide safe working conditions can spill over into adjacent land.

Maintenance activities, regardless of when the work is performed often involve machinery that creates a noise impact on the adjacent land uses, and the machinery can also create dust that can be blown onto adjacent land. Rail welding and grinding which typically result in creation of sparks, run the risk of igniting fires on these adjacent properties as well. It is always important to include planned mitigations in maintenance activity plans to ensure the effect of these elements is minimized to the greatest extent possible.

For urban transit systems where the guideway is semi-exclusive or shared, the maintenance work may require road closures that affect access to adjacent businesses, properties, and land uses. Exclusive guideways may have longitudinal access that can be used for maintenance without impacting adjacent land uses.

## 7.3 INSPECTION, EVALUATION, AND PLANNING

Inspection of the system assets is vital for safety and is an important part of the maintenance effort. The inspections provide the condition data about the system that can be further evaluated and used to plan the programmatic maintenance.

### 7.3.1 GENERAL (2023)

The safety of the public transportation system is a vital part of transit rail operations. The regulations in the transit space are regulated differently in different countries. In the United States, transit safety is enforced by the State Safety Oversight (SSO) organization as regulated by the Federal Transit Administration (FTA). The regulations vary by SSO, and the specifics of the system both technically and operationally.

In Canada, regulation of the transit space is performed at the Provincial level of government.

Regardless of the regulatory framework, evaluation of the inspection data can be used to develop maintenance plans.

### 7.3.2 SIGNALS (2023)

Each of the transit rail modes has specific signaling requirements and practices. The AREMA Communications and Signals Manual (C&S Manual) is a manual of recommend practices published in the interest of establishing uniformity, promoting safety or efficiency and economy through standardization. The C&S Manual makes recommendations representing current signal practices for new installations, maintenance of existing systems, and for replacement on existing installations when general renewal or replacement is planned.

### 7.3.3 TRACK (2023)

Chapter 2 of the AREMA MRE has extensive guidance on the data collection and evaluation of track by automatic equipment including specialized track geometry vehicles or onboard systems.

Because transit systems in the US are regulated under SSOs, they do not have to meet the inspection requirements imposed by the Federal Railroad Administration on their Commuter, Inter-City, and High speed counterparts. It is incumbent on each agency to provide a safe and reliable system, and selecting the types and frequency of inspections that meet the minimum system requirements as approved by the SSO and the need to detect defects early.

### 7.3.4 STRUCTURES (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.3.5 TRACTION POWER (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

## 7.4 RIGHT OF WAY MAINTENANCE

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.4.1 GENERAL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.4.2 MAINTENANCE OF WAY EQUIPMENT (2023)

Outside of the US, maintenance of way equipment is often referred to as 'yellow plant'. Refer to AREMA MRE Chapter 27 for detailed technical requirements for maintenance of way equipment.

The need for maintenance of way equipment varies based on the maintenance philosophy adopted by the system owner. The following sections present the types of equipment typically employed by either in-house forces or contractors to maintain a transit system. The equipment is split into three categories based on how it is configured.

#### 7.4.2.1 Highway and Construction Equipment

This category includes the fleet vehicles and equipment that is common across all types of civil construction and maintenance. Regardless of the maintenance philosophy, a transit agency is likely to own several types of equipment in this category, but many of these pieces of equipment can be contracted for if the maintenance philosophy includes contracting maintenance or programmatic maintenance activities.

- Supervisor Trucks – These vehicles are standard highway trucks that are typically SUV or pickup style vehicles. These vehicles are sometimes fitted with retractable Hi-rail wheels. They may be fitted with radios, toolboxes, and auxiliary warning lights and work lights.
- Tractor Trailers – These trucks are conventional trucks designed to haul freight, but are modified to haul specialized trailers to carry maintenance of way equipment.
- Dump Trucks – Dump trucks are used to carry construction and maintenance materials or debris resulting from maintenance activities. Dump trucks are often fitted to also haul trailers to carry maintenance of way equipment.
- Flatbed Trailer – Flatbed trailers are used to deliver over-sized materials and to remove released materials. Flatbed trailers are hauled by the Tractor Trailer.
- Low-Boy Trailer – Sometimes referred to as goose neck trailers, are used to carry large pieces of maintenance of way equipment and are hauled by a Tractor Trailer. Trailer.

Some versions are designed to form a loading ramp and can be fitted with rails in the deck for carrying on-track equipment.

- Equipment Trailer – Used for moving skid steers, backhoes, and small dozers and is towed by a dump truck.
- Equipment Storage Vehicle – A mobile material vehicle with the capacity to store additional PPE, track maintenance tools, on track protection devices (such as signal shunting devices, barricades, etc.).
- Skid Steers – These versatile machines are used in locations where there is limited space and can perform material handling and debris/snow removal.
- Backhoes – Backhoes are a mainstay in any maintenance fleet. They can be used to handle materials, excavate trenches, and remove debris. Backhoes are often placed on trailers and hauled by dump trucks between work locations.
- Tracked Dozers – Tracked dozers are used to grade the right of way and to maintain access roadways. Tracked Dozers must be hauled on trailers from worksite to worksite.
- Hydraulic Excavators – Hydraulic excavators are used to handle material, clear debris, and to perform excavations. Depending on the size of the hydraulic excavator, larger trailers hauled by the tractor trailer may be required to move them from worksite to worksite.
- Front End Loader – Front end loaders are used for material distribution, grading, and debris removal.
- Specialized Trucks – Some specialized trucks are required for maintenance. These include mechanics vans, fuel/lube service trucks, vehicle repair trucks, bucket trucks, and maintenance crew trucks. These trucks are outfitted to meet the specific needs of the maintenance and repair tasks required.
- Cranes – A rubber-tired machine used to lift, move, pick: material, smaller equipment, site lighting and other distinct items as needed. North America generically refers to cranes as “speed swings”.

#### 7.4.2.2 Hi-rail Equipment

Equipment in this category is standard highway equipment equipped with retractable railroad wheels that allow them to be placed on the track and operate on the track like a train. . The Hi-rail equipment can get to locations without access. roadways. Most hi-rail equipment is radio equipped to work with the operations control center. Many of these types of equipment can be contracted for if the maintenance philosophy includes contracting maintenance or programmatic maintenance activities.

- Log Loaders/Boom Truck – These vehicles are mid-sized trucks fitted with small cranes for handling materials. They can carry and deliver parts for special trackwork, rails, ties, and other materials anywhere that has track access.
- Inspection Trucks – Inspection trucks are typically pickup sized trucks with utility bodies or tools boxes. They typically have auxiliary lights and work lights. They can be used by signal, track power, communications, and track inspectors to perform routine inspections.
- Cranes – A Hi-rail machine often with rubber tires, used to lift, move, pick: material, smaller equipment, site lighting and other various items as needed. Generically referred to as Speed Swings in North America.
- Welder Truck – There are three primary types of welders’ trucks that can be combined into a single unit if desired.
    - An electric/gas welders’ truck is used to repair special trackwork such as rebuilding frogs and rail ends as part of routine maintenance. It can also support

the mechanics and vehicle teams with running repairs. Safety cages or ventilated compartments for the gas welding tanks (oxy-propane and oxy-acetylene) are typically included on these types of vehicles.
    - A Field Welder truck is used to carry the materials and equipment to perform alumino-thermite field welds to join replacement rails and track components. The materials are temperature and moisture sensitive, so box trucks or large compartments are part of the utility body. Small booms are often added to handle the equipment.
    - A Portable Flash Butt Welder (FBW) truck is used if there are a large number of field welds to be made on a regular basis. It contains a large generator and an FBW head mounted on a gantry or boom that performs the rail welding.
- Hydraulic Excavators have been fitted with Hi-Rail equipment to provide greater access along the guideway.
- Side/Rotary Dump Truck – This is a specialized dump truck that can discharge material to the side of the track for maintenance work. Working with a Hi-Rail excavator it can haul debris off of the right of way without access roads.
- Bucket/Platform Trucks – For most systems with overhead wire (catenary) bucket trucks or platform lift trucks are needed for maintenance of the overhead wire system components. These can also be used by the signal and communications crews. Bridge Department can also use a specialized version of these trucks for inspections and repairs.

#### 7.4.2.3 On-Track Equipment

On-track equipment is specialized maintenance equipment that can only operate on the track. Machines in this category tend to be focused on track maintenance. Many of these machines can be contracted for if the maintenance philosophy includes contracting maintenance or programmatic maintenance activities.

- Tamper – A tamper is used to maintain the alignment and surface of ballasted track. As the ballast settles from trains operating over it, the track must be adjusted by tamping more ballast under the ties using these machines. Tampers on transit systems with third rails must fitted with stops, adjustable tamping heads/feet, or specialized clamps and hooks to maintain clearance to the third rail.
    - Production Tampers – Lifts rails and ties to line and surface track at high production rates.
    - Spot Tampers – Spot tampers are referred to by many names including chase, junior, drone , and pup tampers. They follow production tampers to provide a secondary tamp to the ballast. They do not line or surface track although they may be fitted with that equipment. Automatic drone tampers can work in conjunction with the production tampers. Spot tampers are also used in spot repairs including tie replacement and spot surfacing where track jacks or automatic lifting mechanisms on the tamper are used to correct specific defects.
    - Switch Tampers – Special lifting hooks and arms and with adjustable tamping foot placement are specialized to work in the tight confines of turnouts to maximize the tamping effort. On transit systems these tampers should have the ability to pick/lift heavier and larger concrete tie turnouts and larger frogs.
- Ballast Regulator – A ballast regulator is used to shape the ballast section around the ties to maintain the lateral and vertical strength of the track and to provide ballast for the tamper to place under the ties.

- Ballast Broom – Equipment that remove excess ballast from the top of ties by brushing the ballast off of the ties. These can be independent machines, or attached to a ballast regulator.
- Dynamic Track Stabilizer –In order to maintain proper track speeds safely, track and ballast sections, which has been disturbed through maintenance activities, must be properly stabilized. Disturbed track sections can be restored by running trains over the disturbed section at low speed for multiple trains over the course of hours, or by using a dynamic track stabilizer that allows the track to be used at full speed immediately minimizing the effect of the maintenance work on operations.
- Clippers – These machines remove and apply the resilient fasteners on ties and on direct fixation track. Removing and reapplying anchors on over a minimum of 600-feet of track is required when rails are replaced or breaks are repaired to adjust the rail to the correct neutral stress conditions before a rail weld can be made.
- Spike/Screw-driving/pulling machines – Self-propelled machines used to install or remove spikes and screw lags through the holes in tie plates and into wooden or composite ties where conventional ties plates or specialized clip plates are used. Spike driving and pulling machines are typically distinct machines, but the screw lag machines can often install and remove the screw lags.
- Rail Head Grinder – Transit rails require regular grinding to control the development of rail defects such as corrugations that increase the wear on the vehicle wheels and can lead to increased noise from the track.
- Cranes – An ontrack machine used to lift, move, pick: material, smaller equipment, site lighting and other various items as needed. Generically referred to as Burro, Little Giant, or Locomotive cranes in North America.

## 7.5 TRACK MAINTENANCE LIMITS

Track maintenance limits are developed by the individual transit agency and approved through the SSO, and are more restrictive than the minimum regulatory safety limits. The agency determines these values based on multiple factors including reliability and ride quality.

Transit track maintenance limits are dependent on the specific wheelsets used on the vehicles. The ‘normal’ values referenced in the AREMA MRE are based on the freight railroad standard wheel profile and dimensions. The American Public Transportation Association’s (APTA) guidance documents are predicated on wheels similar to the freight wheels and may not provide safe limits for specific transit wheelset designs that deviate from standard freight type wheel dimensions.

### 7.5.1 GENERAL (2023)

Track maintenance limits are a fundamental part of the safety of a public transportation system. Transit systems typically arrange their maintenance limits into four categories designated by color and sometimes speeds. Green designates the limits for full speed operations. Yellow and Red designate worsening levels of deviations and associated lower speeds. The Black condition designates a deviation that makes the track unsafe for operations.

#### 7.5.1.1 Transit Considerations

Transit Wheel Sets - Transit systems have a multitude of wheel profiles and dimensions. These differences require a careful review of the dimensions and a wheel-rail interface study to determine the proper values for these limits.

### 7.5.2 REGULATORY REQUIREMENTS (2023)

In the US because of the structure of the FTA's safety program regulations, there is no universal nationwide standard, like those under the FRA regulations, instead the SSOs are charged with establishing and enforcing safety limits under the FTA's regulations.

In Canada, each province has the authority to establish their own safety limits.

## 7.6 TRACK MAINTENANCE OPERATIONS

Track maintenance is normally housed within an agency's engineering department and may be sub-divided by disciplines including track, signals, communications, and structures.

### 7.6.1 TRACK MAINTENANCE OPERATIONS (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.6.2 UNUSUAL EVENT INSPECTION PROTOCOL (2023)

The unusual event inspection protocol is often focused on severe weather like hurricanes, high winds, and tornados, but should include other catastrophic events that could interfere with safe operations over the system including derailment, downed wire, earthquakes, floods, mud slides, wildfires, chemical spills/releases, vehicles on the tracks, collisions, and undergrade bridges being struck by highway vehicles.

An unusual event inspection protocol is a multi-discipline action plan involving operations, safety, and engineering functions. The basics of an unusual event inspection protocol include:

- Stopping trains in the affected area until the effect of the unusual event can be quantified.
- Holding trains at stations is preferred, but not always possible.
- Evacuating passengers and crew to places of safety and release if other modes of transportation are available or temporary transportation is provided.
- Allowing operations at appropriate speeds in areas that are not affected if the type of event allows continued safe operations.
- Performing appropriate inspections to determine if affected structures and guideway are safe to operate.
- Make repairs and return to full operations when safely possible.

### 7.6.3 NORMAL INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

## 7.7 STRUCTURES MAINTENANCE OPERATIONS

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.7.1 GENERAL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.7.2 REGULATORY REQUIREMENTS (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.7.3 SEVERE WEATHER INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.7.4 NORMAL INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

## 7.8 SIGNAL AND COMMUNICATIONS MAINTENANCE OPERATIONS

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.8.1 GENERAL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.8.2 REGULATORY REQUIREMENTS (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.8.3 SEVERE WEATHER INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.8.4 NORMAL INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

## 7.9 PROPULSION SYSTEM MAINTENANCE OPERATIONS

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.9.1 GENERAL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.9.2 SEVERE WEATHER INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.9.3 NORMAL INSPECTION PROTOCOL (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

## 7.10 FACILITY MAINTENANCE OPERATIONS

The visual condition of the public facilities set the perception of the system's quality and capabilities as a reliable transportation mode. The conditions also set the perception of safety, and riders typically avoid using locations perceived to be unsafe. There is considerable latitude in this area that allows for a wide range of methodologies and associated costs.

### 7.10.1 GENERAL (2023)

The safety of a facility for use by the public sets the minimum acceptable levels of maintenance. Slip, trip, and fall accidents are the prevalent form of injury and care should be exercised to identify, protect, and repair conditions that can lead to injury to the public and the staff. The facilities should also be free from dangers posed by defective devices and inoperable systems. Clean, well-lit facilities attract passengers to transit systems.

### 7.10.2 CLEANING (2023)

(THIS SECTION IS RESERVED FOR FUTURE DISCUSSION.)

### 7.10.3 SNOW AND ICE REMOVAL (2023)

Snow and ice removal is a constant battle in cold regions. Providing the staff and correct equipment to efficiently remove snow and ice is extremely important. The design of the facilities should also include provisions for where removed snow is stockpiled, throwing the snow off of the platform and onto the track is not an appropriate technique due to the damage caused to the track structure by the additional moisture and ice melting chemicals.