

## Practices for Wayside Rail Transit Worker Protection

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79 pages | | PAPERBACK

ISBN 978-0-309-22288-4 | DOI 10.17226/14657

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TRANSIT COOPERATIVE RESEARCH PROGRAM

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**TCRP SYNTHESIS 95**

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**Practices for Wayside Rail  
Transit Worker Protection**

*A Synthesis of Transit Practice*

**CONSULTANT**

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**TRANSPORTATION RESEARCH BOARD**

WASHINGTON, D.C.  
2012  
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The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

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Project J-7, Topic SF-15  
ISSN 1073-4880  
ISBN 978-0-309-22288-4  
Library of Congress Control Number 2011941915

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Transportation Research Board  
Business Office  
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**Cover photo:** Toronto Transit Commission signal maintainer contacting the Control Center before entering track level areas.  
*(Photo by Chris Kozub)*

## FOREWORD

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

## PREFACE

By Donna L. Vlasak  
Senior Program Officer  
Transportation  
Research Board

The purpose of the synthesis was to report the state of the practice to aid transit agencies and other entities in deciding how to develop successful wayside rail track worker protection practices.

The topic panel directed the consultant to conduct in-depth telephone interviews and site visits with selected transit agencies' staffs to provide a comprehensive look at how representative agencies provide successful wayside worker safety programs, covering multiple items. The goal was to aid streetcar, light and heavy rail providers, and other stakeholders in deciding how to proceed in developing and/or revising track worker protection practices. A review of the relevant literature was conducted to identify available and relevant documents and resources drawn from the FTA, GAO, and NTSB reports; FRA regulations and APTA standards resources; as well as numerous state, regional, and local agency issued publications. Thirty-nine publications are listed.

It was determined that in-depth case studies for SF-15 would provide more thorough synthesis reporting of subject areas at select agencies and be more beneficial and useful to other transit agencies than cursory synthesis survey reporting of numerous subject areas across a larger number of agencies.

The transit agencies studies were part of a Track Safety Task Force formed by New York City Transit as a result of track worker fatalities to evaluate safety culture, identify deficiencies and strengths, and develop recommendations for improvement. This task force was later joined by the Toronto Transit Commission in a Track Level Safety Team and charged with further improvements for workers at track level. Other systems soon formed or reconstituted "Rules Committees." Thus, these five transit agencies afforded the SF-15 panel with a range of modal, operational demographic, size, and historical context from which to look at proven practices and processes in implementing wayside rail track worker protection.

Christopher A. Kozub, Mineta Transportation Institute, Woodbridge, New Jersey, collected and synthesized the information and wrote the report, under the guidance of a panel of experts in the subject area. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at [www.trb.org](http://www.trb.org)) retains the color versions.

# PRACTICES FOR WAYSIDE RAIL TRANSIT WORKER PROTECTION

**SUMMARY** From 2003 to 2008, the nation’s heavy rail transit systems experienced eight accidents that resulted in the deaths of 10 right-of-way (ROW) workers, including track inspectors, track workers, and signal technicians, representing a 300% increase in the rate of fatalities and injuries from the historic averages in the heavy rail industry. In 2010, two more rail transit ROW workers lost their lives when they were struck by a high-rail vehicle.

Of the 19 worker fatalities reported to the National Transit Database (2003–2008) for rail transit, 17 were reported for heavy rail service and two for light rail service. Over half of those fatalities reported occurred on the ROW, in addition to the injuries and close calls to track workers that occurred on the ROW during the period.

The objectives of this study are to report the state of knowledge and practice regarding wayside worker protection programs at selected transit agencies and to document the state of the practice, including lessons learned and gaps in information.

Transit agency personnel indicated that in the wake of incidents involving track worker fatalities or near misses, their systems took aggressive actions. For example, as a result of two track worker fatalities on the New York City Transit (NYCT) system, the agency formed a Track Safety Task Force to evaluate the safety culture, identify deficiencies and strengths, and develop recommendations for improvements. After a near miss incident, the Toronto Transit Commission (TTC) established a Track Level Safety Team. This committee, composed of senior management from all the rail operations disciplines and worker representatives, was charged with developing recommendations on how to improve the safety of employees working at track level. Other systems formed or reconstituted “Rules Committees” to revisit their ROW rules and procedures and make necessary improvements. The Massachusetts Bay Transportation Authority (MBTA) essentially rewrote its complete rule book from scratch, in a collaborative effort with labor and management representatives from several departments.

Five systems, including NYCT and MBTA, participated in this synthesis study by providing materials, taking part in extensive interviews and site visits, or both. The other three systems participating were Maryland Transportation Administration, TTC, and New Jersey Transit River LINE operation. These five systems afforded the study team a range of modal, operational, demographic, size, and historical characteristics from which to look at practices and processes. The systems were selected based on the researchers’ experiences and close collaboration and consultation with topic panel members.

The study methodology included a literature review; telephone interviews; a review of rail transit documents including rule books, bulletins, training documents, and trend analyses; and selected site visits. During the site visits, the study team also witnessed flagging and work-site procedures in practice. Three key findings were identified as a result of this effort:

- The high-level standard developed by the APTA *Standard for Work Zone Safety* authorized by the APTA Rail Transit Standards Executive Committee on June 8, 2003, is the only national resource addressing transit track worker safety.

- Each of the five systems studied continually strives to improve the safety and level of protection for their ROW workers.
- Deviations existed in each system's program depth and complexity. These deviations varied, from those that reflected the environmental and operational hazards and characteristics of the systems to those that were influenced more by organizational cultural characteristics and historical practices.

Specifically, transit systems are taking steps to accomplish the following:

- Improve procedures to enhance safety and clarify rules so they are more easily understood;
- Augment their initial and recertification training programs for track workers and flaggers;
- Identify specific pieces of equipment essential to keeping workers safe; and
- Implement audit or inspection processes for rules compliance.

The practices reported by the agencies as having a positive impact ranged from minor changes to major initiatives. A sample of these practices includes the implementation of a joint labor/management pre-job safety inspection in NYCT; new procedures that require a transportation official (supervisor) to be part of setting up certain flagging sites and the deployment of "Emergency Personal Protective Equipment Boxes" throughout the rail system at MBTA; the implementation of computer-based training for recertification training at MTA; and the use of unique-colored vests for watchpersons/flaggers on the River LINE.

Although these practices and several others continue to improve track worker safety, they represent pieces of programs that lack industry consistency and an evaluation mechanism. Overall program effectiveness is difficult to measure given the lack of an industry standard for specific components and practices, and for evaluating program strengths and areas in need of improvement. Within the five systems included in the study, there were four distinct processes for determining, establishing, and carrying out track worker protection levels and measures, with significant differences in staffing levels, risk tolerances, training requirements, and audit processes.

Future research efforts that could benefit rail transit systems in their efforts to improve track worker safety include:

- Development of standardized ROW hazard analysis and mitigation training programs that utilize engaging, adult-learner methods for ROW workers and their supervisors;
- Development of a model plan for a track worker safety protection program;
- Development of a standardized, comprehensive approach to tracking and analyzing accidents, near miss, and rule violation data; and
- Exploration of the use of technology-based inspection methods, such as rolling-stock or high-rail-vehicle-mounted video cameras or sensors in the railroad industry, their applicability to the rail transit environment, and their utility in reducing hazard exposures for track inspectors.

## INTRODUCTION

According to the FTA's Fall 2008 *Rail Transit Safety Quarterly Newsletter*, between 2003 and 2008 the nation's heavy rail transit systems experienced eight accidents that resulted in the deaths of 10 right-of-way (ROW) workers, including track inspectors, track workers, and signal technicians, resulting in a 300% increase in the rate of fatalities and injuries from their historic average in the heavy rail industry. In 2010 two more rail transit ROW workers lost their lives when they were struck by a high-rail vehicle.

Of the 19 worker fatalities reported to the National Transit Database (2003 to 2008) for rail transit, 17 were reported for heavy rail service and two for light rail service. Over half of those fatalities reported occurred on the ROW. This is in addition to the track worker injuries and close calls that occurred on the ROW during the period.

This study focuses on the practices implemented by several rail transit agencies to establish or improve track worker safety protection programs.

### PROJECT OBJECTIVES AND BACKGROUND

The objectives of this study are to report the state of knowledge and practice regarding wayside worker protection programs at selected transit agencies and to document the state of the practice, including lessons learned and gaps in information.

Improved safeguards and safety procedures can reduce accidents and fatalities for rail transit wayside workers across North America. This study identifies successful practices in track worker protection that could serve as models or foundations for programs developed at the system- or industry-wide level.

The discussion of effective safety practices begins with an understanding of the hazards facing rail transit ROW workers. There are myriad potentially dangerous conditions present on the ROW, including slip, trip, and fall hazards; energized power; tight and dark working environments; and elevated work zones. However, the most injurious and fatal hazard to ROW workers continues to be the movement of trains and equipment through work areas. Although all of the agencies included in the study have rules and practices to address the range of hazards, the focus of their programs is on protecting

workers from being struck by a moving train or piece of maintenance equipment.

The initial panel discussion determined that the study should address both heavy rail and light rail modes of transit. The literature review and agency interviews revealed that modal delineations in track worker protection and overall safety programs are less relevant than an approach that considers a transit agency's infrastructure and operations and the hazards associated with employees and contractors working safely within those parameters. The key considerations are listed here.

### Environmental Factors

Environmental factors are any characteristics of the ROW or infrastructure that create a hazardous condition limiting a worker's ability to clear the track in the event of train or other equipment or vehicle movement. Areas requiring special attention include:

- Tunnels. This environment, regardless of mode, presents a variety of hazardous conditions, including limited light and therefore visibility; limited sight distances; tight clearances; and acoustic conditions that can amplify, deaden, or misdirect the sounds of oncoming trains.
- ROW bridges and elevated structures. Although the diminished light and acoustic problems inherent in tunnels are not found in these areas, the hazards of tight clearances, combined with the need for prevention of falls and often amplified weather conditions, particularly wind and ice, present a unique set of hazards.
- Tight or blind curves. Regardless of whether eight-car heavy rail trains are operating in revenue service or high-rail equipment is moving to or from a work site, the limited sight distance in tight or blind curves—above and below ground—presents a potentially very dangerous condition.
- Multiple track ROWs. Most systems are configured with a two-track main line; only one of the systems studied has sections with three or four running tracks. That configuration allows maintenance and construction planners and supervisors to work with transportation and operations personnel to explore ways in which a work site can be bypassed using a local or express track. But the configuration presents a more dynamic and

complicated work area to control owing to the multiple tracks. Two systems in the study have track configurations that appear to be three- or four-track mainlines but actually are two running tracks separated or paralleled by one or two siding or “pocket” tracks. These allow storage of revenue trains between peak periods or of work equipment without returning it to end-of-line yards. The operating rules on these systems require trains and equipment using these tracks to move at restricted speed, permitting the operator to stop when anyone or anything is observed fouling the track.

- Shared-use ROW. A significant variable in the development and implementation of work zone safety measures is whether track runs along an exclusive-use ROW or on the street in mixed traffic. Shared-use ROW introduces a host of additional complications and considerations in protecting employees from not only train movement but also mixed, rubber-tired vehicular traffic.

### Operational Factors

Operational factors are system characteristics that introduce or compound a hazardous condition through continuous train or equipment movement, and energized traction power, including:

- Train speeds. When trains or equipment are operated through work areas at normal or close-to-normal speeds, track workers are constrained in their options and ability to safely clear the “foul area,” and operators are limited in their stopping distances.
- Daily hours of revenue service. Revenue service hours vary from system to system. Systems often shut down revenue service overnight for approximately 4 h. This service cessation provides a work period for track, communications and signals, and traction power employees to perform inspections, repairs, and replacements that otherwise would be performed during normal operating hours.
- Train headways. The variable headways between systems, as well as between different lines within one system, affect the design and implementation of effective practices to protect workers.

Panel discussions and some of the initial agency interviews explored ways in which emergency responders are addressed in ROW safety programs. All the systems in the study offer some form of “ROW Hazard Awareness” training to all police, fire, and emergency medical services agencies serving their system. However, the systems do not offer extensive ROW protection training because operational practices or rules typically dictate the suspension of service and operations once an emergency response agency enters the ROW. During prolonged periods of service disruption, agencies may work cooperatively with the police, fire, or emergency medical services officers to provide them with safe operational zones while starting limited service, but these activities are always

done under the close, on-scene supervision of transportation or operations department supervisors or managers from the rail transit agency.

## RESEARCH METHODOLOGY

### Literature Review

As part of the initial research, a literature review was conducted to identify available, relevant documents and resources. The review used an array of web-based search tools, including TRB’s Transport Research International Documentation database, which integrates more than 900,000 records of transportation research from TRB’s Transportation Research Information Services (TRIS) database and the OECD’s Joint Transport Research Centre’s International Transport Research Documentation database. The researchers also reviewed relevant, open-source documents available from the NTSB, the U.S. Government Accountability Office, and FTA, including research, academic, technical, guidance, and training documents produced by the Volpe Center, the Transportation Safety Institute, and the FTA University Transportation Centers. This process also utilized advice and direction from panel members, APTA staff, rail transit system safety professionals, and representatives from rail transit-oriented labor unions and the Transportation Trades Division of the AFL-CIO.

The search revealed several investigative or analytical reports that examined specific incidents and organizational or systemic issues in the public transit industry and the FTA. The reports issued by the NTSB or the U.S. Government Accountability Office primarily provided detailed insights into incident root and contributing causes for some accidents, recommendations for changes in FTA oversight and data management practices, or suggestions for organizational measures to improve overall system safety practices and cultures within the transit agencies addressed in the report or investigation.

Also discovered in the search were a number of technical and academic research papers, trade publication articles, and trade association reports that focused primarily on railroad—as opposed to rail transit—ROW safety practices. Also, many of these resources were generated abroad, most typically in the United Kingdom, and focused on rail operations in that and other European or Asian countries. These were usually developed by academia, industry, or partnerships and tended toward technical rather than practice-based issues.

The two primary domestic resources identified in the review were the CFR (Code of Federal Regulations) 214, Subpart C—Roadway Worker Protection, which is the regulation governing maintenance-of-way practices on all rail lines under the oversight of the FRA, and the “Standard for Work Zone Safety,” developed through industry consensus, by APTA. The APTA standard—as with most industry standards regardless of sector—provides high-level, conceptual guidelines for what should be included in rail transit system work

zone safety rules and procedures. It does not provide detailed information or prescriptive direction for developing rules, practices, training courses, or other ROW worker protection program components. Likewise, CFR 214 Subpart C provides direction relative to complying with the regulation. It does not offer guidance for developing a track worker protection program. A third document that is in development is another APTA standard, entitled “Roadway Worker Protection Program Requirements.” The draft version of this standard closely follows the 214, Subpart C regulations relative to levels of protection, types of protection, and terminology.

Apart from post-incident reports, which tend to focus on bad practices that caused or contributed to an accident and therefore should not be used, the literature review found minimal resources that could be employed in developing such elements as rules, practices, personal protection equipment (PPE) requirements, communication guidelines, core equipment needs, or training courses, of a comprehensive rail transit ROW worker safety program.

### **Transit Agency Interviews and Site Visits**

Extensive consultation with project panel members determined that a survey method of research would not provide the appropriate level of detail to the study. Although a survey would have helped identify broadly which systems had track worker protection processes and specific rules, it would not have provided the needed breadth and depth of relevant information on successful practices. Focusing in detail on a sample of systems would allow for greater exposure of the procedures and practices used, as well as the experiences and lessons learned in developing and implementing track worker protection program elements, including work rules, training, and technology. Panel members and TCRP staff determined that an acceptable and more effective research process for this project would be to develop case studies that focused on four to five systems that would participate in the study through face-to-face and telephone interviews, host research site visits, and provide extensive materials for review. These materials included rule books; training programs; work orders; bulletins; policy and rule change orders; agency work forms; and specifications for PPE, warning and flagging devices, and other technological devices or infrastructure modifications. The site visits were used to conduct face-to-face meetings with all levels of relevant personnel and to observe track worker protection practices firsthand, from off the ROW. Witnessing flagging and work-site procedures in practice helped illustrate the manner in which policies and rules regarding flagging, PPE, warning devices, and general track-level work practices are synergized to provide an effective track worker protection program.

Ultimately, the five systems that provided materials, participated in extensive interviews and site visits, or both were the Massachusetts Bay Transportation Authority (MBTA),

New York City Transit (NYCT), Maryland Transportation Administration (MTA), the Toronto Transit Commission (TTC), and the Southern New Jersey Light Rail Transit System (River LINE) operation. These systems were selected with thorough input, guidance, direction, and suggestions from the project panel to ensure that, within the scope and resources of the project, the sample set would represent a range of modal, operational, demographic, size, and historical characteristics, including a spectrum of organizational, cultural, and environmental factors. Within this group, two of the largest and oldest rail transit systems in the United States and the oldest in Canada provided a perspective on approaches to addressing large, complex track maintenance operations in systems with little or no downtime and minimal headways. They also offer insights into how the systems, and the ROW safety practices and rules, have evolved over time and through unfortunate incidents. Initial discussions with panel members identified that “maintenance windows” in which track inspections or maintenance can be done, are the biggest challenge in scheduling and in protecting track workers. By including systems with little or no “maintenance windows,” including NYCT, which operates 24 h a day, 7 days a week, the study would identify practices for affording protection in the most challenging situations. Three of the systems also demonstrated how multi-rail modal systems adapt and modify rules to fit the needs of each operation or line. One system, MBTA, has adopted the rail ROW practices for maintenance-of-way (MOW) employees on its new bus rapid transit line and tunnel infrastructure. Lastly, two systems that operate lengthy and growing light rail systems, MTA and the River LINE, have built track worker safety programs on existing Federal Railroad Regulatory guidelines to establish an effective MOW protection program and comply with FRA rules.

The literature review and site visits also revealed a lack of standardization in terminology. Some systems use the terms “flagman” or “flagperson” and “watchman” or “watchperson” to define positions with different duties and responsibilities, and some of the systems use the terms interchangeably. The term “right-of-way” or “ROW” is also defined in varying ways. Some systems define or establish ROW as an area that is a set and consistent distance from either the center of the track or the outside rail. Other systems define it as the area from one edge of the ballast to the other; the property on which all of the track, power, signals, and other wayside equipment and structures are located; or from wall-to-wall or fence-to-fence. Some of the definitions are applicable primarily to heavy rail systems that have fences or walls separating the tracks and supporting systems from public spaces. These definitions, however, would not be appropriate for many light rail systems that run through public streets or on at-grade ROWs that are not protected by fences or other barriers. Another area of a rail transit system that is called by multiple terms is the zone that rail equipment occupies when moving down a track. On some systems, this is part of the broader ROW; on others it defines the ROW. Termed “the dynamic envelope” on some systems, this area or zone is where anyone or anything

within its limits would be fouling the track and be struck by a moving train or work equipment.

Throughout this report, sections that are quoted or paraphrased from specific rail system documents use the terminology of the cited system. The glossary definition represents a consensus of system definitions and/or provides alternate terms or definitions.

#### **ORGANIZATION OF REPORT**

The report is organized in a way that reflects the three phases of protecting track workers: pre-work, work site, and post-work. Although some would view these three steps as a

linear, “cradle to grave” process for each project (such as replacing a section of rail, rebuilding an interlocking, or installing new signal components), from an overall system perspective, it is a cycle whereby work practices are evaluated continually, along with reported incidents and near misses, all of which inform the pre-work and work-site activities of training, rules modification, job planning, PPE selection and usage, and staffing.

By organizing the study and the report in this manner, specific practices for tasks in each step could be discussed, as well as broader, programmatic approaches that have been implemented to ensure continuous improvement in track work safety efforts.

## PRE-WORK ACCIDENT PREVENTION

### INTRODUCTION

The rail agencies included in this study have established rules and procedures to provide structure, guidance, and administrative oversight of employees and contractors working on, around, or near the ROW. The universal goal of each agency's effort is to prevent incidents on the ROW that could result in worker injuries and deaths. However, each agency's roadway worker protection program strives to reach that goal in different ways. The basic components of the programs are similar, but the sophistication and implementation of the approaches are driven by each agency's unique set of environmental and operational factors, as well as organizational history and culture. Some other measures, outside of rules and practices governing track worker protection, have also reduced risk levels for employees by modifying or relocating work processes and modifying equipment designs.

### TARGET AUDIENCES

An agency's rules and procedures regarding roadway worker protection are designed to apply to various audiences based on the level of risk they are exposed to while carrying out their prescribed duties, as well as the risks they could present to other employees. The primary audience protected by the rules and procedures includes employees and contractors performing MOW activities. To keep MOW workers safe, specific rules and procedures also apply to train operations staff. Train operators, control center personnel, supervisors, and managers are responsible for operating the trains through MOW work zones according to the agency's operating rules. In addition, operators at NYCT, MBTA, and TTC provide flagging functions for contractor crews.

### RULES DEVELOPMENT, COMMUNICATION, AND ENFORCEMENT

#### Development

ROW Safety/Railroad Worker Protection rules at each agency included in the study had undergone major revisions within the last 8 years. The impetus for these changes included the need to respond to State Safety Oversight agency recommendations, actions implemented in the wake of serious incidents or accidents, and compliance with FRA regulations. The rules development process ranged from an initiative executed mainly

by the rail operations department to an interdepartmental task force driven effort that included union representation.

MBTA's current ROW Rulebook, issued in 2008, was the result of an ongoing management and labor collaborative effort to create safe ROW work practices. MBTA officials interviewed indicated that they were in the process of reestablishing their rule book committee to evaluate the impact of the 2008 revisions and make needed modifications.

NYCT convened a Track Safety Task Force after two employee fatalities occurred in April 2007. The task force consisted of two representatives from the Office of System Safety, three representatives from the Department of Subways, and three representatives from the Transport Workers Union (TWU) Local 100. The task force was charged with evaluating the safety culture, identifying deficiencies and strengths in their track safety process, and developing recommendations to improve the safety process and culture (*I*, p. 3).

The NYCT Track Safety Task Force invested in efforts to educate the task force members on the scope of the problem and effective strategies for fostering organizational change. To identify the cultural and behavioral factors that influence track safety, a survey of MOW hourly employees and supervisors, train operators, construction flaggers, and train service supervisors was conducted. In addition, the task force members were given training on the process of influencing individual behavior to effect culture change in an organization. The insights gleaned from the employee survey and the guidance provided by the task force training was used to develop the task force's recommendations. These recommendations were implemented in early 2008. The Track Safety Task Force continues to exist to oversee NYCT track safety initiatives (*I*, pp. 4–6).

TTC is in the process of completing a major revision to its Subway/SRT Rule Book to make it more user friendly. The goal of the revision effort is not to change any of the rules, but rather to communicate the existing rules more clearly and to be more specific regarding employee responsibilities. The layout of the revised book will also be easier to read by employing a color-coding scheme and other formatting enhancements.

The agencies interviewed developed and issued their work-site protection rules in different ways. MBTA published all roadway worker protection rules in a separate ROW



Safety Rule Book that applies to both MOW and operations employees. MTA and the River LINE have a *Railroad Worker Protection Manual* that applies to MOW employees. Rules regarding operating employees' responsibilities when traveling through work zones are covered in the overall System Operating Rules. NYCT and TTC integrate both the MOW employee rules and the operating rules into their overall Department of Subways or Subway/SRT Rule Book. Agencies that have separate ROW rule books require all employees, crew supervisors, and forepersons to carry the book with them on the job. Several of the agencies interviewed published their rule books in handy 7-in.-by-4½-in. spiral-bound booklets or binders that are easy to carry and use.

Periodically, the agencies issue additions, changes, or clarifications to the rules. At the River LINE and MTA, the responsibility for updating the ROW rules rests with the Superintendent of Rail Transportation or a similar position. The initial ROW Safety Committee that completed a major revision of MBTA rules in 2008 is not a standing committee. Modifications to the rules are issued jointly by the directors of the operating departments and divisions and the director of safety. The next major revision to the MBTA rulebook is planned in late 2011. This revision effort will be spearheaded by the reconstituted ROW Safety Committee. In New York, changes to the rules regarding track safety (additions, deletions, modifications of rules) must be approved by a standing Track Safety Committee that includes Transportation (MOW and Service Delivery) and System Safety management employees, and union representatives.

At all agencies, the Transportation Department largely "owns" the relevant rule books and is the driving force behind any revisions. TTC, in addition to the standard approaches to revising the rules, has a documented application process. Through this application process, an employee from any department with a vested interest in the rules can apply for a rules change by providing justification for the change to the Rail Transportation Department. The proposed change is reviewed by the department and discussed with the other relevant departments. All rule changes must be approved by all stakeholder departments, such as Signals/Electric/Communications, Track & Structure, Training & Support Services, and Safety.

### **Communication**

Employees working for agencies with ROW rules integrated into the larger operating rule book receive the rule book when they are hired. At that time, they are required to sign a document indicating that they had received and understood the rules. ROW training reinforces specific ROW rules. Employees working for agencies that have a separate ROW rule book receive the rule book at their ROW training and also are required to sign an acknowledgment. For all the agencies, contractor requirements regarding ROW safety are written into the contracts. Some agencies provide contractor employees

with copies of the rule book when they attend ROW training, and others provide contractors with an electronic copy of the rule book and require them to distribute it to their employees.

All the agencies interviewed communicate rule changes via bulletins. In addition, depending on the nature of the modification, changes can be communicated in the issuance of new standard operating procedures, payroll flyers, or toolbox meetings. Generally, the bulletins are e-mailed to managers and supervisors, who reproduce hard copies for employees or post them at work locations. Some agencies require employees to acknowledge receipt of new standard operating procedures or rule changes that relate to policy compliance. The rule changes are also covered in each agency's annual refresher training.

In addition to bulletins, TTC has developed and implemented a more structured rule book version control process. The person to whom the rule book is issued is responsible for updating his or her copy. The person is directed to record all revisions in a "Revision Records" section of the book, and to indicate the change in the appropriate section and rule number by crossing out the current wording and inserting a copy of the change notice. All changes are issued by TTC as a notice and distributed to all cost center department heads. The department heads are responsible for ensuring that all change notices are issued to their employees by having the employee sign for each change notice. The change notices are distributed on paper that is sized and hole-punched to fit directly into the rule book. New rules and revised rules are clearly identified in the change notices (2, pp. iv–viii).

To reinforce the rules, NYCT MOW supervisors are required to advise hourly employees of a prepared Rule of the Day during their job-specific Toolbox Safety Talk before the tour's assigned task. A monthly list of the Rule of the Day is developed by each subdivision. In addition, a job-specific Rule of the Day, which relates to the tasks to be performed, and newly issued safety bulletins and advisories must be discussed. These items are included on the MOW Daily Supervisor's Checklist that each supervisor must complete and forward to his or her superintendent daily. The River LINE includes a Safety Rule of the Day and a Light Rail Rule of the Day as part of the Daily Bulletin issued to employees.

### **Enforcement**

Work rules and procedures are enforced through daily oversight performed by field supervisory personnel. In addition, most of the agencies interviewed have rules requiring employees to report violations to supervisory personnel or the control center. The violations most frequently communicated are MOW workers reporting train operator violations or vice versa. As one agency representative admitted, even though rules require employees to report violations, accidents, and near misses, enforcing these reporting rules is more difficult than enforcing work practice, flagging, and PPE rules.

The agencies interviewed also require some form of structured review process to ensure that the oversight is provided. This usually involves a job site supervisor or foreman completing some form of safety checklist before the commencement of work. These range from checklists to verify that workers have the required PPE to a more detailed evaluation of job site safety concerns. In addition, all the agencies require supervisors to conduct some form of job-site monitoring.

MBTA chief inspectors and area supervisors are required to conduct field observations of each flagging site in their area of responsibility every day. MTA supervisors are tasked with completing one Railroad Worker Protection Monitoring Report per month. Depending on the department, TTC supervisors are required to complete two to eight Job Safety Observations per month. Supervisors at NYCT must inspect each gang that is performing full flagging once per shift. Gangs whose normal job duties are performed under point-to-point flagging are randomly inspected at least once every 5 days. In addition to identifying rule violations, NYCT's supervisor training encourages supervisors to use the monitoring process to acknowledge employees who are observed working safely. The agency believes that positive reinforcement can influence rule compliance and nurture the organization's safety culture.

The supervisory person conducting the review in all cases has the authority to remove a worker from the work site or shut down the entire operation if employees are found to be in violation of the rules. Work can resume upon correction of the violation(s). Disciplinary actions can range from a verbal warning if an employee is missing a piece of required equipment to formal action in accordance with the agency's progressive discipline policy. Interviews with supervisory personnel revealed differences in the seriousness with which minor infractions were handled. Hourly employees at agencies with stricter enforcement complained about the lack of discretion exercised by supervisors in enforcing the rules, but at the same time acknowledged real improvements in the organization's safety culture.

Some of the agencies interviewed also had formal processes in place to use the information collected to help evaluate and improve the overall effectiveness of their roadway worker protection efforts. MBTA requires the monitoring forms to be sent to the operating division chiefs for review and potential corrective actions. Similarly, the NYCT Division of Subways produces quarterly reports that outline the violations observed and corrective actions. These reports are provided to the Office of System Safety and reviewed with workers at quarterly operating unit meetings.

## TRAINING AND CERTIFICATION

All of the agencies interviewed provided some form of training, certification, and recertification related to roadway worker protection. However, each agency reported different

combinations of curriculum and certification/recertification processes for the target audiences. Generally, the training focused on three main topics:

- General hazards associated with working on, around, or near the ROW;
- Employee responsibilities and the specific ROW rules; and
- Flagging procedures.

A summary of the ROW training efforts at each agency follows.

### Massachusetts Bay Transportation Authority

The Operations Training Department is the agency lead for developing and delivering all track safety-related courses based on the ROW Safety Rule Book, including flagging training and other pertinent information provided to them. Labor-management committees review the course pilots. Current offerings are described here.

#### *ROW Rules Training and Certification*

This is an 8-h, instructor-led course that includes 6 h of ROW Hazards and Rules training and a 2-h Occupational Safety and Health Administration presentation from the Safety Department. The entire course is delivered in the classroom. All job classifications governed by ROW rules must complete the training and score above 70% on a test to receive a certification card. Employees and contractors must carry their certification cards at all times on the ROW. The card is listed in the rules as one of the agency's essential pieces of PPE. This training is conducted as part of new ROW employees' orientation. Employees promoted into MOW classifications requiring the training take the course before assuming their new duties. Course participants are given two chances to pass the test. Those not passing after two tries must repeat the full-day course.

All employees and contractors must complete recertification training every 2 years. The recertification training is a 4-h, instructor-led course conducted in the classroom. It is essentially a repeat of the rules component of the initial full-day course.

The ROW Rule Training and Recertification classes are mixed with operations, ROW maintenance, and contractors except for the courses given in Spanish to meet the needs of contractors. The instructors are usually former inspectors. The course is updated every time a new rule book is issued, but interim changes are covered in the class deliveries.

All MBTA employees and contractors attending the course are asked to complete a training evaluation form. The completed evaluations are reviewed by the Operations

Training Department and shared with the operating units. In a few instances, feedback received on the training evaluation forms led to the reassessment and modification of the ROW rules.

### *Flagging Training*

All operators and MOW employees are required to take flagging training. Contractors do not receive flagging training. A flagging team composed of MBTA operators is assigned to each contractor job. Contractors are not allowed to provide their own flagging protection.

Flagging training consists of a 2-day course of which approximately 75% is conducted in the field. All MOW employees and train operators, supervisors, and managers take flagging training. Students must achieve 100% on the test. If a person does not score 100%, an instructor will work with him or her to clear up any issues and prepare to retake the test. The Operations Training Department also developed this training and updates it as necessary. There is no formal certification or recertification process or documents associated with completing flagging training.

### **Maryland Transit Administration**

Once every calendar year, the MTA Training Department provides all roadway workers initial and refresher training on the on-track safety rules and procedures that the workers are required to follow. Light rail employees other than roadway workers (whose primary duties concern the movement and protection of trains) are trained to perform their functions related to On-Track Safety as part of their operating qualification training.

MTA ROW safety training is divided into three modules: basic ROW rules, a flagmen/watchmen module, and an on-site coordinator (OSC) module. The OSC module includes the detailed information on levels of protection that is usually covered in the separate flagging training at other agencies. ROW employees and contractor supervisory personnel receive all three modules. Upon completion of this 8-h training program, participants must score 80% or higher on the test to be certified as an OSC. The nonsupervisory-level contractor employees are provided with the basic ROW rules and flagmen/watchmen modules only. Upon completion of this 6-h training program, participants must score 80% or higher to be certified as flagmen/watchmen. The difference between an OSC and flagmen/watchmen is that an OSC is responsible for the on-track safety of work crews. The OSC establishes working limits and assigns and supervises flagmen/watchmen.

ROW employees and contractors must repeat the OSC or flagmen/watchmen training each year to maintain their certification. A successful practice that MTA has recently implemented is offering employees a computer-based version

of the OSC training for recertification purposes. Employees can complete the required training and end-of-course test online from home. Those opting to complete the refresher training online are not compensated for their time. Employees taking advantage of this option do so to avoid having to sit in class for an entire day.

### **New York City Transit**

The Operations Training Department is the agency lead for developing and delivering all track-safety-related courses based on the Employee Rule Book and other pertinent information provided to them. The courses are described here.

### *Track Safety Training*

This is an 8-h, instructor-led course. Approximately half of the time is spent in the classroom and the other half is spent on the ROW. All personnel who must enter the ROW, including MOW and Rapid Transit Operations employees, must complete the training and score above 70% on the test to receive their certification card. Certification cards are required to be carried at all times on the ROW. People hired into the job classifications that require Track Safety certification are scheduled for the course as part of their orientation training. Employees promoted into classifications requiring the training take the course before assuming their new duties. Employees are given three chances to pass the test. Those not passing after three tries are not permitted to enter the ROW.

All employees and contractors must complete recertification training every 2 years, except personnel who successfully completed flagging refresher training in the past year. The recertification training is an 8-h, instructor-led course conducted in the classroom. The recertification training is different from the initial track safety training and includes class discussions and interactivities that highlight specific safety issues.

### *Flagging Training*

All MOW employees and train conductors who choose to serve as flaggers for construction crews are required to take flagging training. This is a 9-day course with a significant “hands-on” component. The 9-day course consists of 3 days of class instruction, 5 days posting with experienced flaggers, and a 1-day final exam. Point-to-point flagging involving small moving work crews and near-miss incident reporting requirements are incorporated into the training. Students must score 100% on the test to pass the course. If a person is unable to score 100% after three attempts, he or she is not permitted to perform flagging. Requalification requires the successful completion of a 1-day refresher course each year. Employees who successfully complete the annual Flagging Refresher Course are not required to attend the Track Safety Refresher course.

The implementation of standardized flagging training and the 1-day flagging refresher course was a direct result of NYCT's Track Safety Task Force. Previously, different divisions had their own interpretations of flagging rules, training programs differed, and only some employees received refresher training.

The Track Safety and Flagging curriculum is updated on an as-needed basis. Frequently after a near miss or accident, the course scenarios are updated to incorporate "lessons learned" from the incident. The last major overhaul of the training was in 2008 and was a result of the Track Safety Task Force efforts. The training was revised to make it more interactive and engaging. For example, the Track Safety training refresher was changed from a 20-min video to a full-day interactive course. The course instructors are former operations employees with an aptitude and an interest in teaching.

### **Toronto Transit Commission**

All employees and contractor personnel who are required to work at track level must be rule book trained and certified, and must carry proof of certification. All ROW employees attend a 2-day course that addresses ROW hazards, ROW rules, and flagging procedures. There is no separate flagging training or certification requirement. The ROW rules training includes both classroom instruction and field experience encompassing a walk from station to station in a tunnel to get a feel for the environment. Participants must score 80% or higher to receive rule book certification. However, there are some "safety critical" questions that must be answered correctly to pass the test. Rule book-certified ROW employees are re-certified annually by participating in a 1-day refresher training course and scoring 80% or higher on the exam.

ROW rules training is integrated into TTC's 31-day new operator training program. The content is the same as what is taught to the ROW employees. Operators must be recertified every 3 years.

Contractors receive a shorter (1-day) version of the course and must also receive a score of 80% or higher on the end-of-course test. Unless there is an emergency situation, all contract work is carried out in impassable work zones outside revenue service hours or by isolating the contract employees from track level through hoarding. All contract work carried out at track level must be set up and supervised at all times by a rule book-certified TTC employee.

Toronto Police Service Transit Enforcement Officers are provided with a 2-day training program that provides officers with vehicle safety features familiarization, door operations, and track-level tours.

All TTC training is conducted in English. The certification tests are also in English only, but employees can request that

the test be administered orally. Employees who do not pass the test are retrained and permitted to retake the test. New employees unable to pass the test are dismissed. Existing employees are reassigned to their original positions that do not involve them working at track level.

In addition to the ROW rules training, all TTC personnel at the foreperson or higher level are expected to attend a 3-day Risk Assessment course offered at a local university. The purpose of this training is to provide all supervisory personnel with the skills and knowledge to identify and mitigate potential safety hazards in the work environment. TTC personnel interviewed indicated they had benefited from participation in the course.

### *Work Practice Modification/Relocation*

TTC is taking steps to modify work practices on both the subway (heavy rail) and the SRT (intermediate capacity rail) operations, which will reduce some employee risk exposure levels. On the subway lines, TTC has relocated the car-cleaning functions from storage and service yards to end-of-line terminals. The relocation removes these employees from the yard environment, including the hazards of train movement and walking at grade with third-rail power. Cleaners will work at terminals where they will access trains from platforms, eliminating the need to use step rails and grab irons to climb onto trains.

The system also installed walkways in the yards to allow employees to walk through yards to storage tracks without stepping over third rails or walking in track-fouling areas. TTC is examining the feasibility of installing some platforms in the system's three storage yards to ease access for the mechanical employees and switch-yard operators who still need to access train interiors within the yard limits. Another measure has been included in the design of the latest rolling stock. The semipermanently connected six-car train sets, named "Rockets," have ergonomically improved step rails and grab irons at the cab locations, allowing easier and safer access to the interior. The "Rockets" also include new forward-facing indicator lights on the cab fronts that begin flashing when the operator sounds the horn. The lights will switch to steady mode when the brakes are being applied. This provides an additional layer of communication and will let track-level workers know that the operator has observed and acknowledged the workers and work zone warning flags.

On TTC's streetcar operation a necessary maintenance practice has been modified through the customization and application of commercially available cleaning equipment. Previously, the switch points and frogs of in-street tracks were cleaned by a two-person crew who traveled the line in a work truck. At each switch they would stop the truck, and one worker would manually sweep the switch while the other would flag motor vehicle traffic around the site. The system



FIGURE 1 TTC streetcar switch sweeper (Photo: Chris Kozub).

piloted and then adopted a new practice using small rubber-tired street sweepers, as seen in Figure 1. TTC worked with the manufacturer of the sweeper to modify the angle and positioning of the brushes, allowing brushes to reach into the flange-ways of the in-street switches. This modification has removed six employees per day from the hazards of vehicular traffic, allowing safer and faster cleaning practices.

### Summary

All the agencies in this study viewed the implementation of standardized ROW rules and flagging training as a major step in advancing ROW employee safety. MBTA Operations Training reported that the feedback received is evaluated to help guide future rule modifications. Several agencies cited the practice of bringing trainees onto the ROW to emphasize the importance of the training to their safety. After the 2007 ROW worker fatalities, NYCT reevaluated its training and made it more interactive and engaging. Major improvements included integrating more exercises and class discussions into the curriculum. In addition, unlike other agencies in which the refresher training is exactly the same as the initial training, NYCT developed separate refresher training courses for both the ROW and the flagging training. The refresher training is intended to take students to the next level and challenges them to apply the rules and concepts covered in training to actual situations. MTA's initiative to create a computer-based refresher training module is also aimed at getting employees more involved in their learning.

### HAZARD IDENTIFICATION AND EVALUATION

All of the agencies interviewed reported conducting hazard identification and evaluation processes that included ROW worker safety considerations. Generally, these include multi-departmental meetings to review major construction jobs, the issuance of General Orders or similar measures that

identified major track construction and maintenance jobs and the levels of worker protection required, and safety briefings with work crews before commencing work. In addition, most of the agencies interviewed had implemented a Safety Hotline that employees with safety concerns could use to make anonymous reports. The hotline was monitored by the safety department. All credible reports were investigated and addressed as needed.

In their interview, NYCT personnel highlighted the NYCT Department of Subways's successful practice of conducting a joint management/union safety inspection prior to the commencement of all major track construction projects and large-scale scheduled track maintenance jobs (e.g., multiple rail replacement, switch renewal, and extensive plate renewal). A track construction/maintenance superintendent schedules the inspections by contacting the TWU and support divisions (Infrastructure, Signals, and Third Rail Operations) a week or more before a job is scheduled to start. The overall process includes three major steps.

The first step is for all parties to meet and review the job. The track construction/maintenance superintendent gives a brief description of the job. This includes the type of work that will be done on the nights and weekend General Orders (e.g., dig out, rail job, hand chip out, concrete pour, and welding) and the details of the timing and length of the job.

The second step is to conduct the joint pre-job walk-through safety inspection using a standardized inspection form. The inspection is handled like any other ROW maintenance job. The Rule of the Day is reviewed, Tool Box Safety Talk is conducted, and appropriate flagging protection is established. The track construction/maintenance superintendent points out to all parties entering the track area the starting point (column marker) and clear-up spaces. The site is then assessed for:

- Any immediate and obvious conditions or hazards;
- Egress and emergency evacuation exits—identified, properly illuminated, and unobstructed;
- Working blue lights to indicate the location of EAB, ET, and fire extinguisher;
- Emergency telephone(s) and working emergency alarm box(es);
- Full fire extinguisher(s), with an inspection card verifying a recent inspection;
- Electrical hazards;
- Configuration of the track;
- Adjacent track flagging needs, including the number of flaggers required;
- Illumination of the job site;
- Cleaned and illuminated wide areas;
- Adequate ventilation;
- Presence of old material;
- Tripping and slipping hazards; and
- Water conditions.

**Major Track Construction Project  
Joint Management/Union Safety Inspection Placard**

On \_\_\_\_\_ a joint inspection was held by Management/Supervision and the TWU reviewing the following project:

Project Description \_\_\_\_\_

Location \_\_\_\_\_

Track(s) \_\_\_\_\_

An inspection form was completed and filed and a copy is located at the Division/Field Office \_\_\_\_\_ (Telephone # \_\_\_\_\_).

Location \_\_\_\_\_

_____ Management/Supervision Representative	_____ TWU Representative
_____ Print Name	_____ Print Name

Major Track Construction Projects pre-job inspection placard

FIGURE 2 NYCT sample placard (Courtesy: NYCT).

In addition the following are discussed:

- Air quality meter;
- Power off locations;
- Infrastructure drop site;
- Location of material; and
- Asbestos abatement.

The need for a barrier or bunting separating the work track from active adjacent tracks will be determined at this inspection.

Finally, a closing meeting is held immediately following the inspection in which all participants review items that need to be addressed. The track superintendent prepares a Punch List Report that is reviewed by the inspection team and the TWU safety department. Follow-up inspections are scheduled. Before any work commences, an inspection certificate or placard is signed by a supervisor and a TWU safety representative, and displayed at the work site. Figure 2 shows a placard (3, pp. 3.1–3.4, 4.5–4.8).

To help ensure the effectiveness of this process, NYCT developed a 3-day training course for TWU safety representatives and track construction/maintenance supervisors who conduct the joint labor/management pre-job inspections. The

outline for the training appears in Figure 3. In addition to this training, individuals conducting these inspections are required to attend 4½ days of prerequisite training in various safety courses.

**CONCLUSION**

Interviews with multiple representatives from the five agencies for this report revealed that agencies of all sizes are moving toward comprehensive ROW worker protection programs that include rules development in collaboration with labor, specific training requirements, and enforcement initiatives. Successful practices focus on clearly and concisely communicating rules and procedures to target audiences through written documentation and high quality training, and implementing structured processes for encouraging compliance.

The research team met with two ROW work crews during the MBTA site visit. During the meeting, employees emphasized the value of training and the need for supervisors and managers to “walk the talk.” Some concerns were expressed that elements of the MBTA program were too strict, but all workers recognized management’s commitment to the program and acknowledged that MBTA was a much safer place to work because of it.

<b>Major Track Construction Projects Joint Management/Union Safety Inspection Training Curriculum</b>	
1.	Track Safety and Flagging
	a. Identifying clear up spaces
	b. Identifying entrances and exits to the work area.
	c. Identifying emergency alarm boxes.
	d. Identifying power off or third rail protection requirements
	e. Identifying flagging requirements including adjacent track flagging.
2.	Street Flagging
3.	Crane Operations
	a. Street cranes
	b. Rail cranes
4.	"The Box"
	a. Identifying the area within "the box."
	b. Housekeeping requirements.
5.	Illumination
6.	Flexible Barrier Guidelines
7.	Fall Protection/Fall Arrest Systems
9.	Power Tools
	a. Fuel
	b. Electrical – Power cords and Generators
	c. Pneumatic – Compressors and Air lines
10.	Welding and Compressed Gases
11.	Fire Prevention and Protection
	a. Removal or protection of combustible materials
	b. Fire extinguishers
12.	Movement of work trains within a work area
13.	Pay loaders, skid loaders, tampers, ballast regulators, vacuum train, grinders, hopper cars, and other track maintenance equipment
Note: A test must be administered and passed by participants	
Note: Trainees must receive a certificate or other proof of successful completion	
Major Track Construction Project pre job inspection training	

FIGURE 3 NYCT joint management/union safety inspection outline of training curriculum (Courtesy: NYCT).

## WORK-SITE PROTECTION

### INTRODUCTION

This chapter discusses the specific practices and procedures, outlined in each agency's rules, safety bulletins, and training programs, that pertain to track worker protection. These include conducting job briefings and establishing a work site, communications procedures between employees and control centers or towers, track worker PPE, flagger PPE, flagger signaling, designated levels of protection/flagging, flagging, and safety challenges. Most of the practices are excerpted directly from each system's current rule book, and the overall sections are cited within the list of references.

Two systems, NYCT and TTC, have been evolving their rules and practices for decades, learning from experiences and from evaluating and analyzing their procedures. MBTA, according to one of the senior officials, started with a "clean sheet of paper" several years ago to develop a new track worker protection program. As part of this process they referred to, but did not follow, the FRA regulations for track worker protection. The other two systems—MTA and River LINE—share parts of their ROWs with FRA-regulated freight railroads; this requires them to meet and, if they choose to, exceed a FRA-compliant track worker protection program.

### JOB BRIEFINGS AND ESTABLISHING WORK SITES

Each system interviewed uses job briefings. The applicability, based on level of work and protection, and extent of these briefings vary by system. Some also have a process for documenting the establishment of a work site.

#### New York City Transit Authority

In New York, every work site must be reviewed by a supervisor or employee-in-charge. Supervisors hold a pre-job meeting to designate the flaggers, outline the job, communicate the type of flagging protection that will be established, provide an opportunity for employees to discuss their concerns, and complete a checklist. The supervisor or employee-in-charge must advise employees of the location and access to the clear-up locations, which must be within 15 ft of where the work is taking place (4, p. 2.7).

These pre-job meetings are also where and when supervisors are responsible for advising hourly employees of the

prepared Rule-of-the-Day and conducting a job-specific Toolbox Safety Talk before the beginning of the tour's assigned tasks. Newly issued safety bulletins and advisories must also be discussed in this forum. The meeting must cover the aforementioned procedural requirements for establishing and maintaining a safe work environment, and alert personnel of the specific hazards associated with the task (4, p. 2.3).

These meetings are part of a broader practice to establish a safe work site methodically. "The Box" concept is a procedure used to establish a safe work environment for all track work. The term refers to an area of a track or work location framed by a square or rectangular border defined by supervisors or by the person in charge of the work. The width is from wall to wall, wall to column, column to column, or otherwise defined. The length of the box is broader than the immediate work site and includes the adjoining area used for:

- Storage of tools and equipment;
- Clearing up of personnel;
- Walking about by personnel as they perform their assigned tasks; and
- Location of the closest emergency alarm box.

This border defines the area that has been inspected and cleaned of potential hazards before performing work (see Figure 4) (5, pp. 2.3–2.6).

Figure 5 shows the Daily Subways Maintenance Supervisors Checklist that must be filled out at the beginning of a tour when establishing a work site and returned to the superintendent at the end of each day. Copies of the completed forms must be filed at the appropriate subdivision field office for 90 days (5, p. 3.4).

#### Toronto Transit Commission

Toronto requires job briefings but does not address this issue in the Subway/SRT Rulebook. Instead, each department that performs track-level work has developed a specific procedure for where, when, and how to conduct job briefings, including what needs to be covered. Generally, a daily job briefing for each crew is conducted at its main work location, and a safety briefing is conducted at the job site. The foreperson uses a department-specific checklist for the safety briefing. He or she signs the form upon completion of the briefing and retains a copy for the department files.



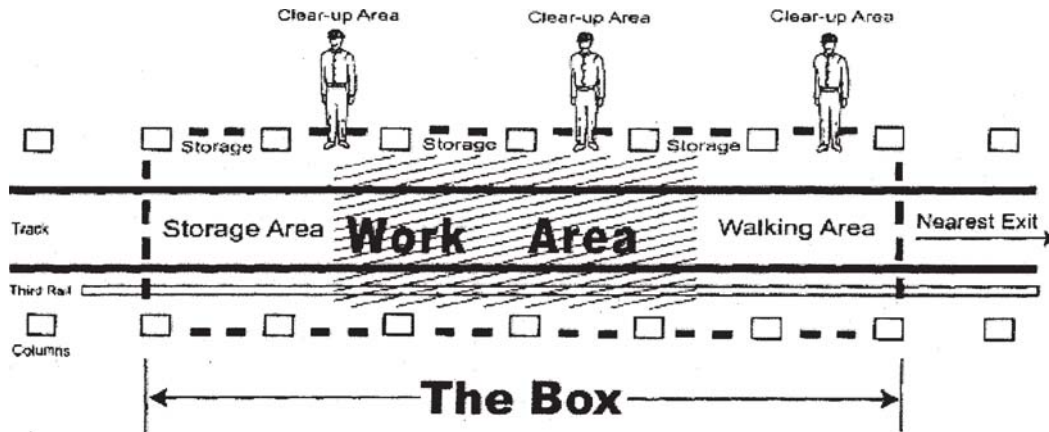


FIGURE 4 NYCT “Box” concept (Courtesy: NYCT).

### Massachusetts Bay Transportation Authority

It is the responsibility of the foreperson, among other duties, to conduct a job hazard analysis and site briefings to ensure the safety of work crews. A job hazard analysis is an evaluation of a work site and a job to be performed at that work site. It must be conducted before the commencement of work to determine if hazards exist and what PPE is appropriate to minimize those hazards. A site briefing is conducted before the start of work on the ROW. The hazards identified in the job hazard analysis and protections required for the job are discussed during a site briefing (6, pp. 9–10).

### Maryland Transit Administration

On the MTA light rail system, before performing any task requiring the coordination of two or more employees, the OSC must conduct a job safety briefing to ensure that all have a clear understanding of the on-track safety provided and of individual responsibilities. The *Railroad Worker Protection Manual* establishes that job briefings should be held at the start of each job, whenever the OSC changes, or whenever the on-track safety changes. According to the basic job briefing outline, the OSC should:

- Stop everything and focus on the job briefing;
- Encourage everyone to participate;
- Review the entire work assignment;
- Determine which type of on-track safety will be provided;
- Assign flagger or watchperson and advance watchperson as needed;
- Encourage employees to share previous similar work experiences;
- Identify potential job hazards;
- Reach a consensus on how the job needs to be done to be injury-free; and
- Review the responsibilities of each employee.

The job briefing for on-track safety is deemed complete only after all employees have initialed the Job Briefing

Acknowledgement Statement (see Figure 6) indicating they understand the safety procedures and instructions presented (7, pp. 21.1–21.3).

### River LINE

On the New Jersey Transit River LINE the approach is similar to MTA’s practices. All roadway workers on the River LINE whose duties require the coordination between two or more workers must perform a job briefing before starting their job. The roadway worker must acknowledge that he or she has a clear understanding of the task, how it is to be accomplished, and the on-track protection procedure to be used.

Job briefings are conducted by a supervisor face-to-face with all employees or contractor employees, who acknowledge in writing that they have received and understand the information in the briefing. Supervisors responsible for the coordination of work are required to maintain a record of the job briefing for a 7-day period. When not practical or possible to conduct a face-to-face briefing, a radio or telephone can be used. The job briefing should include, but is not limited to, the following:

- The specific job to be performed for the day (Example: Installing ties at new interlocking under construction);
- What type of protection the employee in charge intends to use (Example: Depending on the nature of the work, the affected track will be taken out of service or obstructed, or foul time will be requested);
- Responsibilities of each employee (Example: Which employees will be used at “Stop Signs” if the track is to be obstructed);
- Any known hazards or situations that could jeopardize personal safety (Example: The adjacent track is in service and trains will be passing work site at normal speed);
- How equipment is to be operated and which communication method will be used (Example: Will radio or hand signals be used to communicate with the operator?);
- Any requirements that will affect their job (Example: Orders to clear the track by a certain time);

Module 3: Daily MOW/SM supervisor's Checklist      The Daily MOW/SM Supervisor's Checklist

**DAILY SUBWAYS MAINTENANCE SUPERVISORS CHECKLIST**

Date: \_\_\_\_\_ Gang: \_\_\_\_\_ Crew (s): \_\_\_\_\_

Location (s): \_\_\_\_\_ Task (s): \_\_\_\_\_

Check One  
Y N N/A

- 1. Was the nearest EAB/ET functional status verified at the location to determine if planned work needs to be suspended or emergency work performed with the use of a portable radio?
- 2. Were all employees observed at the beginning of the tour concerning their fitness for duty?
- 3. Were the the daily safety rules read? Rule of the Day #: \_\_\_\_\_ and the Job Specific Rule #: \_\_\_\_\_
- 4. List the newly issued safety bulletins and safety advisories that were discussed:

---

- 5. Are third rail alarms (i.e., alarm boxes, red lamp banks) required, where the third rail is de-energized, and a sufficient number prepared for delivery and pre-tested to be functional to ensure an alarm is heard and/or seen by the workers.
- 6. Were **all** gang tools, alarm devices, and tool boxes that will be used inspected for damage, wear, worn repaired/replaced prior to the start of the tour's work?
- 7. Are fire extinguishers needed to support the use of gas-powered tools and prepared for use?
- 8. Is additional work area lighting needed and prepared for use to meet the 5 foot-candle requirement?
- 9. Are temporary tie bumpers and/or wheel stops needed and prepared for use?
- 10. Are 7' Third Rail Mats prepared for use for tools/equipment requiring two or more employees to carry them over energized third rails?
- 11. If Third Rail Mat(s) are being used, were they inspected for:
  - a. Damage (i.e., rips, tears, holes, punctures, or cracking) and for the proper stripe color?
  - b. Sufficient length of mats to completely protect the work area?
- 12. Are air monitors needed for NO<sub>2</sub> (diesel exhaust) or CO (gas engine exhaust) and prepared for use?
- 13. Do flagger(s) need additional illumination and additional bank(s) prepared for use?
- 14. Is drinking water needed and prepared for delivery?
- 15. Do you have STOP Cards and Safety Rule Dispute Forms in your possession?
- 16. Are G.O. Piggybacking Procedures followed?
- 17. Were all employees properly attired at the beginning of the tour (PPE, appropriate clothing for the task, safety vest, safety eyeglasses, authorized safety footwear)?
- 18. Was a "Toolbox Safety Talk" conducted that indicated the proper and safe procedures to be used, as well as specify the hazards of the job **and instruct employees of the safest route to and from the area?**
- 19. If the work is being performed under flagging protection, did you conduct the pre-job meeting and designate flaggers?
- 20. If the work to be performed is under a General Order where the third rail will be de-energized, did you discuss the exact power-off limits with all employees under your jurisdiction?
- 21. Were flags called on to the **Rail Control Center, Local Tower, and your division office?**
- 22. Was the jobsite(s) inspected prior to the start of the task(s)?
- 23. Did you establish The Box by:
  - a. Checking and clearing the area of all correctable tripping and slipping hazards?
  - b. Setting red flagging lanterns/flags and trippers 200 feet past each work area limit (G.O.)?
  - c. Are all clearance niches and areas free of material and debris?
- 24. Is the Labor/Mgmt. Inspection Certificate (major construction projects only) displayed at the work area?
- 25. Was the checklist completed at the beginning of the tour and being forwarded to the field/maintenance office?

Comments: \_\_\_\_\_

M/S Name: \_\_\_\_\_ Pass#: \_\_\_\_\_ Signature: \_\_\_\_\_

**RETURN TO YOUR SUPERINTENDENT AT THE COMPLETION OF EACH DAY. COPIES OF THE COMPLETED FORM MUST BE FILED AT THE APPROPRIATE SUBDIVISION FIELD OFFICE FOR 90 DAYS**

Revision: 2-5-09

FIGURE 5 Daily Subway Maintenance Supervisors Checklist (Courtesy: NYCT).

### Job Briefing Acknowledgement

1. On Site Coordinator \_\_\_\_\_
2. Date: \_\_\_\_\_
3. Working Limits: Track Number(s) \_\_\_\_\_  
 Chain Marker \_\_\_\_\_ To Chain Marker \_\_\_\_\_  
 Station Name \_\_\_\_\_
4. Red Tag implemented with grounding straps Installed?  
 YES NO  
 Location(s) \_\_\_\_\_
5. Type of on track safety being provided.  
 Exclusive Track Occupancy -----   
 Foul Time -----   
 Train Coordination -----   
 Inaccessible Track -----   
 Train Approach Warning -----
6. When clearing the tracks the designated place of safety is  
 \_\_\_\_\_
7. If needed, have flagmen or watchmen been assigned and positioned? Yes No
8. Will Railroad Maintenance Machines be involved in the work?  
 Yes No If yes have safety issues been discussed?  
 Yes No
9. Number of employees in work crew \_\_\_\_\_
10. I understand all aspects of my on track safety and feel that I am adequately protected against trains and/or on track equipment.

Each member of the Work Crew must initial below.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

FIGURE 6 MTA Job Briefing Acknowledgement Statement (Courtesy: MTA).

- All known unusual conditions or situations that may affect the job assignment; and
- If necessary to work under traffic, where will the “safe” location be located to clear the track? Employees must not clear the track by occupying another track unless that track is out of service.

All River LINE roadway workers whose duties require them to work alone and not as part of any other work group must contact their supervisor before the start of their work and conduct a job briefing. The roadway worker must acknowledge having a clear understanding of the task, how it is to be accomplished, and the on-track protection procedure to be used.

Job briefings should include how the worker intends to provide on-track protection against moving track equipment or trains. Discussion between the lone worker and his or her supervisor must include, but is not limited to, the following:

- All specific jobs to be performed for the day (Example: Inspecting track between two specific locations);

- Responsibilities of the lone worker (Example: What portions of the job will require fouls, and when would the track need to be taken out of service?);
- Any known hazards or situations that could jeopardize personal safety (Example: The adjacent track is in service, and trains will be passing the lone worker at normal speed);
- How communication will be established (Example: Will the lone worker be monitoring the radio, and on which frequency?);
- Any requirements that will affect the job, such as orders to clear the track by a certain time if the track is to be taken out of service;
- All known unusual conditions or situations that may affect the job assignment; and
- If necessary to work under traffic, the location of a safe area to clear the track. Employees must not clear the track by occupying another track unless that track is out of service.

Job briefings for both groups and lone workers should be updated regularly. Only one foreperson can be in charge of the work site. The foreperson in charge must keep all other forepersons up to date and must have a clear understanding as to how the job is to be conducted (8, pp. 4–7).

### COMMUNICATION PRACTICES

Each system also has extensive rules or documented standard operating procedures directing and governing the use of radios, cell phones, public address systems, and other forms of communication technology. For this study, the focus is on procedures for track workers to notify control centers or towers and for control centers to notify operators of the presence of employees or work sites on the ROW. These rules and procedures were discussed in the interviews with agency personnel, culled from a review of each agency’s rules, or both.

### New York City Transit

Whenever employees are entering the ROW and some level of flagging protection is required, they must notify the Rail Control Center Desk Superintendent to request and receive permission, and report their position by track and station number. Between the hours of 10 p.m. and 5 a.m. and all day on Saturday and Sunday, the Rail Control Center must notify area trains with periodic announcements of the presence of employees on the ROW and remind train operators to operate with restricted speed and extreme caution and to sound the horn if caution lights or employees are observed. The Rail Control Center must keep a log of the flagging calls.

If an employee is using the ROW to access his or her work place, for example, walking to a train or tower, the employee is not required to notify the Rail Control Center to request permission. The employee must, however, follow all rules

pertaining to PPE and general safety practices for accessing and walking along the ROW. NYCT operations supervisors are required to speak with train operators as they are reporting to work to go over locations of General Orders and any other significant events that are occurring on their line.

### **Toronto Transit Commission**

Employees must call Transit Control by means of a land line to get permission before descending to track level. All crews carry a system radio for direct communication with Transit Control at all times. Transit Control is the communications center of the transit system. Transit Control will inform operating crews when there are employees on the track and where to expect warning lights or flags and work crews.

On Scarborough Rapid Transit (SRT), Transit Control will advise the operator to change from Automatic Train Operation to Cab Signaling or Emergency Mode. Employees must wait for Transit Control to confirm this change from station to station before the work crews enter the track level. On the SRT, Transit Control will advise operators when work crews report clear and instruct the train operator to return to Automatic Train Operation.

If employees are required to access an area located beyond the safety gate at the end of the platform, and will walk along the catwalk area not protected by a yellow railing, they must advise Transit Control and ensure that the platform end gates are closed after entering or exiting track level by means of a station platform.

If employees are conducting a walking inspection that requires them to be at track level for more than 2 h for inspection, troubleshooting, orientation, or track patrol, they must contact Transit Control and request that Transit Control update subway vehicle crews of their location. Employees must repeat this request every 2 h until they have cleared track level.

On SRT, employees must wait for Transit Control to confirm that the system is operating in the Cab Signaling Mode or Emergency Mode before they go to track level.

When leaving track level, the employee in charge must ensure that no employee in the group is still at track level. The employee in charge calls Transit Control immediately after leaving track level (2, pp. 1.9–1.12).

### **Massachusetts Bay Transportation Authority**

All personnel accessing the ROW must notify the appropriate control center dispatcher using the appropriate telephone numbers before entering the ROW. There are separate numbers for each of MBTA's rail transit lines: Red, Blue, Green, and Orange.

The employee informs the dispatcher what area the work crew intends to occupy and requests to be placed on the Right of Way Access List. The employee must have a call number and a working portable radio in his or her possession. Employees must identify themselves by name and call number, and identify what Level of Protection they will be utilizing, what type of work, if any, is being performed, and how many members are in the work crew. The employee must also notify the dispatcher of the name and badge number of the designated flagperson(s).

Callers must tell the dispatcher where the crew will first access the ROW and identify the two points between which the crew will be working. These locations must be stations or landmarks and cannot exceed two stations (i.e., Braintree to Quincy Adams; Stony Brook to Jackson; Orient Heights to Suffolk, or Beaconsfield to Reservoir).

Once employees have completed their work in that specific area, the original caller must contact the dispatcher by means of radio and inform him or her that the crew is clearing one location and moving to another, giving the specific area in which the crew will be working. Whenever a crew leaves the ROW for any reason—break, lunch, or other purpose—the crew must inform the dispatcher that all crew members and all equipment are clear of the ROW. Transportation personnel accessing the ROW use their radios as the primary means of communication with the control center while entering, occupying, or clearing the ROW.

Operators must monitor their radios to be aware of personnel on the ROW. When swinging on or off, operators must inform their relief person about personnel on the ROW. If an operator encounters personnel on the ROW who have not been identified on the Right of Way Access List broadcast by the dispatcher, he or she is directed to contact the control center immediately and inform them of the crew's location. A dispatcher will then send a supervisor to the scene, and vehicles traveling in both directions in the area will be instructed to use caution.

Supervisors are required to monitor their areas and be aware of the personnel on the Right of Way Access List, and to complete periodic checks to ensure that all work crews are adhering to the call on/call off, and other policies and procedures established for ROW access.

Dispatchers are responsible for monitoring operations and taking every step possible to ensure employees and contractors accessing the ROW are complying with established policies and procedures. Any violations must be reported promptly to the appropriate line supervisor or work crew supervisor. The dispatcher must also do the following:

1. Restrict crews from calling in excessive areas of coverage. Crews are restricted to an area between two stations;

2. Maintain an accurate list of all personnel on the ROW, the number of people in the work crew, and the designated flagperson(s) and their location;
3. Confirm that the crew has a working radio;
4. Question crews about the work activity, the work location, and the Level of Protection. If the work activity or work location is not appropriate for the Level of Protection, the dispatcher will deny the work crew access to the ROW and contact the crew's supervisor.
5. Broadcast the Right of Way Access List at least every 20 min. This access list includes all persons and work crews who are on or near the ROW (6, Section 9.0).

### **Maryland Transit Administration and the River LINE**

In accordance with their FRA-compliant rules, these two agencies require all employees to call the control center whenever they enter or clear the ROW. This requirement is covered in each section of their rules that pertain to each level of track protection. Additionally, MTA broadcasts an "all-call" to all operators in service whenever an employee calls on and off the ROW.

### **All Systems**

Universally across the five systems, communications between groups of track workers or lone workers and the control center or tower are by means of radio. On the MTA, identified radio "dead zones" have been addressed by issuing an MTA cell phone to each MOW vehicle on the system. These cell phones are not to be used on the ROW and may be used only when radio transmissions are not possible. All systems require that each work group have at least one working radio, and in cases in which lone workers are permitted, the lone worker must have a working radio. All systems require employees to clear the ROW when their radio malfunctions or fails.

### **TRACK WORKER PERSONAL PROTECTIVE EQUIPMENT**

Personal protective equipment, communally referred to as PPE, is required for track workers on every system. Given the diversity of system sizes, operating environments, and previously mentioned hazards, the study does not attempt to compare PPE requirements across systems. A summary of the PPE items, specifications, and use at each system follows.

### **New York City Transit Authority**

All employees working on the ROW, regardless of department, are required to wear at a minimum NYCT-issued safety vests, safety glasses, and NYCT-approved safety shoes or boots (13, Rule 6.08). Employees walking on the ROW must also carry an approved light to illuminate the walking surface. The currently approved lights are high intensity incandescent

or LED powered by three C batteries, Streamlight, or similar lights. These approved lights must be used to provide sufficient light to permit moving about safely. If an employee encounters a train while on the track, this light can also be used to flag a train.

Other conditions or tasks may require additional protective equipment. Respiratory protection is required in oxygen-deficient or low-air-quality environments. Fall protection is required when working from certain heights and locations, and additional protective face shields, gloves, footwear, hard hats, and jackets are sometimes required.

Employees working around the energized third rail are required to use enough ¼-in., 3-ft wide rubber mats, in good repair, to cover the third rail in the work area. When multiple mats are required, there must be a minimum 1-ft overlap between mats.

All metal tools used in the vicinity of the third rail must be insulated with appropriate insulation that is in good repair. Insulated tools are inspected daily before they are brought to the work site. Insulation that becomes damaged during work can be repaired by applying a minimum of four layers of electrical tape to the affected area of the tool. This is only a temporary repair and is only approved for that specific day's work (13, Rule 6.08).

### **Toronto Transit Commission**

Specific guidelines for PPE are detailed in department rules as opposed to the general Subway/SRT Rulebook. According to the Safety Department, minimum PPE required by all employees working at track level includes:

- Head protection with reflective material (hard hats or bump caps);
- Safety glasses;
- Safety shoes (ankle high with toe and sole protection);
- Reflective leg and arm bands;
- Appropriate track-level warning devices, yellow, red, or green safety lights, flags and personal flashlights; and
- Approved train signaling device, Lenser light, or yellow and red flags.

The rule book directs employees to wear approved PPE when they are at track level as required by the work they are performing and their department rules. The PPE is approved by the Safety Department, but each department is not required to use the same equipment. The Safety Department recently replaced large battery pack lanterns with a small, hand-held LED Lenser Flashlight. Employees from all departments responded favorably to this change.

TTC is currently undertaking two initiatives relative to PPE. The first involves the Safety Department designing a

high visibility T-shirt that workers can wear in place of a vest in hot weather. This is particularly appealing to employees who spend a good deal of time working on surface track. The T-shirt specifications include:

- Fluorescent yellow–green color;
- Double-layer premium mesh polyester breathable material;
- Left chest, sealed cell phone pocket and pen slot;
- Fully compliant with CSA Z96-09 Class 2, Level 2 standard (tag attached to inside collar);
- 3M #5510 2-in. Zebra tape, applied to 4-in. orange reflective backing;
- “X” on back, vertical stripes on front, all meeting at the horizontal stripe at the hip (6 in. below normal waist striping);
- TTC heat transfer on back; and
- Embroidered TTC logo on front.

Figure 7 shows a prototype of the T-shirt. The T-shirt costs approximately \$42 with a minimum order of 1,000 shirts.

The second initiative involves the Track Level Safety Team’s comprehensive review of all PPE used by employees from the various departments that enter track level. The goal of this initiative is to develop PPE standards to be adopted across the departments. For example, committee members mentioned that although all workers were required to wear a vest, the requirement for arm and leg bands varied. The committee also explored the benefits and limitations of several models of vests and recommended the adoption of a new, more reflective vest.

#### Massachusetts Bay Transportation Authority

To maximize ROW safety, MBTA requires all employees to utilize appropriate PPE while working on or near the ROW. PPE is considered critical to the protection of employees from hazards such as:

- Moving vehicles;
- Electrical hazards;
- Sharp or falling objects;
- Rolling objects or pinch points;
- Harmful dust; and
- Chemicals.

Employee questions regarding PPE or any safety equipment are referred to their supervisor for review and resolution.

In keeping with the authority’s mission that employees work in a safe environment, various forms of PPE and safety equipment are identified as critical. This includes clothing, equipment, and accessories designed to increase worker visibility and enhance safety while providing additional protection against any known or unknown hazard. The minimum PPE required for all employees working on the ROW follows:

- Reflective orange high-visibility safety garment or vest, which must be approved by the Safety Department;
- Working flashlight;
- Whistle; and
- Valid ROW license indicating that the person has been trained as required.

In addition, one person per crew must have a working portable radio.

MBTA clothing rules specifically prescribe that in addition to wearing a safety department-approved orange high-visibility safety garment or vest when on the ROW or in the yard area, the following rules must be observed:

- Transportation employees must wear the prescribed uniform when engaged in flagging activities. During inclement weather, additional weather gear may be worn over the uniform.



FIGURE 7 TTC reflective T-shirt (Courtesy: TTC).

- Proper shoes or boots with rubber soles must be worn (no high heels, sandals, sneakers, or steel-toed shoes).
- Employees must not wear clothing or shoes that will hinder them in any way during the performance of their duties.
- Raincoats longer than knee length are prohibited.
- Proper work gloves or leather gauntlets are needed when engaged in maintenance work, track cleaning, installation of light banks, and the like.
- When a worker wears special clothing, particularly hoods and ear protection, care must be taken so that the individual is fully aware of the working environment, paying special care to all types of traffic in all types of weather conditions.
- Exception—Orange outer garments with high-visibility reflective strips, which have been approved by the Safety Department, may be worn on the ROW in place of an approved vest.

Supervisors are required to:

- Maintain an adequate supply of PPE for worker safety;
- Issue the approved PPE to employees as necessary, as part of their uniform;
- Provide PPE (i.e., flagging equipment, hard hats) for special details;
- Provide appropriate training in use and care of PPE (i.e., respiratory and hearing protection) and provide appropriate fit testing for respiratory protection;
- Maintain a Material Safety Data Sheet (MSDS) List for protection against hazardous chemicals and materials; and
- Administer and ensure compliance with all procedures associated with the rule book (6, pp. 43–44).

### **Maryland Transit Administration**

Employees working on or about MTA light rail tracks must follow these rules:

- Wear approved safety vests properly fastened over outer clothing to ensure high visibility;
- Wear approved hardhat (ANSI Z89);
- Wear approved safety glasses (ANSI Z87). Head covering must not interfere with seeing, and sunglasses, hats, or any other attire must not restrict vision or distort color perception. Sunglasses are prohibited at night.
- Wear approved hard sole shoe that provides adequate protection (ANSI Z41). Sandals, cloth, canvas, wedge type, high heel, athletic, or recreational shoes are prohibited.
- Jewelry, if worn, must not constitute a safety hazard or impair an employee's ability to perform his or her duties in a safe and efficient manner;
- While operating or working around noisy equipment, employees can only use earplugs or hearing protection if there is adequate track protection against approaching trains (7, pp. 1.8–1.10).

### **River LINE**

Roadway workers are required to wear a high-visibility vest or other approved garment, approved footwear, hard hat or approved head covering, and safety glasses when on or about the track (8, p. 3).

### **WARNING AND PROTECTIVE DEVICES AND TECHNOLOGY**

All of the systems involved in the study use some form of warning lights, audible devices, or portable trip or stop equipment to enhance the level of protection afforded to a work site.

### **Flags and Warning Lights**

Traditionally, “flagging” was done with colored flags, hence the name. Similar to the universal application of colors to railroad and road signaling, red means stop, yellow is caution or proceed at a reduced speed according to agency rules, and green is an indication to resume normal operating speeds for the line or area. Over time these flags, which are still used by all systems in outdoor, daylight conditions, have been supplanted in tunnel and after-sunset situations by colored portable warning lights that can be powered using hard-wire power or batteries.

These flags or lights can be held by a flagger or watchperson; hung along the track; placed in the gauge or along the track on the ground; or placed in or on top of cones in the gauge or along the track; according to each system's rules and rules for specific types of flagging. These flags and lights communicate to train operators specific orders, based on the rules, to reduce speed, stop, proceed at reduced speed, or proceed at normal speed (see Figure 8 for typical flagging signal colors and meanings or applications, and Figure 9 for examples of flags and lights).

### *Toronto Transit Commission*

A successful practice highlighted in interviews with safety, operations, and maintenance personnel was the TTC's Track Level Safety Team's initiative to implement the use of blue light warning devices as a signal to train operators that workers are at track level, between stations. Based on positive feedback, the program has evolved significantly over time.

Initially, all crews were required to place a blue flashing light in the track bed 50 ft from the end of a station. The purpose of the light was to alert train operators to the presence of workers at track level between the station they were departing from and the next station. This safety practice was further enhanced with the posting of blue speed-limit signs along the track bed in advance of low visibility sections of track, such

Object	Color	Meaning/Application
Light or Flag	Red	Stop
Light or Flag	Yellow	Reduce speed (typically ten (10) miles per hour or less) and be prepared to stop within half the sight distance
Light or Flag	Orange	Reduce speed (typically ten (10) miles per hour or less) and be prepared to stop within half the sight distance
White	Light	With appropriate arm motions can be used to signal trains to stop, reduce speed, proceed, or back up
White	Disc	Used to communicate directions from watchmen to work crews, including “Clear the track” and “Resume work”
Light or Flag	Green	Resume normal operating speed for the area and/or conditions

FIGURE 8 Examples of flagging signal colors (*Courtesy: MBTA*).



FIGURE 9 Examples of flags and lights. (*Clockwise from above left*) Red (stop) flag placed in cone in gauge of track; flagger using red flag to stop an oncoming train; green flag in cone and green light on station platform indicating that trains are clear of a work site and can resume normal operating speed; battery-powered warning light, most commonly used underground or after sunset (*Courtesy: MBTA*).



as blind curves. The signs remind operators to reduce train speed to 15 mph when they have observed a blue light, in case workers are present. TTC is now testing an automated Work Area Warning (WAW) system, developed in-house by the Signals Engineering and Communications Department, on the Sheppard Subway line.

The WAW system establishes standard locations at each station and integrates the placement of the warning light with a radio-frequency identification (RFI) tag. WAW builds on the tag system technology used to execute customer station announcements, to supply automated track worker visual and audible warnings to train operators. Each station is equipped with a blue light tag placed in a yellow holder mounted in a standard location on the station wall. The work crew obtains approval to enter track level, retrieves the blue light and RFI tag from the holder, and places it in the designated location on the track bed. As a train leaves the station, the operator should observe the flashing blue light at track level and sound a long blast on the horn. In addition, the operator will receive a text message on the cab radio display indicating “Caution

Workers Ahead,” will hear an audible “beep” tone in the operating cab, and will see a blue “WAW” LED flashing on the radio unit. The operator can press a “Cancel” button to silence the tone, but the text message and the flashing blue LED cannot be cleared or stopped by the operator. The operator will proceed according to all work zone rules and regulations, being prepared to stop in the event that the crew or equipment is unable to clear track level safely. Once the train enters the next station; all alarms and notifications will be canceled (see Figure 10).

The TTC reported that it can implement the WAW system at relatively low cost because it uses existing communications infrastructure. Ultimately, TTC plans to evolve the WAW system in the following ways:

- Permanently integrate the blue lights and controllable RFI tag into the existing system circuitry to eliminate the need for workers to place the light and tag in the gauge to establish protection. Initially, this hard-wired configuration would be activated through an access-



controlled panel at the ends of each station platform. Ultimately it would be activated and deactivated through the control center following notification from a track-level worker entering or exiting the ROW with his or her crew.

- A second phase would integrate the WAW into its speed control tag system to enforce speed limits in work zones. This would be done by first warning an operator that he or she is exceeding the speed limit, followed by the activation of a train-stop procedure in which the train would come to an emergency stop. This would not be done by controlling or reducing a train's speed, as is possible in some Automatic Train Operation systems.

Current TTC plans project the completion of full testing on the initial RFI tag-based WAW system and implementation of system-wide installation on all subway lines in 2012.

### Audible Warning Devices

Flaggers and watchpersons are always required to carry an audible warning device, most often a whistle or compressed air-powered horn. These are used to warn or communicate with other flaggers, watchpersons, or employees at the work site. See Figure 11 for examples of audible warning devices.

### Barricades

Another layer of protection, which is used most commonly in longer-duration work sites, is physical barriers or barricades to indicate that a track is out of service. These devices are usually intended not only to protect the track workers but also to prevent a revenue train or other on-track movements from colliding with equipment at the work site or running through

an area where a piece of rail or switch has been removed (see Figure 12 for examples of barricades).

### Portable Train Stop

Several systems use a relatively low-tech but proven device called a portable train stop (PTS) or portable trip device. Older systems such as NYCT, MBTA, and TTC have used these devices for several decades. On some or all the lines on these systems, fixed train stops or trip devices are still an integral part of the signal system. Whether fixed or portable, the principle of the device is that it is placed next to a rail and has an "arm" that will trip a corresponding arm on the bottom of the rolling stock, which will then stop the train by activating the brakes. On the TTC system, all revenue and nonrevenue work equipment is equipped with trip arms activated by passing a portable or fixed trip device (see Figure 13 for an example of a portable trip device).

The procedure for using the portable train stop in flagging and work-site protection is consistent across the agencies that use these devices. For example, at NYCT the PTS, designed primarily for use by flaggers, is applied to the rail to ensure the positive stop of an approaching train if a train operator fails to acknowledge the stop signal displayed by the flagger. The PTS is used in connection with flagging operations only after the proper display of caution lights or flags in accordance with the rules.

The PTS may be used at any point on a track where a temporary train-stopping device is required. The PTS consists of two separate units, one known as the base, the other as the stop arm. The effect of the PTS, when properly installed, is the same as that of the automatic stop arm located at signals. When in position, the stop arm engages the tripping device of the moving train, causing an emergency application of the



FIGURE 11 Examples of audible warning devices. Compressed-air, hand-held horn used by flaggers (*left*) and whistle that is part of required PPE for most track workers and all flaggers in the study (*right*) (Courtesy: MBTA).



FIGURE 12 Examples of barricades. Commercially available barricade in place (*top left*); clamp-on stop flag and battery-powered red light (*top right*). Bottom photo shows work area on two-track ROW protected by barrier on each track using boards chained to rails and battery-powered red lights mounted in center of gauge (*Courtesy: MBTA*).

brakes. The PTS must be applied to the track at the same location where the flagger is stationed, and must be placed so that it will engage the tripping device on the forward end of an approaching train.

After the necessary caution lights or flags have been set up in accordance with the rules, the base of the PTS must be clamped securely to the base of the rail, with the stop arm disengaged. When ready to flag trains using the PTS, the flagger must place the stop arm securely in its proper tripping position in the base. The flagger must display the red flag or the red light to the full view of the operator of an approaching train. When conditions are safe to allow the passage of a train, the flagger must remove the stop arm and perform flagging operations in accordance with the rules.

Under no circumstances should the stop arm be in its tripping position after the flagger has given a “proceed” signal to the train operator. Flaggers must exercise special care to

avoid unnecessary tripping of a train. Only the flagger placing a particular PTS, or the flagger’s supervisor, may remove the stop arm once it has been placed in the tripping position, except upon orders of the Control Center desk superintendent (9, Rule 3.79).

#### **Electronic Train and Track Worker Detection Devices**

MBTA and MTA are using devices manufactured by ProTran that communicate to track workers and train operators the presence of an approaching train or of employees along the ROW. The ProTran devices were initially developed and tested through the TRB Transit IDEA Program. Completed in 2008, Transit IDEA J-04/IDEA 55 “Warning Device for Rail Transit Personnel for Approaching Trains” assisted in bringing this device from concept through prototype development and evaluation phases. Site testing of the device, conducted in the IDEA Program, was done in Cleveland (GCRTA), Philadelphia



FIGURE 13 Example of portable trip device (Courtesy: TTC).

(SEPTA), and Boston (MBTA). TTC is also field testing a separate product called TrackSafe, being developed by Bombardier.

#### *Massachusetts Bay Transportation Authority*

According to MBTA personnel, as of March 2011, the ProTran devices are only used on the Green Line (light rail line), as a supplement to established rules for flagging and track protection. The device is placed along and connected to the track and transmits a signal to personal alert devices (PADs) worn by track workers and to a designated flagger device (DFD), a receiver worn by flaggers.

MBTA states in the instructional training for this equipment that:

- These products do not replace existing MBTA policies and procedures. They will work in conjunction with safety procedures, adding an additional layer of safety to track workers.
- They provide visual and audible warnings to the flaggers and work crew.
- They provide a designated employee with the option to warn flaggers or the work crew.

- The devices use wireless technology for advanced detection.
- They are not a “fail safe” feature (10).

MBTA track workers who were interviewed for this study expressed concern regarding the reliability of the equipment and complained about its overall size and weight when transporting it. They did, however, welcome the extra level of warning and protection that it affords.

#### *Maryland Transit Administration*

Using the same equipment, MTA has taken implementation to the next step by installing transmitter/receivers in the cab of each light rail vehicle. Each employee accessing the ROW is also issued a PAD or a DFD that he or she is required to wear and use while on the ROW. The PADs and DFDs are tested at the beginning of each shift to ensure battery life and functionality. This system not only alerts ROW employees to the presence of approaching trains, but also alerts operators to the presence of employees on the ROW.

Like MBTA, MTA has not altered any existing rules and procedures, but has added this technology as another layer of protection for track workers. Aside from the rule that employees must wear and use the devices when on the ROW, MTA also now requires employees who experience mechanical failure of their device to leave the ROW and wait for a replacement PAD or DFD before returning to work.

Some MTA managers stated that there have been some issues with battery life in the PADs and DFDs, and that employees have complained about the bulk and discomfort associated with wearing the devices. Like MBTA however, supervisors and managers welcome the concept of an additional layer of protection (see Figure 14).

#### *Toronto Transit Commission*

TTC hosted a pilot of the TrackSafe product in fall 2011. The goal of TrackSafe is to provide improved location awareness and relevant alerts to train operators and roadway workers. Roadway workers are equipped with a wrist band that they use to “tag in” at a kiosk at their point of entry to track level. No other equipment is required for the roadway worker, allowing the worker to carry necessary equipment and to enhance safety with minimal effort. Upon check-in, the workers enter their work plan, or simply confirm a previous reservation they have made with the Control Center. The check-in software also provides for “rules” enforcement, ensuring that only authorized people can access track level.

As the roadway work crew proceeds at track level, the crew tags in at various checkpoints, creating an Alert Warning



FIGURE 14 Examples of portable warning devices. Portable train detection device being installed on ROW (left); employee wearing PAD used by MBTA and MTA (right) (Courtesy: MBTA).

Zone (AWZ) by automatically illuminating LED lights that warn train operators of the location of roadway workers as the train approaches the AWZ. Roadway workers are alerted to the presence of an approaching train through audible and visual alerts that are engaged when the train enters the AWZ, providing adequate time for the workers to proceed to a safe location as the train passes. See Figure 15 for an illustration of the TrackSafe system components.

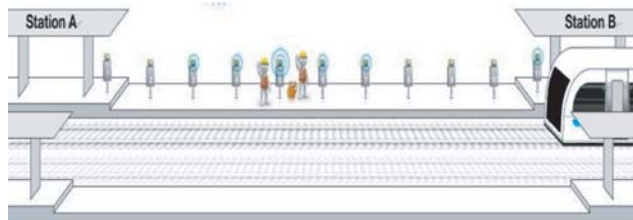


FIGURE 15 TrackSafe components (track level). System components placed every 500 ft along ROW (top); track worker RFI device (bottom) (Courtesy: TTC).

The first stage of the pilot, which involves testing the technology on Bombardier’s test track, is in process. A number of potential areas are being evaluated for implementation of the product in the TTC system.

**FLAGGING EQUIPMENT**

There was no consistent definition of the terms “flagman” or “flagperson” or of “watchman” or “watchperson” used by the agencies interviewed. NYCT and MBTA use “flagman” or “flagperson” exclusively to describe the persons responsible for setting up and staffing flagging configurations. TTC and the River LINE call the employees responsible for these same job functions “watchpersons.” MTA uses “flagman” to describe the person responsible for controlling train movement through the work site. The MTA refers to the people who serve as the intermediary between the flagmen and the ROW work crew in situations where there is not a clear line of sight between the two, as “advance watchmen.”

In addition to the PPE required to enter the ROW, almost all the systems interviewed mandate additional PPE for flaggers and watchpersons. They also have lists of required equipment that flaggers and watchpersons must have with them to perform their duties.

**New York City Transit**

The NYCT Department of Subways requires flaggers to have the following equipment:

- Standard track worker PPE;
- Reflectorized vest with an identifiable NYCT logo;

- Lights or flags in working condition and of prescribed color based on the type of flagging to be done. Flags must be at least 23 in. by 29 in.
- Whistle or air horn. Air horn must be used in areas with excessive noise.
- PTS; and
- Piece(s) of stout cord, between 4 ft and 6 ft in length, for tying the red light or the red flag to the stop arm of the PTS [9, Rule 3.75 (b)].

### Toronto Transit Commission

Along with basic PPE, TTC requires watchpersons to carry:

- White flashlight or yellow/red flag;
- Air horn;
- Whistle; and
- Appropriate combination and quantity of green, yellow, and red lights and flags and PTS for the type of work zone (2, pp. 6.1–6.5).

### Massachusetts Bay Transportation Authority

Aside from the minimum PPE required for all MBTA employees on the ROW, flaggers—depending on work situation—need the following:

- Set of flags;
- Air horn;
- PTS (on Green Line only); and
- Minimum of 1 to 14 warning devices (6, pp. 23–37).

To respond to flaggers not having the proper equipment for jobs, MBTA installed Emergency Personal Protective Equipment Boxes at key subway locations and stocked them with flagging equipment required for work site safety and emergency incidents. The boxes ensure field employees have the required tools to perform tasks safely without waiting for equipment to be brought from a remote site. Each box is secured by a P-Lock padlock and can be accessed by employees of various classifications who are ROW-trained. See Figure 16 for photographs of emergency PPE boxes (11).

### Maryland Transit Administration

MTA flaggers are required to have the following equipment when there is good visibility at a work site:

- Warning whistle;
- Red flag;
- Air horn;
- Safety vest;



FIGURE 16 MBTA emergency PPE boxes (Courtesy: MBTA).

- Hard hat; and
- Safety glasses.

Additionally, watchpersons in these conditions are required to have a standard white disc.

In tunnels, at night, or in otherwise limited visibility conditions caused by fog, rain, or snow, flaggers and watchpersons are required to have:

- Warning whistle;
- Approved white light;
- Air horn;
- Two red fuses;
- Safety vest;
- Hard hat; and
- Safety glasses (7, Rule 20.4).

## River LINE

In conditions of good visibility, watchpersons, advance watchpersons, and employees-in-charge are required to carry a whistle or horn. Watchpersons must also carry a standard white disc, and advance watchpersons are required to carry a standard white disc and a red flag.

In situations of poor visibility, such as in tunnels or at night, watchpersons and advance watchpersons, must carry a white light in place of standard white discs and employees-in-charge must carry a white light in addition to their other equipment and PPE. Advance watchpersons should also replace their red flag with red fuses that can be used in pairs (8, p. 22).

Unique to the River LINE, of all of the systems in the study, is the requirement for watchpersons and advance watchpersons to wear a red “watchman” vest to delineate the watchperson or advance watchperson from the rest of the work crew, as seen in Figure 17.

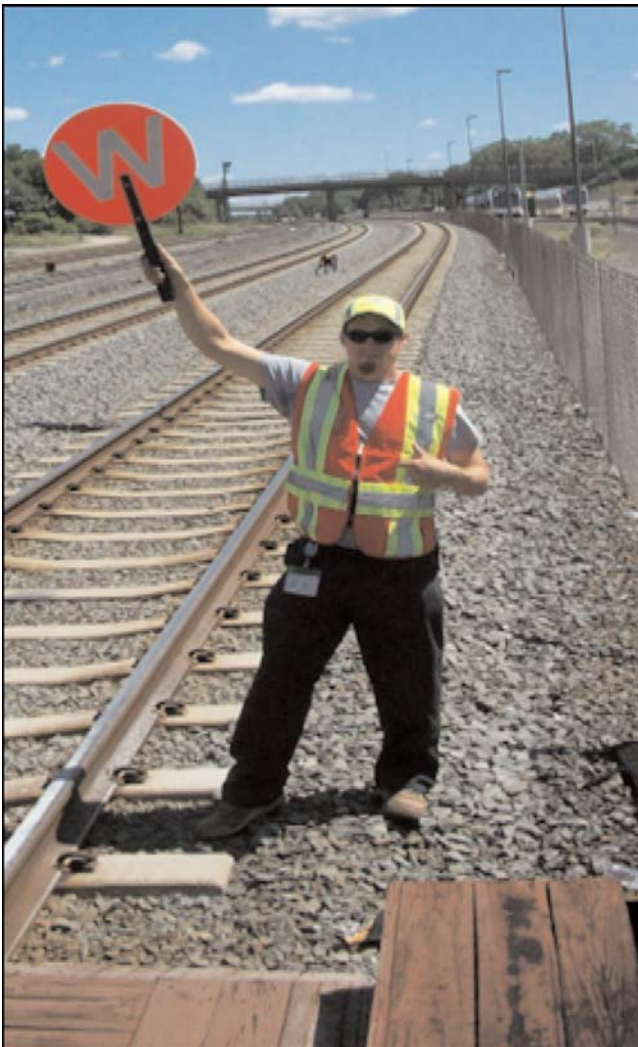


FIGURE 17 River LINE watchperson using orange disc and wearing required red “watchman” vest (Courtesy: River LINE).

## DESIGNATED LEVELS OF PROTECTION AND FLAGGING

Each of the five systems included in the study have predetermined levels of track protection or work zone classifications that are established within the systems’ rule books. In every case, all inspections and work must be performed in accordance with one of these stratifications.

### New York City Transit

The NYCT Department of Subways has established three levels of track protection. These levels apply to work of any degree and inspections performed on the system. The levels do not apply to employees who are using the ROW to access their work location, such as an operator walking to a train or an employee walking to a tower or equipment room. In these cases, employees must wear appropriate PPE and follow general safety guidelines for walking on the ROW, but they are not required to call the Control Center or tower to request and receive permission.

Whenever a worker employed by an entity other than NYCT enters the ROW, a designated representative of the appropriate Department of Subways Division must provide and maintain appropriate flagging protection in accordance with the rules and the nature of the work. In cases in which work is being performed in rooms, such as electrical distribution rooms or pump rooms, which can be accessed from the end of the station platform and without entering the tracks, one NYCT flagger must escort workers to and from the room while equipped with a red light or flag. This can be done only after the passage of a train.

When train operators observe one or more yellow lights or flags or orange fluorescent flags, they must reduce their speed to no more than 10 mph and sound two blasts of the horn, repeating if the view ahead is obstructed by a curve or otherwise, and be prepared to stop their trains within one half the range of vision.

### *Point-to-Point Flagging*

Point-to-point flagging is a procedure [Rule 3.76(a)] for workers who are performing duties in pairs or small groups, moving along the trackway and performing work that could be suspended at any time, with all members of the crew capable of immediately proceeding to a clear-up space within 15 ft. It is prohibited on operating tracks between 0600 h and 0900 h and between 1600 h and 1900 h Mondays through Fridays and at all times in under-river tunnels.

In point-to-point flagging, a flagger is assigned to warn and protect the work crew and cannot perform any other duties while so assigned. Underground at all times and outdoors between sunset and sunrise, the flagger displays a flashing

yellow light on the trackway 650 ft in approach to the work area. An orange fluorescent flag is used outdoors on the trackway between the hours of sunrise and sunset, 650 ft in approach to the area to be worked on. The flagger assigned to warn of approaching trains must be able to see his or her flashing yellow light and the employees he or she is protecting. If this is not possible, “full or standard flagging” is required. If the employees are continuously moving while performing their work or inspection, and clear-up space is within 15 ft, the flagger can be less than 650 ft but no closer than 50 ft in advance of the employee(s).

Use of the PTS is required when the crew pauses to work in one location or when the crew enters an area where a clear-up space is not accessible within 15 ft. Whenever the PTS is used, the flagger must display the flashing yellow light or orange fluorescent flag 650 ft in advance of the work and must be in a position no closer than 150 ft in advance of the work. The flagger must install the PTS utilizing the red light or red flag. The flagger signals approaching trains to stop until he or she receives verification that the crew is clear of the track. Then the flagger can signal the train to proceed, using the approved light or hand signals. On express track, or where there is a long, descending grade, or at any point where track conditions or train schedules permit train speeds of 35 or more mph, the flashing yellow light or orange flag must be displayed at a point 300 ft farther in the direction from which trains approach.

If the crew is performing work between two tracks, a flagger must be assigned to warn and protect the employee from trains on each track. On lead tracks, loop tracks, and middle tracks on the mainline in a three-track system, or where it is not uncommon for trains to operate in either direction, a flagger is required on each end to warn of approaching trains in both directions.

### *Full Flagging*

This practice is used when more extensive work is being performed than would permit point-to-point flagging, but when the track can remain in service. The process at the site begins with the person in charge of the work providing for and ensuring that the required flagging protection is established and maintained for the safety of the work crew and the safe passage of trains. Depending on the division performing the work, a supervisor or another qualified flagger must accompany the flagger in setting up and removing the flagging. The responsibility of the escorting supervisor or flagger is to watch for and warn of approaching trains and to verify that the flagging is properly established and removed.

The flagger and the escort place yellow lights or flags in accordance with Rule 3.80. This rule provides specific flagging distances and configurations for 12 different scenarios, depending on track layouts, curves, grades, or operational issues. The flagger and the escort then place one green light,

one green flag, or both at a safe distance beyond the farthest point of work or obstruction. This safe distance must be at least the maximum length of trains permitted on the subdivision where the work is being performed. Whenever turnouts or crossovers within the areas protected by caution lights or flags allow diverging train movements to another track, one green light, one green flag, or both must be displayed on the second track, the same distance as that displayed on the track to be worked on.

The flagger then proceeds to a specific position, designated in Rule 3.77, and places the red light, red flag, or both on a tie between the running rails adjacent to the rail to which the PTS is to be attached, and places the white light out of view of train operators. The PTS is then attached by the flagger to the rail, and the stop arm is inserted into the base with the red light or flag attached to the arm by the stout cord in such a manner as to permit waving the red flag or swinging the red light across the track with the stop arm in the tripping position.

Only after completing these steps can the flagger notify the crew that it is safe to enter the track area. The flagger then stands in a safe position to perform the assigned flagging duties, holding the red light or flag by hand when a train is in approach of the flagging area. Under no circumstances can this distance be less than 150 ft from the work area.

As a train approaches the caution lights and flags, the flagger must sound two long blasts of a whistle or air horn to warn the work crew, leave the stop arm in its tripping position, and swing the red light or red flag across the track until a prearranged all-clear signal is received from a designated NYCT employee with the crew. This signal indicates that the flagger may allow trains to proceed through the protected area. Upon receipt of an all-clear signal, the flagger must remove the stop arm, step into a prearranged place of safety, conceal the red light or flag from the train operator’s view, and then give a proceed signal to the train operator. After the train passes, the flagger must replace the red light or redisplay the red flag and replace the stop arm in the tripping position, then return to a safe position.

If, as the train approaches, the all-clear signal is not received by the flagger from the designated NYCT employee with the crew, or if the flagger observes any unsafe condition after receiving the all-clear signal, the flagger must continue to give the train operator a stop signal with a red light or red flag until the train has come to a stop. The stop arm must be left in the tripping position. Once the train has stopped, the flagger must continue to swing the red light or hold the red flag across the track until receiving the all-clear signal or until he or she is satisfied that the unsafe condition has been corrected.

If it appears that the train is going to pass through the flagger’s stop signal, the flagger must continue to wave the red light or red flag as a stop signal to the train operator at the same time sounding short blasts of a whistle or air horn to



warn the crew of the impending danger, as long as it is safe to do so. The flagger must then release the red light or flag, so that it falls between the running rails, leave the stop arm in tripping position and step quickly to a place of safety while continuing to sound the whistle or air horn. The flagger or supervisor must then report the incident immediately by telephone to the Control Center desk superintendent.

After all persons, equipment, tools, and materials for which the flagging protection had been established are removed from the track area, and the person in charge of the work reports that the work has been completed, the flagger along with another qualified flagger must remove the flagging protection in the following order:

1. Remove the PTS completely;
2. Remove the red light or red flag and place it in a concealed position;
3. Remove the green lights or flags; and
4. Remove the yellow lights or flags, keeping all lights lighted until he or she has reached a station platform or the place where the lights are to be stored.

When flagging protection is removed, all flags must be taken down, not rolled up on the flagstaff where they had been displayed. The employee-in-charge of the work must remain at the location of the work until all obstructions have been removed, the flagger has safely removed all flagging protection and is safely prepared to leave the site, and at least one train has safely passed the area where the work was performed. The Control Center desk superintendent of the subdivision is then notified by the employee charged with the work that it is completed.

### *General Order Protection*

This practice is used when a track will be taken out of service for maintenance, repair, or replacement and so does not allow for safe passenger service train movement through the work area. These areas are protected by an unmanned red flag or lamp and PTS configuration at each end of the work area. Under General Orders, work areas are also isolated by the Control Center through predetermined modified service operations, including simple reroutes, operation through a separate line, shuttle service through the affected area, and single-track operation. In some cases, depending on the nature and scope of the work to be performed, third-rail power may be de-energized through some or all of the work area covered in the General Order. Once a General Order is complete and all personnel, equipment, and flagging and barriers are removed, a test train must first be operated through the work area to ensure it is safe for revenue operation (9, Flagging Rules).

### **Toronto Transit Commission**

TTC uses five levels of protection for ROW access: walking inspections; three types of work zones; and restricted speed

track areas. Whenever Transit Control gives permission for a walking inspection, work zone, or restricted speed track area, it must advise the operating train crews to watch for employees and or warning devices at track level at the specific locations.

An operator who sees a light or flag at track level must obey all hand signals and be prepared to stop. An operator is required to stop the train:

- At a red light or red flag;
- Immediately when any object is waved violently by anyone;
- Immediately when given a hand signal that is not clearly understood; and
- Immediately when conflicting signals are received.

If a white light or yellow flag or a flashing yellow light/yellow flag is seen, the operator must:

- Sound the horn with a long blast;
- For walking inspections (white light or yellow flag)
  - Reduce speed to no more than 8 mph by the time the front of the train reaches the person(s) at track level, being prepared to stop and
  - Maintain the speed of the train at no more than 8 mph until it has cleared all persons at track level;
- For work zones (flashing yellow light/yellow flag)
  - Reduce speed to no more than 8 mph, by the time the front of the train reaches halfway between the flashing yellow light/yellow flag, and the red light/flag, being prepared to stop
  - Maintain the speed of the train at no more than 8 mph until its front reaches the green light/flag (major work zones) and the entire train has cleared all persons at track level, unless posted otherwise
  - If the work area conditions permit trains to travel at a greater speed, warning signs indicating a maximum speed of 12 mph are posted at track level, between the running rails, no less than 50 ft beyond the last worker at track level in the work area;
- Travel up to the posted maximum speed of 12 mph once the front of the train passes over the maximum speed warning sign, until the front of it reaches the green light/flag and the entire train has cleared all persons at track level;
- For major work zones where work is being performed in one direction only, trains traveling on the track opposite of the work area proceed at no more than 8 mph, unless warning signs are posted at the yellow light/flag indicating a maximum speed of 12 mph. The maximum speed is observed from the time the front of train reaches the yellow light/flag until the front of the train passes the green light/flag.

In the event that the maximum speed warning sign is not observed or is unclear, trains must proceed at the maximum speed (8 mph). Prior to descending to track level, all work

crews are required to establish a flashing blue light at the leaving end of the preceding station.

### *Walking Inspections*

Walking inspections are used for employees who often go to track level for duties that do not require them to set up work zones and for workers walking along the tracks on their way to and from work zones. The maximum number of persons allowed at track level on a walking inspection is five. Some of the work functions that require walking inspection protection are:

- Visual inspection of the track, switches, and other parts of the subway system;
- Trouble-shooting to locate a fault with the track, switches, signals, or other parts of the subway or light rail system;
- Orientation and training of new employees;
- Track patrol;
- Inspecting vehicles; and
- Quality assurance checks.

Under normal circumstances, employees may not walk alone on the mainline track and, when in a work group, employees must keep in line of sight of each other. Employees are instructed to walk in the direction of the approaching trains, and at least one person in each crew or group may be supplied with a radio for direct communication with Transit Control (wayside).

### *Work Zones*

In situations in which employees will be working at track level, work zones are used to protect employees. Employees can set up work zones at track level anywhere in the system. In the yards, however, some rules are different and are covered under a separate section of the rules.

There are three kinds of work zones: minor, major, and impassable. The kind of work zone to be set up depends on the type of work and how long it will take. Employees decide which work zone will give them the protection they need to do their job safely. If employees are not sure which kind of work zone they need while doing a specific job, they should discuss it with their foreperson or immediate supervisor.

Under TTC rules, crews should stay inside the work area and use only yellow, green, and red lights or flags to mark a work zone. Lights are used in the tunnel section, and flags in the open cut sections. In open cut sections, lights are used at night or when visibility is reduced by fog, snow, smoke, or other conditions.

In all open cut sections during daylight hours, a flashing yellow light is placed between the running rails at least 500 ft ahead of the approach end of the work zone with a yellow

flag next to it. On the light rail system a flashing yellow light is hung on a flagpole next to the track with the yellow flag next to the light.

Work crews include a watchperson for all major work zones and for any work zone in which employees can see for a distance of less than 500 ft. When there is more than one crew in a work zone, one person is designated as “in charge” of both work crews. This person is responsible for setting up the appropriate work zone.

If a work zone is set up in a crossover, center track, or yard area, extreme caution, as well as extra lights and flags, is used because vehicles may approach from any direction.

If the work zone overlaps tunnel and open cut sections, warning lights in the tunnel sections and warning flags in open cut sections are used. If the work zone is in a tunnel section but near the beginning of an open cut section, or in an open cut section near the beginning of a tunnel, the flashing yellow light or yellow flag are put further ahead of the work area than usual. This will give the operator of an approaching subway vehicle an earlier warning.

When the work has been completed, the person in charge must:

- Remove all track-level warning devices, beginning at the leaving-end and working toward the approach-end flashing yellow light;
- Proceed with the work crew to the appropriate station; and
- Advise Transit Control that employees are no longer at track level and cancel the work zone.

### *Minor Work Zones*

Minor work zones are appropriate when:

- Work at any location will take less than 2 h;
- A minimum of two and no more than five people are in the crew;
- Subway vehicle speed reduction in only one direction will be required; and
- Employees are sure that a minor work zone gives them enough protection to do their work safely and to clear the track safely when a subway vehicle approaches.

Setting up and using a minor work zone includes the following:

1. Call Transit Control to get permission to go to track level and set up a minor work zone. The person requesting the work zone must also be the person to cancel that work zone, unless otherwise arranged.
2. Obey all rules in “General Rules for Setting up Work Zones.”

3. Place a flashing yellow light at the approach end of the work zone. In open cut sections during daylight hours, place a yellow flag, next to it. Place the light, or the light and flag, at least 500 ft from the work area.
4. Place a red light or flag right in front of the work area at the approach end.
5. Give one member of the work crew the job of “watchperson.”
6. If permission has been granted by an authorized departmental employee to allow subway vehicles to travel at a greater speed, the 12 mph yellow maximum speed warning sign is placed immediately after the work area.
7. Clear the track safely and quickly when a subway vehicle approaches.

A watchperson at a minor work site has the following duties and responsibilities:

1. Tell the work crew when a subway vehicle is approaching;
2. Make sure that everyone in the work crew is clear of the tracks;
3. Remove the red light or flag when everyone is clear; and
4. Give the approved hand signals to direct the subway vehicle operator through the work area, using a white/red combination light, or a yellow flag during daylight hours in open cut sections.

In a minor work zone, warning lights or flags should not be placed on the track opposite the work zone. When a speed reduction is required in both directions, the work area should be protected with a major work zone.

### *Major Work Zones*

Major work zones are appropriate when:

- Employees’ duties require them to work at the same location longer than 2 h;
- There are six or more people in the work crew;
- A speed reduction is required in both directions (i.e., working in the devil strip or center bench areas); and
- Employees are sure that a major work zone gives them enough protection to do their work safely and to clear the track safely when a subway vehicle approaches.

Setting up and using a major work zone includes the following:

1. Call Transit Control to get permission to go to track level to set up a major work zone. The person who requests the work zone must also be the person to clear that work zone, unless otherwise arranged.
2. Obey all rules in “General Rules for Setting up Work Zones.”

3. Place a flashing yellow light at the beginning of the work zone at the approach end of the track. In all open cut sections during daylight hours, place a yellow flag beside the track next to the flashing yellow light. Place the light or the light and flag at least 500 ft from the work area.
4. Place two or more yellow lights or flags between the flashing yellow light and the start of the work area. Place these lights or flags at evenly spaced intervals, on or next to the track.
5. Place a watchperson with a red light or flag between the running rails immediately in front of the work area at the approach end of the track.
6. Place two additional yellow lights or flags beyond the work area for 100 m at the leaving end of the track, evenly spaced, 150 ft apart.
7. Place a green light or flag at least 500 ft beyond the work area at the leaving end of the track. Place this green light or flag on or next to the track.
8. If permission has been granted by an authorized departmental employee to allow subway vehicles to travel at a greater speed, the 12 mph yellow maximum speed warning sign is placed immediately after the work area.
9. Place warning lights or flags on the track opposite the work area, except in circular tunnel or box sections on the Sheppard Line. Place these warning lights or flags as follows:
  - Place a yellow light or flag at least 500 ft ahead of the work area
  - Place a green light or flag at least 500 ft beyond the work area
  - If permission has been granted by an authorized departmental employee to allow subway vehicles to travel at a greater speed, on the track opposite of the work area, where work is performed in one direction only, place the 12 mph yellow maximum speed warning sign immediately after the yellow light.

A watchperson must be posted for any major work zone or where visibility is reduced to less than 500 ft. The watchperson stands where it is possible to see an approaching train and the work crew, and where the work crew can hear the watchperson’s air horn or whistle. The watchperson on a major work zone has the following duties and responsibilities:

- Carry the following safety equipment:
  - White/red combination light or flags to signal trains
  - Air horn
  - Whistle.
- Listen and watch for the approach of a train.
- At the first sound or sight of a train, give a long blast on the air horn. If the air horn does not work, use the whistle.
- Make sure that the work crew and equipment are clear of the tracks.
- Remove the red light or flag from the track only when the work crew is clear of the area.

- Use the white light or yellow flag to give approved hand signals to the train operator to proceed through the work area, if it is safe to do so. Give the “proceed” signal with the yellow flag in all open cut sections during daylight hours.
- Do not leave the working position until replaced by another qualified employee.
- Do not perform any duties other than those of a watchperson.

A second watchperson is required if:

- One watchperson cannot see both the flashing yellow light and the work crew clearly; or
- The work crew will not be able, for any reason, to hear the first watchperson’s air horn or whistle.

The first watchperson stands where it is possible to see both the flashing yellow light and the second watchperson. The flashing yellow light or yellow flag and light must be 500 ft ahead of the first watchperson. The second watchperson stands where it is possible to see both the first watchperson and the work crew. The second watchperson will also sound the horn or whistle when the first watchperson sounds the horn or whistle. The second watchperson must make sure that the work crew and equipment are clear of the tracks. The second watchperson will then remove the closest red light or flag when it is safe to proceed. The first watchperson will then remove the other red light or flag and give an approved hand signal.

If the work crew will be leaving the work zone temporarily, the crew must inform Transit Control when it departs and when it returns. When the work crew, including the watchperson, leaves a major work zone while the job is in progress, the watchperson will:

- Make sure that the work crew is clear of the tracks;
- Turn off the red light or remove the red flag; and
- Switch the flashing yellow light to a steady yellow light.

When the work crew returns to the work area, the watchperson will:

- Switch the steady yellow light back to a flashing yellow light;
- Turn on the red light or replace the red flag; and
- Inform Transit Control.

When it is time to remove lights, the process begins at the leaving end and works towards the approach end flashing yellow light.

### *Impassable Work Zones*

Impassable work zones are areas through which trains are unable to enter. They are usually established during non-

revenue service hours and protected by a PTS at each end. Impassable work zones are appropriate when employees:

- Cannot clear the track safely to allow trains to pass by using any other type of work zone;
- Need the extra protection of an impassable work zone; or
- When work is being performed at track level by contractors.

Setting up and using an impassable work zone entails the following:

1. Call Transit Control to get permission to go to track level to set up an impassable work zone.
2. Obey all rules in “General Rules for Setting Up Work Zones.”
3. Place a PTS—double red light combination on each track that leads to the work area from any direction. If possible, place each PTS at least 500 ft from the work area. If this is not possible, place the PTS as far away as possible.
4. Place a flashing yellow light on each track that leads to a PTS—double red light combination. Place the flashing yellow light at least 500 ft from the PTS at the approach end. Place a yellow flag next to it in all open cut sections during daylight hours.
5. Place warning lights or flags on the track opposite an impassable work zone except in circular tube sections. Place a yellow light or flag at least 1,000 ft ahead of the work area.
6. Place a green light or flag at least 1,000 ft beyond the work area, on the track opposite an impassable work zone, except in circular tube sections.

To ensure that an area is impassable, employees must note the following:

- Additional track-level safety devices may be needed in crossover and center track sections. If employees are not sure what safety measures to take, they should discuss the impassable work zone layout with their foreperson or immediate supervisor before going to track level.
- The placement of PTS—double red light combinations may change in crossover and center track sections.
- Additional PTS—double red light combinations may be needed in some locations.

### *Restricted Speed Track Areas*

A restricted speed track area is an area where trains are required to reduce speed. Under normal circumstances there are no workers in the area unless a walking inspection has been authorized. Rail vehicles must slow down to 8 mph at the yellow light or flag and proceed at the default speed of 8 mph or as indicated on the yellow speed sign, until the front of the train reaches the green light or flag at the leaving end of the

area. If the yellow speed sign is not observed or is unclear, rail vehicles proceed at the default speed of 8 mph. On approach, operators must sound the horn with a long blast. If the operator stops in a restricted speed track area, the horn must be sounded with two short blasts before moving (2, pp. 6.1–6.50).

**Massachusetts Bay Transportation Authority**

MBTA’s rules define five levels of protection for people working on the ROW. Every ROW work site must be evaluated and a determination made as to what level of flagging protection is appropriate for the job. See Figure 18 for a summary of the five levels of protection.

*Level 1: Prohibited Access Area*

Under this level of protection, no access is permitted unless the individuals or work crews have exclusive access rights to the work area. Signs are posted in prohibited access areas. Train traffic must be stopped before an individual or work crew enters the area. During service hours no access is permitted until the Control Center dispatcher has confirmed that all vehicle movement has been suspended and the dispatcher has given exclusive access to the individual or work crew. Substitute service will be provided, if needed. The dispatcher must confirm that the work area is clear prior to allowing any movement of work trains or high-rail equipment. After being notified by the dispatcher that high-rail equipment is stationary and secure, work may commence.

*Work Crew Responsibilities* One member of the crew must call the Control Center dispatcher to request permission for

access. The crew member must clearly identify the work location, the reason for access, and the number of people in the crew. The work crew will then stand by until the dispatcher gives permission to enter the area. After receiving clearance from the dispatcher, the work crew will safely enter the area. Upon completion of their tasks, the work crew will clear the area and notify the dispatcher, confirming that all personnel are clear and in a safe location.

*Dispatcher Responsibilities* Upon receiving a request from a work crew to enter a Level 1 area, the dispatcher obtains the name of the person requesting access, radio number, number of persons in the crew, area of access and reason for access. The dispatcher will then confirm, via the Day Orders, that the crew has received prior authorization to access the area under Level 1 protection. If the work is not listed on the Day Orders, the dispatcher may deny access. In an emergency, the dispatcher may authorize access under Level 1 regardless of the Day Orders.

All designated Level 1 areas are clearly marked with a warning sign. However, Level 1 protection can be used in any area, not just those designated Level 1 areas, if circumstances require a heightened level of protection. The hazard assessment, which is required under all levels, provides the individual or work crew with the opportunity to examine the work site and determine if unusual circumstances warrant additional protection.

More than one work crew is allowed to be in a Level 1 work zone concurrently. However, each work crew must function as a separate unit and must follow all ROW rules, and each crew must possess and utilize its own personal protective equipment.

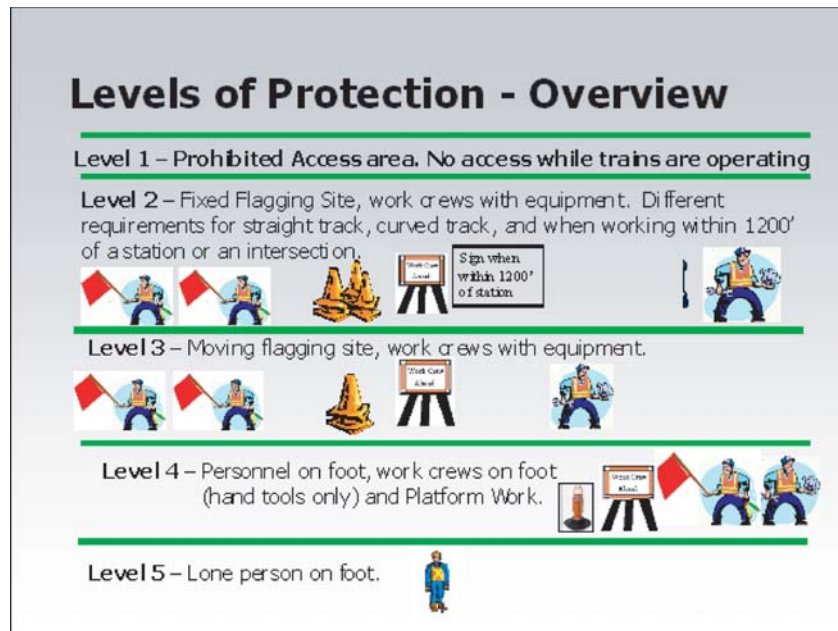


FIGURE 18 MBTA levels of protection (Courtesy: MBTA).

### *Level 2: Fixed Flagging Site*

This level of protection, the fixed flagging site, is for anyone (employee or contractor) working within 10 ft of the centerline of the tracks, including overhead or beneath, or for any work activity involving equipment, such as a crane, that has the potential to foul the ROW, even if the equipment or crews are working beyond 10 ft from the centerline of the track.

*Level 2 Procedures* Under Level 2 protection, 1,200 ft of warning devices is placed before the work area. A PTS on rapid transit lines or a warning device with a red flag on light rail lines is installed 500 ft before the work area. Flagger 1 is stationed 500 ft before the work area to remove and replace the portable trip or the warning device with the red flag with each passing vehicle. This flagger is also responsible for signaling to operators when to stop and when to proceed, and for watching the other flagger(s) for a signal when the work crew is clear of the ROW. Flagger 2 is stationed near the crew to warn them of oncoming vehicles and to verify and signal to flagger 1 when the crew is safely clear of the ROW. On curved track, additional flaggers may be needed and must be stationed between flaggers 1 and 2 so that each flagger can see the flagger nearest to him or her in each direction.

To set up a Level 2 site, flaggers 1 and 2 place a minimum of 13 warning devices beside the track, at 100-ft intervals, 1,200 ft before the work crew. The first warning device must contain a yellow flag. Flagger 1 places a red flag in the warning device 500 ft before the work crew, placing this warning device between the running rails (light rail only), and installs a portable trip on the track 500 ft before the work crew (rapid transit line only). Flagger 2 places a warning device with a green flag at least six car lengths beyond the work crew on the Red, Orange, and Blue Lines and at least three car lengths beyond the work crew on the Green Line. Flagger 1 is positioned 500 ft before the work area at the warning device with the red flag or portable trip and holds a red flag across the tracks. Flagger 2 is positioned near the first person working in the crew closest to oncoming traffic.

*Level 2 Flagging Procedures* Flaggers can use air horns to contact each other and to signal members of the work crew. However, these audible signals cannot be used instead of visual proceed signals.

- Flagger 1—When the work site is properly set up and he or she is ready to protect the work crew, signals to flagger 2.
- Flagger 2—Does not allow the work crew to access the ROW until:
  - The flagging site is properly set up
  - Flaggers are prepared to protect the crew
  - He or she has received the signal that flagger 1 is ready to protect the work site.

Upon viewing the warning device with a yellow flag, operators proceed at 10 mph. Upon reaching the flagger with

the red flag across the tracks, trains must come to a complete stop and stand by for a signal from the flagger.

- Flagger 1 stands to the right side of the rail with a red flag held across the tracks.
- When flagger 2 observes an approaching vehicle, he or she directs the work crew to clear the ROW.
- When the vehicle has come to a complete stop, flagger 1 turns to make visual contact with flag 2 and waits for flagger 2's "proceed" signal.
- Flagger 2 confirms that all members of the work crew have cleared the ROW, then gives the "proceed" signal to flagger 1 by waving a yellow flag up and down.
- Flagger 1 removes the portable trip or the warning device with the red flag, then stands clear of the ROW and gives the vehicle the proceed signal by waving a yellow flag up and down.

Upon receiving the signal, the operator proceeds at restricted speed until reaching the warning device with the green flag. As soon as the vehicle has passed, flagger 1 immediately reinstalls the portable trip on the running rail (rapid transit line only) or replaces the warning device with a red flag between the running rails (light rail only) and holds a red flag across the tracks ready to stop the next vehicle.

At times it may be impractical to set up a standard Level 2 work site, such as when the work site is within 1,200 ft of a station, platform, or intersection. To allow work to proceed during service hours without reducing safety, vehicle speed is restricted between the preceding station, platform, or intersection and the work site. This ensures that all approaching vehicles are prepared to stop before reaching the work site.

To set up flagging in these situations, employees follow all Level 2 procedures with the following adjustments:

- An approved "Work Crew Ahead" warning sign is placed at the end of the station platform before the work crew.
- A warning device is placed at the end of the platform before the work site.
- The number of warning devices depends on the distance between the preceding station and the work site. Flagger 1 is stationed 500 ft before the work site or on the end of the preceding platform. If the work site is closer than 500 ft from the platform a "Work Crew Ahead" is also placed on the beginning of the proceeding platform.

Figure 19 is a photograph of the Work Crew Ahead sign. Figure 20 provides graphical representations of different Level 2 work site configurations.

### *Level 3: Moving Flagging Site*

In some cases, the nature of the work and the short time (less than 1 h at one location) it would take to complete the work make it impractical to set up a Level 2 work site. To allow



FIGURE 19 MBTA Work Crew Ahead sign (Courtesy: MBTA).

this work to proceed during service hours without reducing safety and while ensuring the same level of protection as provided in Level 2, a Level 3 work site restricts vehicle speed in advance of the work site. This ensures that all vehicles approaching a Level 3 work site are prepared to stop before reaching the first flagger.

Under Level 3 protection, at least four warning devices and a warning sign are used. One warning device and a sign are placed 1,200 ft in advance of the first work location or at the end of station before the work site, and one warning device (with a red flag in it) is placed between the running rails 500 ft before the work crew (or before a PTS on a rapid transit line). When the nearest station is less than 500 ft from the first work location, a warning sign is placed at the beginning of the station. The warning sign must be approved by the Safety Department and must include a warning of the work crew ahead and indicate that restricted speed is required.

Flagger 1, stationed 500 ft before the work area (at the end of the nearest station if less than 500 ft from the work site), removes and replaces the portable trip or the warning device with the red flag with each passing vehicle. This flagger is also responsible for signaling to operators when to stop and when to proceed, and for watching the other flagger(s) for a signal when the work crew is clear of the ROW.

Flagger 2 is stationed near the crew to warn them of oncoming vehicles and to verify and signal to flagger 1 when the crew is safely clear of the ROW. On curved track, additional flaggers may be stationed between flaggers 1 and 2 so that each flagger can see the nearest flagger in each direction.

Level 3 flagging procedures are the same as Level 2 flagging procedures. See Figure 21 for a graphical representation how a Level 3 work site is set up.

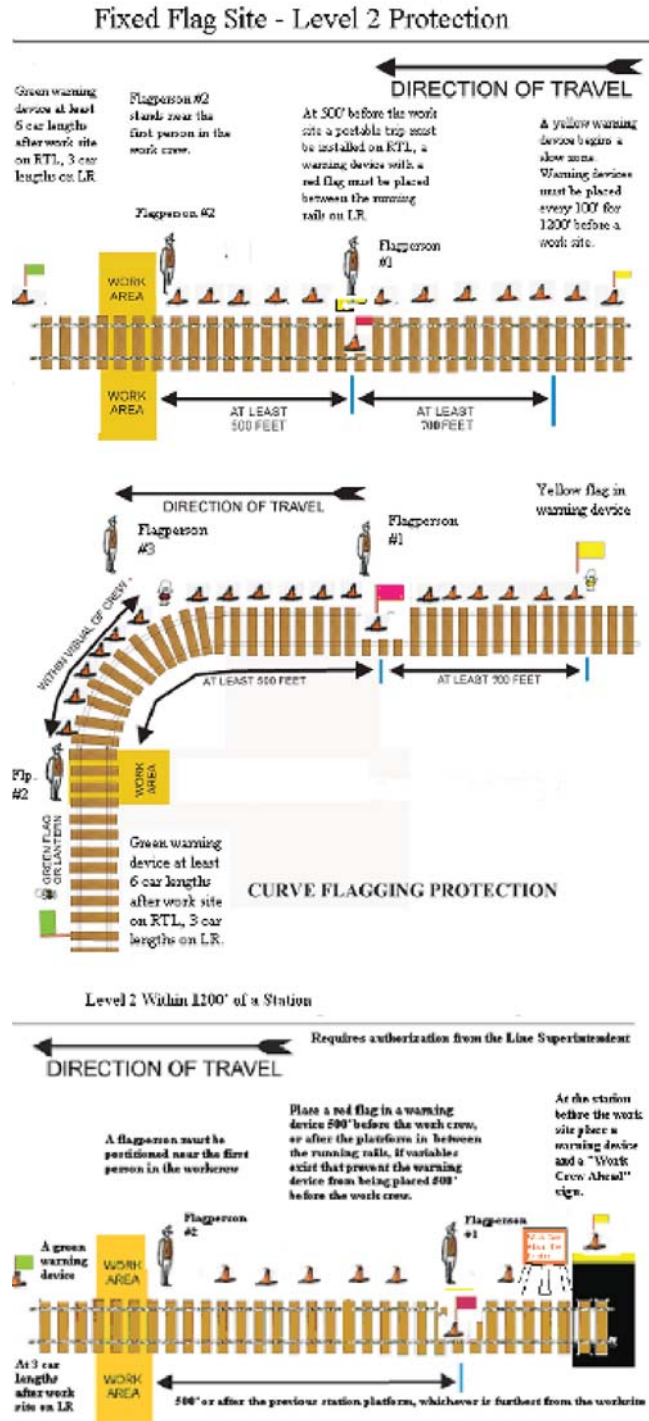


FIGURE 20 MBTA Level 2 work site configurations (Courtesy: MBTA).

*Level 4: Personnel on Foot*

Level 4 protection is used when a worker needs to perform a task on the ROW that may distract him or her from remaining constantly aware of the inherent danger associated with being on the tracks. In this situation, two or more workers are assigned to the task. One worker completes the necessary tasks and the other is responsible for watching for traffic and acting as

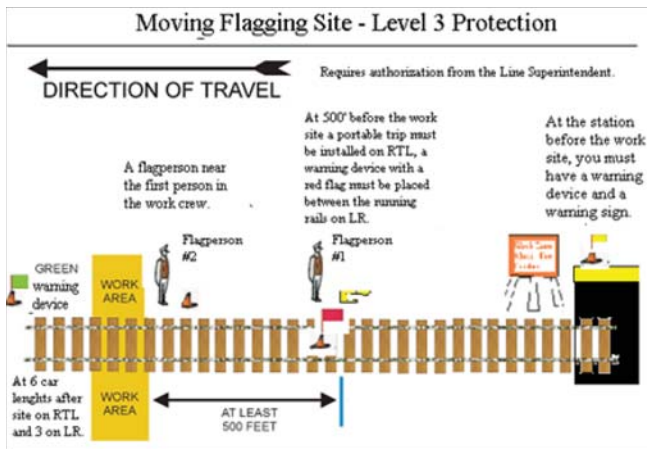


FIGURE 21 MBTA Level 3 work site (Courtesy: MBTA).

flagger at all times. To provide Level 4 protection, the work location must not prevent the workers from seeing oncoming vehicles; safe havens must be available; and the work activity must not utilize any equipment, other than hand tools, that would inhibit the workers from protecting themselves from ROW hazards.

**Level 4 Flagging Procedures** One crew member must work as the flagger to protect the crew. In Level 4, work crews entering the ROW must set up a flashing light, lantern, or warning device approximately 100 ft before the work crew (on curves the flashing light or lantern must be placed far enough before the crew so that it is visible to oncoming trains). The flagger must be located a distance ahead of the protected worker(s) based on current circumstances, such as track alignment and noise, and remain at all times in visual and audible contact with the protected workers. This flagger's main responsibility is to watch continually for oncoming vehicles and notify the crew immediately of an oncoming vehicle.

The flagger should be at least 25 ft from the other workers to ensure that he or she does not become involved in the work activity or distracted by other workers. Upon seeing an oncoming train, the crew must immediately stop all work activity and clear the ROW. The flagger should attempt to stop oncoming trains until the work crew is clear of the ROW. Unlike when approaching a Level 2 or 3 flagging site that is protected by a portable trip or warning devices, the vehicle may not be able to stop before the work crew, and therefore the work crew must clear the ROW immediately.

#### Level 5: Lone Person on Foot

This level of protection is appropriate for a lone worker who is constantly vigilant in protecting himself or herself from the inherent danger of the ROW, and who assumes responsibility for his or her own safety. Other conditions for Level 5 protection include:

- An employee or contractor is traveling to a safe point, such as inside a signal bungalow, vent fan room, or elevator room.
- A transportation employee is operating a switch on hand.
- The work being done, if any, requires no tools or equipment.

Under Level 5 protection, the worker must be sure that the work activity or location does not inhibit him or her from being protected from all ROW hazards.

**Level 5 Procedures** Personnel on foot are required to walk against the normal direction of vehicle travel whenever possible. They must remain constantly vigilant for oncoming trains, and ensure that they have a clear view of approaching vehicles and, at any moment, can step clear and into a safe haven. The work location must not inhibit the workers from seeing an oncoming vehicle and must provide safe havens. The work activity must not utilize any equipment, other than hand tools, that would inhibit workers from protecting themselves from ROW hazards.

As a train approaches, workers must stand clear of the tracks and stay in a place of safety until the train is completely clear of the area. Before returning to the ROW, they must check both directions for additional oncoming vehicles. If a person reaches a place where a curve in the track, vegetation, equipment, or anything else blocks the view of oncoming vehicles, he or she should leave the ROW and go around the area (6, pp. 20–37).

#### Maryland Transit Administration

MTA must comply with FRA regulations because it shares the ROW with a freight railroad. The levels of protection, as well as the methodology for determining what level of protection to use and how to carry out the duties, responsibilities, and procedures for each level, are compliant with CFR 214 subparts focusing on ROW worker safety. The practice of track worker protection used by this system is known as On-Track Protection.

The first step in determining the level of protection to be used is to determine the type of track in question. Controlled Track is track upon which all movements of employees, trains, railroad maintenance machines and equipment must be authorized by a Control Center. Non-Controlled Track is track upon which employees, trains, railroad maintenance machines and equipment are permitted by MTA Light Rail operating rules or special instruction to move without receiving authorization from a Control Center.

The next step is to determine whether a work crew or a lone worker will be protected. Figure 22 provides an overview of the decision matrix for MTA's On-Track Protection.



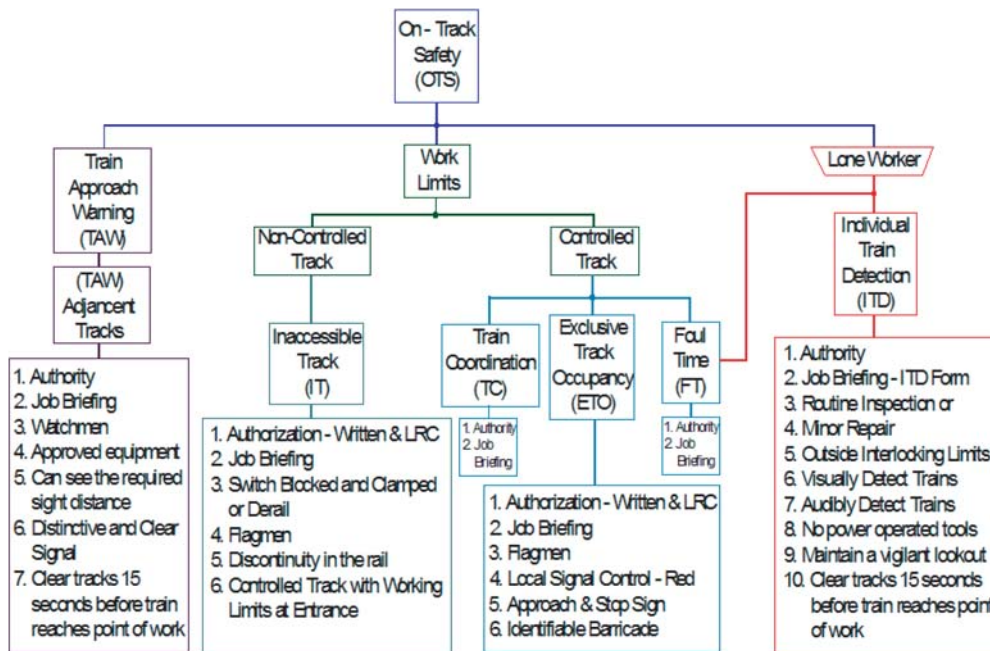


FIGURE 22 On-Track Protection decision matrix (Courtesy: MTA).

### Alternative Protection

Signal Department employees and crews on MTA have both the ability and the authority to protect their work sites—which are primarily at interlocking—through the localized use of the Automatic Train Protection (ATP) system. Under certain levels of track protection the Signal Department employee can request and receive authority to assume control of the ATP system at the interlocking, an example of which is seen in Figure 23. This allows the employee several options:

- The employee can control train movement by controlling the signals at the interlocking. This not only provides visual signaling to an operator that the site is occupied but also creates a situation whereby if a train were to “run” a signal, the ATP would bring the train to a stop, just as in normal, system-wide, ATP operation.
- The employee can control the speed of trains moving through the area. This is not possible through Control Center control of the system, but the technology installed at each interlocking allows for speed controls, enforced through the ATP, to be set for “normal” operation, and reset at the interlocking by a signal department employee, for other situations. This could be used when signal crews are working on repairing or replacing impedance-bonds, signal wiring, or other system components. It could also be used to set speeds for operations other than signal department work, such as emergency service operations off of but alongside the ROW, or adverse weather conditions.
- Efficient and safe operations using this method actually allow a signal department employee in the electrical shed at the interlocking to have both visual connections with

the crew on the ROW, as well as an advance indication of approaching trains—in either direction—by using the ATP board at the interlocking. By controlling signals and speeds through the ATP, and directly (visually and verbally) communicating with the work crew, the signal department employee can alert the crew to clear the tracks and, once safely done, can allow the train to pass through the interlocking without ever stopping. This would not be possible if the employee had to rely solely on line-of-sight detection of train movement.

The On-Track Protection matrix (see Figure 22) is designed to help determine the types of protection available in a particular situation. The types of protection available are:

- Exclusive Track Occupancy (ETO)
- Foul Time (FT)
- Train Coordination (TC)
- Inaccessible Track (IT)
- Train Approach Warning (TAW)
- Individual Train Detection (ITD).

Figure 24 summarizes the situations in which each type of protection is used.

### Exclusive Track Occupancy

Exclusive Track Occupancy (ETO) is a method of establishing working limits on controlled track in which the authority to move trains and other equipment is transferred by Light Rail Control (LRC) to the OSC. In tunnels, where side clearance is limited and no other places of safety are provided, the OSC

must arrange for the use of the track through ETO as protection against approaching trains.

The authority for ETO given to the OSC will be transmitted on a written or printed document and by oral communication to the OSC by LRC. OTCs obtain permission to establish ETO by calling LRC using a radio or cell phone and providing a description of the work to be performed, the work limits by chain marker or station, the radio call number, and the call numbers of the crew.

Employees cannot enter the mainline until LRC gives them instructions to do so. When authority for ETO is transmitted orally, the OSC must repeat the transmission to LRC for verification. The OSC in charge of the working limits maintains possession of the written or printed authority.

MTA Light Rail makes a written or electronic record of all authorities issued to establish ETO. The extent of working limits established through ETO is defined by one or more of the following physical features clearly identifiable to a light rail vehicle operator, locomotive operator or other person operating railroad equipment:

- A flagger with instructions and capability to hold all trains and equipment clear of the working limits;
- Fixed signals displaying “Stop and Stay”;
- A 5 mph Approach Speed Limit Sign and Work Limit Stop Sign where the OSC prohibits vehicle movement. The vehicle can only proceed when permission is given by the OSC. When permission is given, the vehicle must not exceed restricted speed through the work limits; and
- A clearly identifiable barricade prescribed by the MTA Light Rail operating rules that trains may not pass without proper authority.

Movements of trains and railroad maintenance machines within working limits established through ETO are permitted only under the direction of the OSC. Such movements are at restricted speed, unless the OSC has specifically authorized a higher speed.

#### *Foul Time*

Foul Time (FT) is a method of establishing working limits on controlled track in which a railroad worker is notified by LRC that no trains will operate within a specific segment of controlled track until the railroad worker reports clear of the track.

Working limits established on controlled track through the use of FT must comply with the following requirements:

- Foul Time is given orally by LRC only after LRC has withheld the authority of all trains to move into or within the working limits during the FT period.



FIGURE 23 MTA interlocking signal shed and components. Speed control settings for each track within area of interlocking (*top*). MAS is maximum allowable speed for each track. Control board for interlocking within interlocking shed (*center*). Interlocking shed along the MTA ROW (*bottom*) (Photos: Chris Kozub).

TYPES OF PROTECTION	TYPES OF TRACK			
	Controlled Track		Non - Controlled Track	
	Work crew	Lone	Work crew	Lone
Exclusive Track Occupancy (ETO)	<input checked="" type="checkbox"/>			
Foul Time (FT)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		
Train Coordination (TC)	<input checked="" type="checkbox"/>			
Inaccessible Track (IT)			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Train Approach Warning (TAW)	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	
Individual Train Detection (ITD)		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>

FIGURE 24 MTA types of track protection (*Courtesy: MTA*).

- Employees obtain permission to establish FT from LRC. They must call LRC via radio or cell phone and give their radio call number and the call numbers of other employees in the crew, a description of the work to be performed, the amount of FT being requested, and the working limits by chain marker or station.

Employees cannot enter the mainline until LRC gives them instructions to do so. OSC to whom FT is transmitted orally must repeat the track number, track limits, and time limits of the FT to LRC for verification before the FT becomes effective.

LRC will not permit the movement of trains or other on-track equipment into the working limits protected by FT until the OSC who obtained the FT has reported clear of the track. FT is a simplified method of establishing working limits. It is distinguished from ETO by not requiring a written copy of the authorization, and by not requiring any flaggers, signal control, stop signs, or barricades.

#### *Train Coordination*

Train Coordination (TC) is a method of establishing working limits on track upon which a train holds exclusive authority to move, whereby the crew of that train yields that authority to a railroad worker. Working limits are established on controlled track by an OSC through the use of TC according to the following requirements:

- TC is within the segments of track(s) upon which only one train holds authority to move.
- The OSC obtains permission to establish TC by calling the LRC using radio or cell phone and providing a description of the work to be performed, the working limits by chain marker or station, and his or her radio

call number, as well as the call numbers of the other employees in the crew.

Employees cannot enter the mainline until LRC gives instructions to do so. Each OSC to whom TC is transmitted orally must repeat the track number, track limits, and time limits of the TC to LRC for verification before TC becomes effective.

The OSC who establishes working limits on controlled track by TC must communicate with the train operator and determine that:

- The train is visible to the OSC who is establishing the working limits.
- The train has stopped.
- Further movements of the train will be made only as permitted by the OSC of the working limits while the working limits remain in effect.
- The train operator will give up authority to move when the OSC of the working limits has released the working limits to LRC.

#### *Inaccessible Track*

Inaccessible Track (IT) is a method of establishing working limits on non-controlled track by physically preventing entry and movement of trains and equipment. Working limits on non-controlled track are established by rendering the track that is within working limits physically inaccessible to trains at each possible point of entry by at least one of the following features:

- Flaggers with instructions and capability to hold all trains and equipment clear of the working limits;

- A switch or derail aligned to prevent access to the working limits and secured with an effective securing device by the OSC of the working limits;
- A discontinuity in the rail that precludes passage of trains or locomotives into the working limits; or
- Working limits on controlled track that connects directly with the IT established by the OSC of the working limits on the IT.

LRC will secure a remotely controlled switch aligned to prevent movement by:

- Applying a blocking device or a clamping device to remove power from the switch motor; and
- Notifying the OSC that protection has been provided.

LRC will not remove the protection until receiving permission from the OSC.

The authority for IT is given to the OSC of the working limits on a written or printed document and by oral communication from LRC. OSCs obtain permission by calling LRC using radio or cell phone and providing a description of the work to be performed, the working limits by chain marker or station, and his or her radio call number and the call numbers of the other employees in the crew.

Employees cannot enter the mainline until LRC gives them instructions to do so. When authority for IT is transmitted orally, the OSC will repeat the transmission to LRC for verification. The OSC in charge of the working limits will maintain possession of the written or printed authority. Trains and railroad maintenance machines within working limits established by means of IT will move only under the direction of the OSC, and must move at restricted speed. No operable locomotives or other items of on-track equipment, except those present or moving under the direction of the OSC of the working limits, can be located within working limits established by means of IT.

### *Train Approach Warning*

Train Approach Warning (TAW) is a method of establishing on-track safety by providing watchpersons to look out for approaching trains. Watchpersons will warn the work crew early enough to allow them to be in the clear at least 15 s before the train reaches the point of work. This will allow the work crew time to move to or remain in a place of safety. In using TAW, railroad workers who foul any track outside of working limits (working limits are not established) shall be given warning of approaching trains and other on-track equipment by one or more watchpersons.

Before an employee fouls the tracks using TAW, the OSC must obtain permission to enter mainline tracks by calling the LRC using radio or cell phone and providing a description of

the work to be performed, location by chain marker or station, his or her radio call number, and the call numbers of the other employees in the crew. Employees cannot enter the mainline until LRC gives them instructions to do so. OSCs are to repeat back any instructions received from LRC before entering yard or mainline tracks. When the work is complete, all personnel, tools, and equipment must not foul the track, and LRC must be notified that the crew is clear of all mainline tracks. Before two or more employees who are working together foul a track using TAW, they must establish sufficient lookout, one in each direction or one in both directions, for approaching trains.

TAW will be given in sufficient time to enable each employee to move to and occupy a previously arranged place of safety. The watchperson must warn the work crew in sufficient time to enable them to be clear of the tracks at least 15 s before the train (moving at the maximum authorized speed) reaches their point of work. Watchpersons assigned to provide TAW must devote full attention to detecting the approach of trains and communicating a warning, and must not be assigned any other duties while functioning as watchperson.

The means used by watchpersons to communicate a TAW must be distinctive and must clearly signify to all recipients of the warning that a train or other on-track equipment is approaching. Every employee who depends on TAW for on-track safety must maintain a position that will enable him or her to receive a TAW signal communicated by the watchperson at any time while on-track safety is provided by TAW.

Watchpersons shall communicate TAW by a means that does not require a warned employee to be looking in any particular direction at the time of the warning, and the warned employee, regardless of noise or distraction of work, can detect the warning signal. A watchperson will, if practical, be stationed clear of all tracks at a point where he or she will have the best view of approaching trains in both directions. Also, the watchperson will be a sufficient distance from the work crew to prevent attention being distracted by the work, but not farther than his or her audible warning can be distinctly heard.

### *Individual Train Detection*

Individual Train Detection (ITD) is a procedure that permits a lone worker to acquire on-track safety by seeing an approaching train and leaving the track 15 s before it arrives. ITD may be used only under circumstances strictly defined in the *Railroad Worker Protection Manual*.

Individual Train Detection may be used to establish on-track safety only:

- By a lone worker who has been trained, qualified, and designated by the MTA Light Rail Training Department;
- While performing routine inspection and minor correction work;

- On track outside the limits of an interlocking or a controlled point;
- Where the lone worker is able to visually detect the approach of a train moving at the maximum authorized speed on that section of track and clear the tracks 15 s before the train reaches the work area;
- Where no power-operated tools or railroad maintenance machines are in use within earshot of the lone worker; and
- Where the ability of the lone worker to hear and see approaching trains and other on-track equipment is not impaired by background noise, lights, precipitation, fog, passing trains, or any other physical conditions.

When using ITD, the worker must fill out the Statement of On-Track Safety for a Lone Worker and request permission to enter the mainline using ITD by calling the LRC using radio or cell phone and providing a description of the work to be performed, the location by chain marker or station, and his or her radio call number.

A worker cannot enter the mainline until LRC gives him or her instructions to do so. The worker must repeat back any instructions received from LRC before entering the yard or mainline tracks. When the work is complete, the worker must not foul the track, and LRC must be notified that the worker is clear of all mainline tracks.

Upon the approach of a train on any mainline track or adjacent track, the worker must clear all tracks. A lone worker retains the absolute right to use on-track safety protection other than ITD if he or she deems it necessary, and to occupy a place of safety until another form of on-track safety can be established. A lone worker using ITD for on-track safety while fouling a track may not occupy a position or engage in any activity that would interfere with his or her ability to maintain a vigilant lookout for approaching trains moving in either direction. A lone worker who uses ITD to establish on-track safety must first complete a written Statement of On-Track Safety. The lone worker must produce the Statement of On-Track Safety when requested by a FRA representative or supervisor (7).

#### *River LINE*

Although there are some differences in terminology and practices that reflect the size and structure of the River LINE, its track worker safety program is essentially identical to that of MTA.

### **SAFETY CHALLENGES**

Every system included in the study has some form of “Challenge” or “Dispute Resolution” whereby members of ROW work crews can document concerns regarding the

hazards associated with a task or work location and the associated level of protection. Given the similarities in most of the processes, this section of the report will provide a sample of the practices from three of the five systems: NYCT, MBTA, and the River LINE.

#### **New York City Transit—Safety Rule Dispute Resolution Process**

NYCT supervisors are directed to utilize the Safety Rule Dispute Resolution Form when a TWU-represented employee or group of employees asserts that the work requested violates a safety rule or procedure. These forms must be made available from the supervisor at the work location to any TWU-represented employee who wishes to raise such an allegation. In such cases, only work relating to the allegation stops until the dispute resolution process is completed. All work not related to the allegation continues.

Section 1 of the form is completed by the employee who is making the allegation. If a group of employees is asserting the violation, one employee completes the form on behalf of the group. The information must be as specific as possible. After completing this section, the employee gives it to the supervisor identified on the form.

The supervisor and the employee discuss the issue and the applicable rules, and the supervisor must complete Section 2, noting his or her explanation and actions, and if the employee agreed or disagreed. If agreement is reached, work may resume. If the employee disagrees, the supervisor must note the disagreement. The concern is then raised immediately to a manager. Each employee must sign the form, noting the time and date.

In Section 3, the manager notifies the TWU and MOW Operations immediately, interviews the supervisor and the employee, and renders a decision. The interview may be conducted by telephone. If the issue is resolved, the manager must complete this section of the form by the end of the shift. If the issue cannot be resolved by telephone, the manager must report to the location and complete this section immediately after rendering a decision. The decision of the manager is final and binding on both parties. The manager will direct the employee(s) back to work.

The complete form, regardless of the type of resolution, is distributed to the appropriate division head, the Office of System Safety, the TWU, and the employee. A Division Review Panel convenes periodically to review the forms. Reports are then provided to the Senior Vice President of Subways and the Vice President of System Safety. Figure 25 provides a copy of the NYCT Safety Rule Dispute Resolution Form.

# SAFETY RULE DISPUTE RESOLUTION FORM

This section is for the employee who is alleging a violation of a departmental or applicable NYC Transit-wide safety rule or a section of an applicable law.

An employee or group of employees directed by supervision to violate a departmental or applicable NYC Transit-wide safety rule or applicable law can utilize the following procedure in order to have the situation immediately reviewed by a supervisor and manager, if necessary.

If a manager is present when the issue is raised, the alleged violation need only be reviewed by the manager.

This procedure does not supercede or replace the provisions of the Collective Bargaining Agreement.

Employee Name	
Title	Pass #
Dept./Division	
Supervisor	Pass #
Date	Time
Task Being Performed	
Location	

1. In this section the employee must specifically describe the alleged violation. Indicate or describe the rule or standard being violated.

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Time \_\_\_ a.m. \_\_\_ p.m. Date \_\_\_/\_\_\_/\_\_\_

Employee Signature (required)

2. In this section the supervisor at the location must indicate what actions he/she took regarding the concerns that the employee has indicated. If the employee does not agree with the explanation or action, indicate what the disagreement is and refer the matter to a manager who must notify his/her divisional Control Center and advise them to immediately notify the TWU of the issue (888-898-6608). If there is no divisional Control Center the manager must notify the TWU. The manager must immediately review the matter.

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Employee Agree  Disagree

Employee Signature

Time \_\_\_ a.m. \_\_\_ p.m. Date \_\_\_/\_\_\_/\_\_\_

Supervisor Signature (required)

3. In this section a manager from the division must indicate what actions he/she took regarding the concerns that the employee indicated above. Upon explaining to the employees what changes will be made at the work site or that the challenge is not valid, the manager will direct the employee back to work. If the employee/gang refuses the manager's decision, appropriate action may be taken against the employee(s). If the supervisor/manager fails to correct a valid safety condition, appropriate action will be taken against the supervisor/manager.

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Time \_\_\_ a.m. \_\_\_ p.m. Date \_\_\_/\_\_\_/\_\_\_

Manager Signature (required)/Print Name/Pass Number

*Upon completion of this form it must be forwarded to the division head, the Office of System Safety (fax #718-243-4770), and the TWU Director of Safety and Health (fax #212-724-5826).*

Supervisor/Manager Copy

58-12-0070

FIGURE 25 NYCT Safety Rule Dispute Resolution Form (Courtesy: NYCT).

## Massachusetts Bay Transportation Authority—Good Faith Challenge

If an employee does not have the appropriate PPE or feels that the work he or she is performing or being asked to perform puts him or her and others in danger, that employee is empowered and obligated to rectify this safety concern by initiating a "Good Faith Safety Challenge" to the employee in charge or to the Control Center dispatcher.

The supervisor in charge of the work must respond immediately to the "Good Faith Safety Challenge" or to any

complaint of an unsafe condition. An evaluation must be made on how the unsafe condition can be resolved to allow the safe continuance of work. Figure 26 provides a copy of the MBTA ROW Good Faith Safety Challenge form.

## River LINE Good Faith Challenge

River LINE roadway workers have the absolute right to challenge, in good faith, any directive that would violate any regulation governing on-track safety. The roadway worker remains clear of the track until a challenge is resolved.

**MBTA Right of Way  
"Good Faith Challenge Form"**

This section is to be filled out by the employee making the "Good Faith Challenge":

Name: \_\_\_\_\_

Badge number: \_\_\_\_\_

Crew assignment: \_\_\_\_\_

Class/Job Title: \_\_\_\_\_

Date: \_\_\_/\_\_\_/\_\_\_ Time: \_\_\_:\_\_\_ AM / PM

Work location: \_\_\_\_\_

Line: \_\_\_\_\_ Station: \_\_\_\_\_

Direction: \_\_\_\_\_ Track Number: \_\_\_\_\_

Employee Responsible for Flag Protection

Name: \_\_\_\_\_

Title: \_\_\_\_\_

Date of occurrence: \_\_\_\_\_

Statement: (This requires the use of the MBTA Right of Way Rulebook  
What ROW rule is not being complied with? \_\_\_\_\_  
Furnish the reason for the "Good Faith Challenge": \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Please provide, if possible, other employees with information concerning this circumstance.

Name/Badge: \_\_\_\_\_ Name/Badge: \_\_\_\_\_

Name/Badge: \_\_\_\_\_ Name/Badge: \_\_\_\_\_

Signature of employee making "GFC": \_\_\_\_\_  
=====

Determination of Supervisor: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Supervisor's signature: \_\_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_  
=====

Determination of Protection from Trains Dispute Panel: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Panel/Member's signatures:

Name: \_\_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

Name: \_\_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

Name: \_\_\_\_\_ Date: \_\_\_/\_\_\_/\_\_\_

FIGURE 26 MBTA ROW Good Faith Safety Challenge form (Courtesy: MBTA).

When a roadway worker has concerns about any directive that would violate the regulations governing on-track safety the following procedures apply:

1. The roadway worker will discuss the on-track safety procedures at the work location with the employee in charge. The worker and the employee in charge try to clarify any misunderstandings and resolve any differences of opinion about the on-track safety procedures.
2. If the worker and the employee in charge are unable to resolve the conflict, the employee may challenge the on-track safety procedures. To issue a challenge, the worker must:
  - a. Do so in good faith. The worker must have an honest concern that the procedures in place do not comply with these on-track safety regulations.
  - b. Be able to explain the concern about the proposed on-track safety procedures being applied.
3. If the worker decides to challenge the on-track safety procedures, he or she must:
  - a. Notify the employee in charge.
  - b. Notify any other roadway workers of the concern.
  - c. Remain clear of the track.
  - d. Explain the reason(s) for their concern on a "Roadway Worker Challenge Form" (see Figure 27).
  - e. Give the form to the employee in charge.
4. The employee in charge will review the challenge form and determine whether:
  - a. The worker's statement of on-track safety procedures at the work location is accurate and the on-track safety procedures comply with regulations.
  - b. If the employee in charge determines that the worker's concerns are valid, the employee in charge changes the procedures so that they comply with the regulations. If the worker considers the challenge resolved, the employee in charge forwards the challenge form to the Superintendent of Maintenance's (or designee's) office, and the worker returns to work.
  - c. If the employee in charge determines that the worker's concerns are not valid, he or she notifies the worker and documents the determination on the form. If the worker considers the challenge to be resolved, the employee in charge forwards the

## River LINE RWP Challenge Resolution Form

**All actions required under the directive being challenged must cease until the challenge is resolved.**

Date _____	Employee Name _____
Employee-in-charge _____	Subdivision _____
Track No. _____	Working Limits _____

On-Track Protection In Use (Please circle one):

Inaccessible Track	Watchman/Lookout
Form D/ Track Permit	Foul Time
Individual Train Detection	Lone Worker

Instructions received in Job Briefing per RWP requirements:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Instructions or Safety Requirements being challenged:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Resolution and other relevant information:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Employee Signature _____	Is this challenge Resolved?    Y    N
Employee-in-charge Signature _____	Was the requested action taken?    Y    N

***In the case that a challenge can not be resolved at the work site, an employee has the right to elevate the challenge to the relevant Superintendent and/or the Safety Department for resolution.***

Elevation of Challenge to Superintendent/ Safety Department Required?    Y    N

Action required to resolve elevated good-faith RWP challenge

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Superintendent Signature _____	
System Safety Manager Signature _____	

FIGURE 27 River LINE Roadway Worker Protection Challenge Resolution Form (*Courtesy: River LINE*).

- challenge form to the line engineer’s (or designee’s) office, and the worker returns to work.
  - d. If the worker still does not consider the challenge resolved, the employee in charge contacts the supervisor for a resolution.
  - e. The supervisor reviews the challenge form and determines whether the proposed on-track safety procedures at the work location comply with the regulations. The supervisor contacts the employees named on the form to make this determination.
5. If the supervisor determines that the challenge was valid, the supervisor arranges for the procedures to comply with the regulations. Once the procedures are in compliance, the workers return to work. If the supervisor determines that the challenge was not valid, the supervisor explains the decision to the worker.

The challenge is considered resolved, and the workers return to work.

- 6. A copy of the completed challenge form is forwarded to the superintendent of maintenance’s (or designee’s) office.

### Toronto Transit Commission

The Ontario Occupational Health and Safety Act gives all workers the right to refuse unsafe work. The TTC implementation of the employee process to refuse unsafe work is as follows:

- Employee reports concerns to supervisor.
- If unresolved, the matter is referred to the joint Labor/ Management Health and Safety Committee.



- If unresolved, the TTC Safety Department is consulted.
- If still unresolved, a representative from the Ministry of Labor is called in to arbitrate.

## **CONCLUSION**

Research and discussions with agency employees have validated that the “meat and potatoes” of a track worker safety program are the practices for providing protection and warnings to track workers relative to train movement. The set of rules and practices listed in this chapter illustrate a wide range of approaches to determining, communicating, and executing track worker protection. Although some of these

differences may be the result of the size and nature of the systems, others demonstrate varying organizational approaches and priorities regarding safety and tolerances for service disruptions and diversions.

Although the goal of every system’s program was a comprehensive approach including rules and procedures for equipment, communications, entering and exiting the ROW, setting up and performing flagging, and challenging safety condition concerns, it is difficult for the agencies to determine the effectiveness of the approaches. Chapter four explores the systems’ approaches to ensuring rule compliance and tracking near misses and accidents, and identifying what improvements are needed.

## SAFETY AUDITS, INCIDENT REPORTING, ANALYSIS, AND FOLLOW-UP ACTIONS

### INTRODUCTION

This chapter explores the processes agencies use to evaluate the effectiveness of their ROW worker protection program. The most obvious measure of effectiveness is the number and type of accidents that occur within an agency. As investigation reports reveal, accidents do not just happen; they result from what could be a simple failure to a complex combination of a variety of situations and circumstances. Agencies that experience accidents conduct investigations to understand what happened and learn how to prevent similar events from occurring. All the agencies studied had baseline policies and procedures in place to provide for the ongoing evaluation of their program. Some had implemented more comprehensive approaches to data collection and analysis to enable the ongoing refinement of their efforts.

### STATE SAFETY OVERSIGHT PROGRAM

In 1991, Congress required for the first time that the FTA establish a program providing for the state-conducted oversight of the safety and security of U.S. rail systems not regulated by the FRA. In April 2005, the FTA issued a Final Rule making changes to the substance and format of the existing 49 CFR part 659. The intent of the changes was to improve the performance of the State Safety Oversight Program and to ensure the following outcomes:

1. Enhance program efficiency;
2. Increase responsiveness to recommendations from the NTSB and emerging safety and security issues;
3. Improve consistency in the collection and analysis of accident causal factors through increased coordination with other federal reporting and investigation programs; and
4. Improve performance of the hazard management process (*12*, Part IV, p. 22563).

Under the 2005 Final Rule, rail transit agencies must develop a system safety program plan, review it annually, and modify it as needed. As part of the process, all elements of the system safety program must be reviewed in an ongoing manner over a 3-year cycle. The agency's chief executive must submit a statement of compliance or noncompliance with its system safety program plan, along with the agency's annual report, to the oversight agency. If an agency is in noncompliance, the report must identify the areas that do not

conform to the system safety program plan, and must list measures being taken to bring these areas into compliance.

In addition, rail transit agencies must have a hazard management process in place that includes the ongoing identification of hazards, the evaluation and prioritization of elimination or control measures, a mechanism to track identified hazards to resolution, thresholds for notification and reporting hazards to the oversight agency, and ongoing reporting of hazard resolution activities to the oversight agency (*13*, pp. 32–38).

The State Safety Oversight rules apply to all of the agencies interviewed for this study, except TTC. The primary responsibility for demonstrating compliance with 49 CFR Part 659 rests with System Safety. The Office of System Safety serves as the primary liaison between the State Safety Oversight organization and the agency. System Safety develops the System Safety Program Plan with input from the rest of the organization and conducts the internal auditing. Generally, the auditing consists of ensuring that rules, policies, and procedures are in place and are effectively communicated to employees, and tracking employee and customer accidents and incidents.

### ACCIDENT INVESTIGATIONS

Rail transit agencies investigate any accident that involves a collision with an individual on a rail ROW. Usually, safety department personnel conduct the investigation with assistance from the operating department where the accident occurred.

In general, the investigators:

- Question all witnesses;
- Compile all documentary evidence; and
- Ascertain all applicable safety rules.

Upon completion of the investigation, the investigators prepare a written report that sets forth the material facts leading to and causing the incident; determines the principal and contributing causes; reaches conclusions as to the persons, policies, procedures, and practices responsible for the incident; and provides recommendations for changes in safety rules, work rules, or other policies, practices, and procedures to prevent the occurrence of similar incidents. The recommendations are vetted through the affected departments. A set of corrective actions are agreed upon and planned to be

implemented. Progress on the actual implementation of the corrective actions is usually tracked and reported to agency management and the oversight organization.

## NEAR MISSES

NYCT was the only agency interviewed that followed a structured process for reporting near miss incidents. The process includes an analysis of Potential Employee Contact (PEC)-type near miss incidents and Non-PEC-type near miss incidents. A PEC-type near miss incident is an incident involving a train or a ROW operation that could have resulted in an employee fatality or serious injury. A Non-PEC-type near miss incident is an incident involving a train or a ROW operation that could have resulted in a customer injury or property damage but does not present the potential for an employee fatality or serious injury.

PEC near miss incidents include:

- General Order violations;
- Improper flagging;
- Potential employee contact with trains while working on the roadbed;
- Portable trip overruns;
- Failure of train to blow horn when passing yellow caution lights; and
- Train passing work area at excessive speed.

NYCT Division of Subways personnel are required to report all PEC near miss incidents immediately to their supervisors. The reporting protocol for supervision is as follows:

- Notify RCC immediately;
- Notify the Divisional Chief Officer immediately;
- Notify the Office of System Safety immediately; and
- Initiate an investigation within 24 h of the incident to determine the causative factors involved.

An incident report must be issued within 30 days of the incident to the Divisional Chief Officer of the employees involved and submitted to the Office of System Safety. That office produces and distributes quarterly reports that analyze the incidents by type, department, and operating division (14, p. 10.6).

The NYCT Office of System Safety shared a copy of its *2010 Year End Near Miss Trend Analysis* with the study team. During the calendar year 2010, 15 PEC-type near miss incidents were reported, the same amount as in calendar year 2009 (15, pp. 1–2). The report provided a detailed analysis of the different types of incidents (i.e., portable trip overrun, improper flagging, potential employee contact/miscellaneous) and a review of the incidents, contributing causes, and departmental responsibilities. It also requested corrective action plans from departments with multiple related incidents.

## RULES VIOLATIONS

None of the agencies interviewed had a structured process for employees reporting rules violations. Generally, reports and complaints would be made by MOW employees about train operators violating speed restrictions, or by train operators about improper flagging arrangements or unprotected employees on the tracks. These reports are made verbally to the Control Center or supervisory personnel. The reports are investigated by management, and disciplinary actions are taken when warranted.

Several agencies have implemented structured management processes to identify and take corrective actions on rules violations. These approaches go beyond what is required by the State Safety Oversight program to audit job sites. The MBTA Safety Department conducts approximately 100 random safety audits of work sites each year to check for proper use of equipment and flagging procedures. If inadequate flagging protection or equipment is observed, work is stopped until the situation is corrected and a determination is made on how work may proceed safely. Employees cited for violating rule book procedures can be subject to discipline.

The TTC has a Quality Assurance unit within its Safety Department. It includes seven staff members and a unit supervisor who focus on safety performance in operations, ROW maintenance, and vehicle maintenance. The information from their audits and evaluations is used to develop reports and analyze trends in rule compliance and overall system safety.

The NYCT Office of System Safety conducts 350 to 400 safety inspections of on-track work each year in conjunction with union representatives. The purpose of these surprise inspections is not to “catch” workers doing the wrong thing, but rather to identify safety issues and take corrective actions. The inspections are executed primarily at night when most construction and maintenance work is performed and includes work with both NYCT and contractor crews. An inspection report is completed and reviewed with the job supervisor and forwarded to management. Issues identified through the inspection process are investigated to determine if system-wide measures are needed (e.g., rules changes, employee information). Feedback from the inspections is also funneled to training personnel so information can be incorporated into existing courses. In 2010, supervisors who received consistently good marks on safety inspections were recognized.

In addition, to the Office of System Safety efforts, the Department of Subways has implemented auditing initiatives. The Senior Vice President of Subways convenes a quarterly audit team that conducts inspections of work activities on the tracks. The results of the inspections are forwarded directly to him or her for corrective actions. The MOW Division also recently began conducting weekly “Safety Blitzes.” The blitz team usually consists of about 26 management (superintendent and manager level) representatives from inside the various

disciplines within the MOW Division. The team is broken down into small groups of three to four people from different disciplines (i.e., track, signals). Each small group conducts multiple inspections during its safety blitz tour of duty. If rule violations are discovered during an inspection, the team instructs the workers on proper procedures. If there are blatant violations jeopardizing the safety of the workers, the work is stopped and the job site is shut down.

The results of the Safety Blitz inspections are reviewed with the supervisors in charge of the work sites. The intent of the program is to improve the safety culture. MOW management believes there have been many benefits. The cross-discipline teams have promoted understanding and knowledge-sharing across the different work classifications. Management's commitment to the program and its focus on correcting behaviors, not administering disciplinary actions, demonstrates to employees that the organization is serious about safety. Finally, management's direct observation of work sites has led to the realization that certain work rules are not feasible in the "real world."

MOW management reviews accident statistics, near miss incident investigations, safety inspections, Safety Blitzes, and other relevant trend analyses at quarterly Safety Enhancement Briefings for all employees.

#### **ONGOING DATA EVALUATION AND CONTINUOUS IMPROVEMENT**

All the agencies interviewed strive continually to improve safety through everyday experiences, inspections, audits, investigations, and the like. NYCT's Office of System Safety stresses data analysis as a tool for identifying problem areas and determining the effectiveness of practices to reduce

hazards and enhance safety. The office maintains and updates a variety of databases to generate reports, provide data to regulatory agencies, and to support data analysis. Those relevant to ROW worker protection include:

- Employee Accident Database System;
- Employee Fatality Database;
- Near Miss Database; and
- Contractor Accident Database (*14*, pp. 9.1–9.5).

The data analysis enables the organization to identify common trends and problems and to determine if the number of incidents is increasing or decreasing over specific time periods. Trend analyses focus on employee and customer accidents, near miss incidents, fire incidents, and common deficiencies resulting from inspections, audits, investigations, reviews, and surveys.

#### **CONCLUSION**

The challenge of getting employees to make reports that would incriminate fellow workers was raised frequently. Each agency had specific reporting procedures for accidents and accident investigation processes. However, structured processes for reporting near miss incidents or rules violations did not exist, with the exception of NYCT's near miss reporting requirements. All the agencies took swift and corrective actions when rules violations were uncovered but some, excluding NYCT, acknowledged that they could do more with regard to data tracking and analysis. NYCT personnel, including representatives from the Office of System Safety and the Department of Subways, viewed the data tracking and trend analyses put in place as the result of their Track Safety Task Force initiative as significant improvements and valuable tools in addressing ROW worker safety.

## CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

A 300% increase in the number of track worker fatalities and injuries from 2003 to 2008 clearly demonstrates an industry-wide issue regarding right-of-way (ROW) employee safety and protection. The objective of this study is to report the state of knowledge and practice regarding wayside worker protection programs at selected transit agencies and to document the state of the practice, including lessons learned and gaps in information.

The research revealed that, in the wake of these incidents, some rail transit systems took aggressive actions to form task forces or reconstitute “Rules Committees” to revisit ROW rules and procedures and make necessary improvements, enhance employee training programs, and implement more comprehensive auditing and investigative processes. Most of these were collaborative efforts, involving labor and management representatives from several departments.

Three major findings were identified as a result of this endeavor. First, there is an effort at every one of the five systems included in the study to improve continually the safety and level of protection for their ROW workers. Second, deviations in systems’ program depth and complexity varied. Some of these deviations were based on the environmental and operational hazards and characteristics of the systems, whereas others reflected organizational cultural characteristics or historical practices. Third, aside from a high-level standard developed by APTA for work zone safety in rail transit, there are no national resources, standards, or consensus relating to rail transit track worker safety programs.

There were a number of similarities and differences in the track worker protection programs of the five systems studied. Collectively, the employees interviewed at each agency expressed a sense of pride in their work and their affiliation with their respective organizations, as well as a sense of accomplishment in improving track worker safety. Without fail, every employee, from senior manager to junior laborer, stated that his or her workplace was safer than in the past. The programs are continually evolving, based on reviewing and refining practices and training programs; testing of new technologies; auditing rules compliance; and, in some cases, tracking and analyzing data on incidents, near misses, and other metrics.

Although there is a sense of conviction and commitment on the part of the managers responsible for daily oversight of maintenance-of-way work and safety, there is also a level of

uncertainty concerning the depth and degree to which managers can evaluate the program other than the obvious measure of the number of accidents or incidents. Sentiments echoed at several of the systems were, “How safe is safe?” and “How do we know if what we are doing is enough, too much, or just right?”

Down at the track level, where safety practices actually get used, front-line employees at one system stated that they had a good understanding of the rules, but not the hazards that the rules are intended to protect them from. This underscores the priorities that system managers must highlight on a daily basis. There is a clear need to emphasize rules compliance and a consistent pattern of enforcement and disciplinary actions for violations. This is achievable through implementing and communicating clear, easily understood, and structured rules and procedures. Yet there is also a need to focus on hazard recognition and mitigation—on both systemic and individual levels. This can be accomplished through engaging and interactive training programs, labor–management partnerships, safety campaigns, and a top-down and bottom-up prioritization of safe practices and principles. The two principles or approaches are not mutually exclusive but, rather, complementary. Implementing a program that incorporates both concepts will bring an agency closer to establishing a safety culture within the organization and implementing a sustainable and practical approach to system safety.

New or “out-of-the-box” approaches to reduce track worker hazard exposure could also be explored more extensively in the rail transit sector. For example, railroads—such as Class 1 freight railroads—have been using vehicle-mounted video and sensor-based technologies for years to inspect track gauge, wear, and metal fatigue. The possible use of this technology in rail transit applications could significantly reduce the need to put lone or small groups of inspectors on the ROW. Most of the study interviewees concur that these small, roving inspection teams are at a greater risk than are crews at larger, established work sites.

Specific findings within the study revealed a number of factors that the systems identified as significant in their track worker safety protection:

- The importance of rules and procedures to provide structure, guidance, and administrative oversight of employees and contractors working on, around, or near the ROW;

- A basic strategy of ROW-specific rules and enabling procedures, supported by frequent training and consistent enforcement, has been implemented by all the agencies studied, with some variation of emphasis on one component or another.
- A number of training initiatives have been implemented to train, inform, and prepare track workers better to carry out their duties safely. Most of the training programs use lecture and presentation delivery methodologies.

A number of programmatic consistencies in work site practices exist across the agencies interviewed, but significant deviations exist in such elements as staffing levels, terminology, protection level determination, established “safe distances,” or the use of equipment in protective measures. Environmental and operational factors play a role in this to some extent—such as the amount of elevated ROW or the off-peak headways between trains—however, other variations in the tolerance for lone workers, the process for setting up flagging, the length of training, and methodology for performing audits and investigations do not appear related to these factors. Additional research, as well as an effort to develop a comprehensive model plan based on an industry consensus of successful practices, could help identify true, factor-based deviations and establish baseline standards and consistencies. Such a plan could help drive the dialogue within the industry and agencies regarding the need for balanced, proactive approaches to improving safety, and also provide the resources to help implement or enhance safety protection programs.

Post-work analysis, such as safety audits, incident reporting, data analysis, and other follow-up actions, is an area that can easily be neglected owing to other demands and priorities, some agency personnel report. Industry efforts to develop comprehensive practices for auditing work sites, as well as identifying off-the-shelf software applications and relevant guidelines for customizing them to efficiently track accident, near miss, and rules violations data could make these practices more practical, productive and widespread.

Building on these findings, further studies could explore a variety of topics, including:

1. The development of a rail transit track worker protection program guidance document, including a “Model Plan” that outlines, in some level of detail, the steps in developing or updating a program; core practices of a program; optional practices that could be considered, depending on specific hazards or characteristics; training elements; incident tracking methods; and other components. This document would help create a more detailed baseline for a track worker protection program than is currently available and help increase industry-wide consistency in program implementation and management.
2. An assessment of current practices and programs for tracking accidents, incidents (such as minor injuries), near misses, and rules violations with an emphasis on trend analysis-based initiatives, as opposed to disciplinary-based programs. A second phase in this effort could be to develop a standard tracking and analysis program and guideline that transit systems could use to enhance their ongoing data analysis and continuous improvement efforts.
3. The development of performance measures with which transit systems could gauge the overall effectiveness, from both safety and risk perspectives, of their track worker protection program and consider the “value added” of a variety of approaches and practices. This tool would help answer the question, “Do we know what we’re doing is the right thing?”
4. The development of a comprehensive and interactive ROW hazards training program and collateral materials for maintenance-of-way workers to increase industry-wide consistency in hazard identification, reporting, and mitigation, ultimately to increase track worker safety. The program could be developed in a manner similar to other national courses in the public transit sector, taught as an off-the-shelf course or customized by an agency to incorporate system rules, procedures and specific hazards.
5. The development of a similar, comprehensive, high-quality training course for supervisors, focusing on hazard assessments and mitigation and on managing rules compliance within the work force. Ultimately, the way an agency practices track worker safety is the result of how front and mid-level supervisors routinely inform and educate their subordinates on safe practices and enforce rules and procedures. This program could be developed in a similar fashion as the training initiative outlined previously.
6. The exploration of the use of technology-based inspection methods, such as rolling stock- or high-rail vehicle-mounted video cameras and sensors in the railroad industry, their applicability to the rail transit environment, and their utility in reducing hazard exposures to track inspectors.
7. An assessment of the current practices and system standards for defining and establishing safe zones in rail transit environments, such as niches, platforms, between-tunnel passageways, and other areas deemed acceptable areas of refuge during train movement, along with practices of marking safe zones and unavailable or restricted zones such as those with no clearance, or niches or passageways that are occupied by fixed equipment.

## GLOSSARY

- Adjacent tracks**—Two or more tracks with track centers spaced less than 25 ft apart.
- Approach end**—Direction from which trains will come toward a work zone, toward employees walking along the track, or entering a station in normal direction of travel.
- Automatic Train Protection (ATP)**—System that continuously displays the maximum authorized speed, actual speed, and operating mode, and enforces compliance with the speed by an audible warning and an application of the brakes if the speed is exceeded.
- Block**—Length of track with defined limits, on which train movements are governed by an automatic block signal system or by instruction of the Control Center.
- Clear of all mainline tracks**—Distance of not less than 7.5 ft outside the rail (10 ft from the centerline) of all mainline tracks, unless track center spacing is 25 ft or more.
- Controlled point**—Location at which signals are controlled automatically or manually.
- Controlled track**—Track upon which a railroad’s operating rules require that all movements of employees, roadway maintenance machines, equipment, and trains must be authorized by the Rail Control Center.
- Crossover**—Switches and tracks arranged to provide a route from one track to another.
- Devil strip**—Narrow area between opposite direction tracks where there are no pillars or center bench.
- Emergency stop**—Button that activates track brakes, emergency friction brakes, and track sanding to bring the rail vehicle to a quick, irretrievable stop.
- Equipment**—Any machinery that is utilized on the track, highway, or elsewhere.
- Exclusive track occupancy**—Method of establishing working limits on controlled track in which the authority to move trains and other equipment is transferred by Light Rail Control to the on-site coordinator.
- Fixed signal**—Signal of fixed location along the track indicating a condition affecting the movement of a train. May be a block signal, speed limit sign, slow zone disc, or any other type of signal.
- Flagger or flagperson**—Person dedicated to protecting work crews by watching for oncoming vehicles and following prescribed procedures to assure that vehicles do not enter work areas until all workers are off the ROW. Flaggers are in charge of assuring safe passage of vehicles past work sites.
- Foul time**—Method of establishing working limits on controlled track, in accordance with Roadway Worker Protection Rules, in which a roadway worker is notified by the Rail Control Center that no trains will operate within a specific segment of controlled track until the roadway worker reports clear of the track.
- Fouling a track**—Placement of an individual or equipment in such proximity to a track that the individual or equipment could be struck by a moving train or on-track equipment.
- High-rail vehicle**—Truck or automobile with retractable flanged wheels that permit it to be used on either roads or tracks.
- Inaccessible track**—Method of establishing working limits on non-controlled track by physically preventing entry and movement of trains and equipment.
- Individual train detection**—Procedure that permits a lone worker to acquire on-track safety by seeing approaching trains and leaving the track 15 s before a rail vehicle or track maintenance machine arrives.
- Interlocking**—Arrangement of signals and signal appliances interconnected so that their movements must succeed each other in a prearranged sequence. Permits vehicles to pass safely from single track to double track and vice versa.
- Job/site briefing**—Discussion conducted with a work crew prior to the start of work on the ROW that includes information on the means by which on-track safety is to be provided, and instruction on the safety procedures to be followed.
- Light rail vehicle**—Transit vehicle with AC propulsion utilized for transportation of patrons.
- Locomotive**—One or more units propelled by any form of energy, operated from a single control, and used in train or yard service.
- Lone worker**—Individual worker who is not being afforded on-track safety protection by another worker, is not a member of a work crew, and is not engaged in a common task with another worker.
- Mainline track**—Track where scheduled trains are operated.
- Niche**—Indentation in a tunnel sidewall that provides a safe haven for authorized personnel working on the right of way to ensure clearance of oncoming vehicle traffic.
- Non-controlled track**—Track upon which employees, trains and roadway maintenance machines and equipment are permitted to move without receiving authorization from Rail Control Center.
- On-site coordinator**—Trained and qualified employee who communicates with the Rail Control Center and designates the working limits, type of on-track safety to be used, and assigning and positioning of work crew, flaggers, and watchpersons/lookouts. The on-site coordinator conducts the job briefing before any roadway worker fouls the track.
- Open cut sections**—Sections of subway or light rail track area that are not in a tunnel.
- Out of service (track)**—Section of track that is not safe for operation, or is restricted from use as a result of maintenance.
- Personal protective equipment (PPE)**—Clothing, equipment, and accessories designed to provide a barrier against workplace hazards. When used properly, protects workers against known hazards.
- Portable train/trip stop**—Device that attaches to rails that will cause the train to enter emergency brake mode in the event that an operator fails to obey the signal system or flagger.

- Qualified employee—Person who has been formally tested and approved within the length of time required for a specific purpose by an authorized representative of the employer.
- Regular train—Train designated by schedule.
- Restricted speed track areas—Area in which subway/light rail vehicles are required to reduce speed. Under normal circumstances there are no workers in the area unless a “walking inspection” has been granted.
- Right-of-way—mixed street—Trackway located in a street lane that is reserved for the use of trains. Motor vehicles may use the trackway lane when necessary to pass an obstruction.
- Right-of-way—private—Trackway reserved for the exclusive use of trains, which may include grade crossings.
- Roadway worker—Employee or contractor performing job functions on a railroad’s ROW. Also referred to as railway worker, railroad worker, and track worker.
- Roadway Worker Protection Manual*—Rules and instructions issued in a book under this title containing safety and operating rules to define the responsibilities of on-track workers and procedures for protecting them.
- Running rails—Rails comprising the track upon which a train moves.
- Signals—Illuminated colored aspects (or lights) that give information to the operator about speed, routing, and train operations.
- Signal violation—Occurs when a subway or light rail vehicle operator does not obey a restrictive signal. This may involve a signal train stop contact or the front of the subway vehicle going past the signal without tripping.
- Subway vehicle—Passenger trains, work car vehicles, or any other vehicle that operates in the subway system.
- Third rail—Energized rail, the source of 600 V of electricity that power rail transit vehicles.
- Track—Space between the rails and a space of not less than 7.5 ft outside each rail (10 ft from the centerline).
- Track equipment—Self-propelled or other equipment or machinery when used on the track.
- Track level—Any location off the station platform, past the end gate, wall to wall (any part of the tunnel structure), fence to fence (any property between the fences in an open cut area), or any catwalk not protected by a yellow railing.
- Track switch—Device used to divert vehicles from one track to another.
- Traction power—Electrical power that makes subway and light rail vehicles move. Supplied through the traction power rail(s). When traction power is on, the traction power rail(s) are “live.”
- Traction power interruption—May occur because power has been cut at an emergency alarm station or because something is wrong with the electrical supply. When traction power is off, the traction power rail(s) should still be treated as if they were live.
- Train operator—Employee who controls the movement of the train.
- Trip/train stop—System of on-board and wayside equipment that automatically stops a rail vehicle when a stop signal is passed.
- Warning device—Cone, flag, lantern, strobe light, flashing light, or other device, which has been approved by an agency, that warns vehicle operators that they are approaching personnel on or near the right of way.
- Watchperson/lookout—Employee who has been annually trained and qualified to provide warning to roadway workers of approaching trains or on-track equipment. Should be properly equipped to provide visual and auditory warning, with whistle, air horn, white disc, red flag, lantern, or fuse. Sole duty is to look out for approaching trains and on-track equipment and provide at least 15 s advanced warning to employees.
- Work area—Part of a work zone where work is being done.
- Work crew—Group of two or more individuals working as part of a team within a specified work zone.
- Work zone—Area identified with lights or track level warning devices signifying employees working at track level.
- Yard—System of tracks used for the making up of trains and storing of cars, upon which movements must be made in yard mode, at yard speed, subject to applicable rules and special instructions.
- Yard area—Area where trains are stored, repaired, or maintained.
- Yard tracks—All tracks used for car storage, repair, or other purposes.



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# APPENDIX A

## Transit Agency System Maps



FIGURE 28 New York City Transit Subway map.



FIGURE 29 MBTA Rapid Transit map.



FIGURE 30 TTC Subway/Scarborough RT System map.

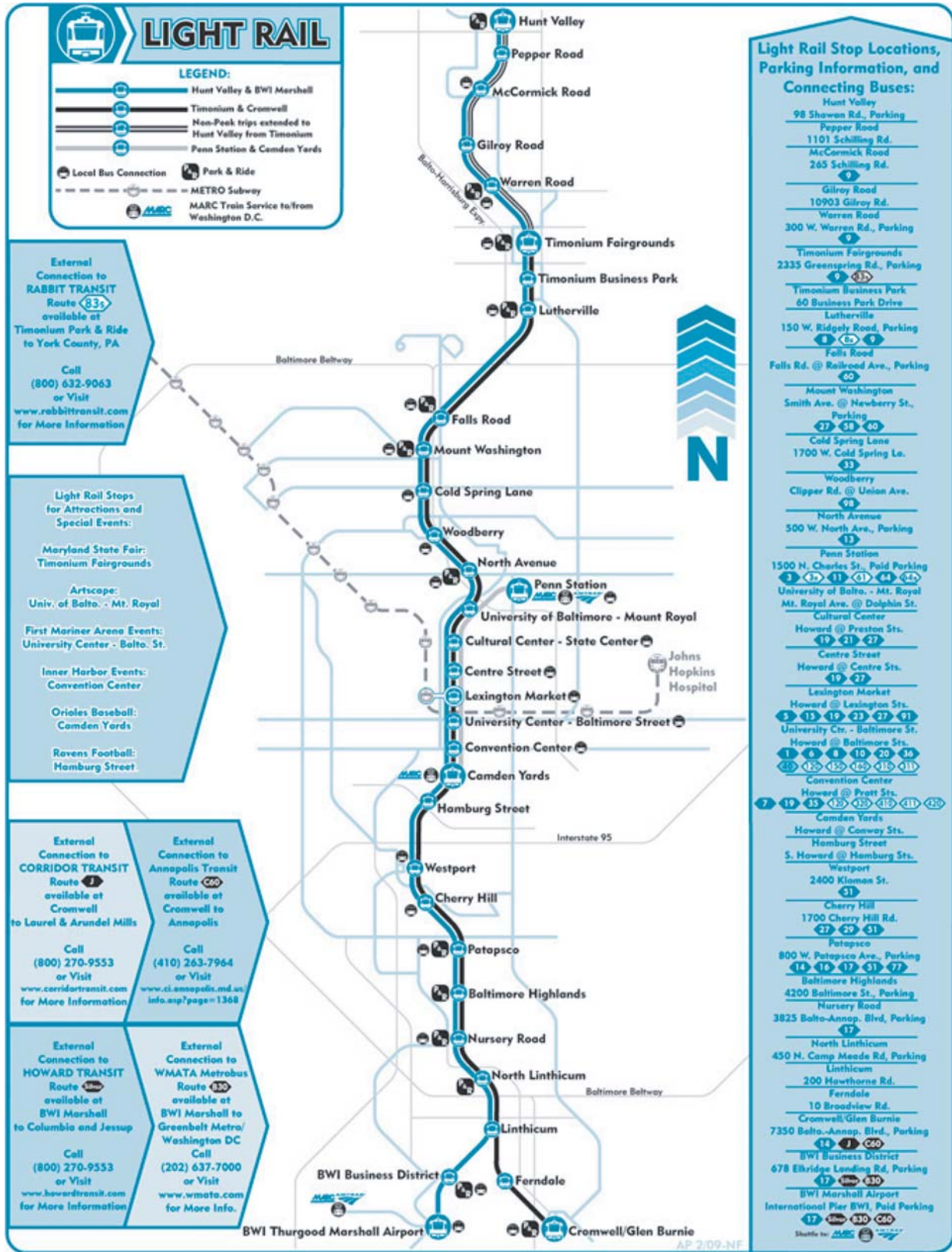


FIGURE 31 Maryland MTA Light Rail System map.



FIGURE 32 NJ River LINE System map.



## APPENDIX B

### Agency Interview Guide

#### TCRP Synthesis J-07/Topic SF-15 – Interview Guide

#### Practices in Wayside Rail Track/Transit Worker Safety Protection

Agency Name: \_\_\_\_\_ Date: \_\_\_\_\_

#### Section I: Rules, Training, and Certification

##### Section I-A: Rules

1. What crafts are governed by rules on ROW safety procedures? (Check all that apply.)
  - Track
  - Traction Power
  - Communications and Signal
  - Buildings, Facilities and Bridges
  - Vehicle/Rolling Stock Maintenance
  - Operators
  - Control Center Employees
  - Emergency Responders
  - Other: \_\_\_\_\_
  
2. Are employees and contractors governed by the same rules?
  - Yes
  - No (if no, please explain why): \_\_\_\_\_
  
3. Do employees and contractors receive a “hard copy” rule book?
  - Yes for both employees and contractors
  - Not contractors (if so, why): \_\_\_\_\_
  - Neither (if so, why): \_\_\_\_\_
  
4. Are those receiving a copy of the rule book required to sign a receipt that they received and read the rule book?
  - Yes
  - No
  
5. Are ROW rules and practices for MOW workers concurrent with ROW emergency response procedures for operators and customers?
  - Yes
  - No
  
6. Are MOW workers knowledgeable of ROW emergency response procedures for operators and customers?
  - Yes
  - No
  
7. If “Yes,” how are they made aware of these procedures?
  
8. Are these procedures in the “rule book”?
  - Yes
  - No
  
9. What department is the lead in developing and updating ROW rules?
  - Safety
  - ROW Maintenance
  - Operations
  - Training
  - Combination of listed departments
  - Other: \_\_\_\_\_
  
10. Are Labor/Management Committees used in developing and/or revising rules?
  - Yes
  - No

11. What is the composition of the L/M Committee, how often do they meet, and are they accountable to any organization and/or labor senior officials?
12. How were your ROW rules, policies, and practices developed?
- From scratch
  - After reviewing existing sources at other transit systems
  - Copied directly from other transit system sources
  - By a consultant/contractor
  - Other: \_\_\_\_\_
13. How often are ROW rules updated?
- Every year
  - 2 to 5 years
  - 5 to 10 years
  - Greater than 10 years
  - As needed
  - After an incident
  - Other: \_\_\_\_\_
14. How long has it been since the last revision was made to your agency's ROW rules?
- Less than 1 year
  - 1 to 3 years
  - 3 to 5 years
  - 5 to 10 years
  - Greater than 10 years
15. How are the rules communicated to new employees? (Check all that apply.)
- Training
  - Rule book distribution
  - Supervisory direction
  - Employee/worksites briefings
  - Bulletins
  - Other: \_\_\_\_\_
16. How are revised/new rules communicated to existing employees? (Check all that apply.)
- Training
  - Rule book distribution
  - Supervisory direction
  - Bulletins
  - Other: \_\_\_\_\_
17. Are employees required to sign a document upon receiving/reading new/revised rules?
- Receiving:
    - Yes
    - No
  - Reading:
    - Yes
    - No

#### Section I-B: Rules Training

18. What training is provided regarding ROW rules and procedures?
19. Are all employees and contractors covered by ROW rules put through the same training programs?
- Curriculum:
- Yes
  - No (if not, explain): \_\_\_\_\_
- Course session:
- Yes
  - No (if not, explain): \_\_\_\_\_
20. What department in your agency is the lead for developing ROW rules training?
- Safety
  - Training
  - Maintenance
  - Operations
  - External Source

21. How many departments provide ROW rules training for employees, contractors, transit police, and external emergency responders? (Please identify the departments and the audiences they provide the training to.)
- 1
  - 2
  - 3
  - 4
  - 5
22. How was your ROW rules training program(s) developed?
- From scratch
  - After reviewing existing sources at other transit systems
  - Copied directly from other transit system sources
  - By a consultant/contractor
  - Other:
23. How often is the curriculum(s) updated?
- Every year
  - 2 to 5 years
  - Greater than 5 years
  - As needed
  - After an incident
  - Other:
24. How is the ROW rules training program(s) delivered?
- Classroom (Instructor led): Duration is \_\_\_\_\_ hours
  - Classroom (Peer-to-peer): Duration is \_\_\_\_\_ hours
  - Computer-based/on-line: Seat-time length is \_\_\_\_\_ hours
  - On-the-job/in-the-field
  - Combination of above options (please describe): \_\_\_\_\_
25. Are employees tested upon completion of ROW training?
- Yes (Min passing score: \_\_\_\_\_)
  - No
26. Are contractors tested upon completion of ROW training?
- Yes (Min passing score: \_\_\_\_\_)
  - No
27. What happens to participants that do not achieve the minimum test score?
- Dismissed/terminated
  - Re-trained and re-tested up to \_\_\_\_\_ times
  - Reassigned
  - Other (please explain):
28. Are employees and/or contractors certified upon successful completion of ROW training and/or test?
- Yes
  - No
29. Do employees and/or contractors need to be recertified in ROW rules?
- Yes
  - No
30. If they need ROW rule recertification, how often is it required?
- Annually
  - Every 2 years
  - 3 to 5 years
  - Greater than 5 years
31. Are the ROW rules recertified by:
- Repeating the original class
  - Retaking the original test
  - Retaking the original class and test
  - Taking a specific recertification class
  - Taking a specific recertification test
  - Taking a recertification class and test
  - Other:

32. How is the ROW rule recertification class and test delivered?
- Classroom—Duration: \_\_\_\_\_ hours
  - Computer-based/on-line—Seat-time length: \_\_\_\_\_ hours
  - In-the-field—Duration: \_\_\_\_\_ hours
  - Some combination of above (please explain): \_\_\_\_\_
33. Which best describes the instructors who conduct ROW training:
- Rail instructors
  - Safety trainers
  - Senior ROW employees
  - Supervisory employees
  - External/contractor instructors
34. Are L/M Committees used in developing and/or revising training programs?
- Yes
  - No

### Section I-C: Flagging Training

35. What training is provided on flagging rules and procedures?
36. What audiences are given flagging training? (Check all that apply.)
- All ROW employees
  - Specific ROW employees
  - Contractors
  - Transit police officers
  - External emergency responders
37. Are all employees (and others) assigned to do flagging put through the same training programs?
- Curriculum:
- Yes
  - No (if not, explain): \_\_\_\_\_
- Course session:
- Yes
  - No (if not, explain): \_\_\_\_\_
38. How often are workers assigned to flagging trained on flagging rules?
- Once, when hired
  - Twice a year
  - Every year
  - Every other year
  - Every 3 to 5 years
  - Only when rules are revised or new rules are issued
39. What departments do flagging training?
40. How often is the flagging training curriculum(s) updated?
- Every year
  - 2 to 5 years
  - Greater than 5 years
  - As needed
  - After an incident
  - Other:
41. How was your flagging training program(s) developed?
- From scratch
  - After reviewing existing sources at other transit systems
  - Copied directly from other transit system sources
  - By a consultant/contractor
  - Other:
42. How is the flagging training program(s) delivered?
- Classroom (Instructor led): Duration is \_\_\_\_\_ hours
  - Classroom (Peer-to-peer): Duration is \_\_\_\_\_ hours
  - Computer-based/on-line: Seat-time length is \_\_\_\_\_ hours
  - On-the-job/in-the-field: Duration is \_\_\_\_\_ hours
  - Combination of above options (please describe):

43. Are employees tested upon completion of flagging training?  
 Yes (Min passing score: \_\_\_\_\_)  
 No
44. Are contractors tested upon completion of flagging training?  
 Yes (Min passing score: \_\_\_\_\_)  
 No
45. How are employees who do not successfully pass the flagging test addressed?  
 Dismissed/terminated  
 Retrained and retested up to \_\_\_\_\_ times  
 Reassigned  
 Other (please explain): \_\_\_\_\_
46. Are employees and/or contractors certified upon successful completion of flagging training and/or test?  
 Yes  
 No
47. Do employees and/or contractors trained and certified as flaggers need to be recertified?  
 Yes  
 No
48. If they need flagging recertification, how often is it required?  
 Annually  
 Every two years  
 3 to 5 years  
 Greater than 5 years
49. Are they recertified by:  
 Repeating the original class  
 Retaking the original test  
 Retaking the original class and test  
 Taking a specific recertification class  
 Taking a specific recertification test  
 Taking a recertification class and test  
 Other: \_\_\_\_\_
50. How is the recertification class and test delivered?  
 Classroom—Duration: \_\_\_\_\_ hours  
 In-the-field—Duration: \_\_\_\_\_ hours  
 Computer-based/on-line—Seat-time length: \_\_\_\_\_ hours  
 Some combination of above (please explain): \_\_\_\_\_
51. Which best describes the instructors who conduct flagging training:  
 Rail instructors  
 Safety trainers  
 Existing flagging employees  
 Supervisory employees  
 External/contractor instructors
52. Are L/M Committees used in developing and/or revising flagging training?  
 Yes  
 No

#### Section I-D: Safety/Hazard Assessment Training

53. Do workers receive general safety training aside from what is presented in rules and/or flagging training, which includes hazard identification and assessment?  
 Yes  
 No
- If “Yes,” what training do they receive and how often?
54. What department in your agency is the lead for developing general safety (Hazard Identification) training?  
 Safety  
 Training  
 Maintenance  
 Operations  
 External Source

55. How many departments provide general safety (Hazard Identification), and/or hazard protection (i.e., confined space, respiratory protection) training for employees, contractors, transit police, and/or external emergency responders? (Please identify the departments and the audiences they provide the training to.)
- 1
  - 2
  - 3
  - 4
  - 5
56. How is the general safety (Hazard Identification) training programs(s) delivered?
- Classroom (Instructor led): Duration is \_\_\_\_\_ hours
  - Classroom (Peer-to-peer): Duration is \_\_\_\_\_ hours
  - Computer-based/on-line: Seat-time length is \_\_\_\_\_ hours
  - On-the-job/in-the-field: Duration is \_\_\_\_\_ hours
57. How often is the curriculum(s) updated?
- Every year
  - 2 to 5 years
  - Greater than 5 years
  - As needed
  - After an incident
  - Other:

#### Section I-E: Safety Inspections and Audits

58. Are track (worksite) safety inspections conducted?
- Yes (by whom?)
  - No
59. If “Yes,” how often are they conducted?
- Multiple times per day
  - Daily
  - Weekly
  - Monthly
  - Other (please explain):
60. Can the personnel conducting the inspections shut down a worksite or limit the scope and/or size of the worksite
- Yes
  - No
61. What is done with the findings of these inspections?
62. Are internal safety audits used to review rules, procedures, and/or training programs?
- Yes
  - No
63. Who performs the internal audits?
64. Are external safety audits used to review rules, procedures, and/or training programs?
- Yes
  - No
65. Who conducts the external audits?
66. Are the results of audits used to address gaps, revise rules, change practices, or modify training programs?
- Yes
  - No
67. If “Yes,” what are some examples?

**Section II: Worksite Protection****Section II-A: Briefings and Communications**

68. Are job briefings used at the start of every work day for ROW workers?
- Yes  
 No
69. Are job or task briefings combined with safety briefings?
- Yes  
 No
70. Are specific safety briefings conducted for each crew before they enter the ROW?
- Yes  
 No
71. Are specific safety briefings conducted when work crews move from one worksite location to another?
- Yes  
 No
72. Are safety briefings documented, including facilitator and participant names, time and location of briefing, and topics, issues, hazards addressed in the briefing?
- Yes  
 No
73. Are safety checklists used prior to entering the ROW or changing worksite locations?
- Yes, checklists need to be completed/filled in by employees  
 Yes, they are provided as a guide, no documentation/completion required  
 No, checklists are not used
74. If the checklists are completed, are the documents filed and retained in a specified location?
- Yes (if so, where)  
 No
75. Are work crews directed, through rules, to inform the control center each time they enter or exit the ROW?
- Yes  
 No
76. Is the control center required to inform work crews of every train movement through a work area?
- Yes  
 No
77. If “Yes,” how is this information/notification communicated?
78. Do work crews have the authority to request train movement stoppages or restricted speed operations through a work area?
- Yes  
 No
79. If “Yes,” how is this request made and who can make it?
80. Who can work crews communicate with directly? (Check all that apply.)
- Control Center  
 Work crews at other sites  
 Train operators  
 Supervisors  
 Transit police  
 Other: \_\_\_\_\_
81. According to rules or policies, is carrying personal cell phones at a worksite:
- Permitted  
 Prohibited  
 Not addressed
82. If carrying cell phones is permitted or not addressed, can ROW workers use cell phones at the worksite?
- Yes  
 No

83. If cell phones are not permitted, what is the penalty for carrying and/or using one while on duty?
84. How many radios are provided to each work crew and to whom?
- 0
  - 1
  - 2
  - 1 for each employee on the crew
85. Are radios assigned to work crews equipped with “Emergency” or “Alert” buttons?
- Yes
  - No
86. Can the location of radios assigned to work crews be tracked or identified by the control center?
- Yes
  - No
87. Have there been problems with the reliability of this technology?
88. Are codes or signals used in radio communication procedures between work crews and/or with the control center?
- Codes and signals are used in normal working conditions and emergencies
  - Codes and signals are used only in emergency situations
  - Codes and signals are not used in radio communication
89. Are there pre-identified radio “dead-zones” on your rail system?
- Yes
  - No
90. Are work crews permitted to work within these dead-zones during revenue service periods?
- Yes
  - No
91. Are there specific procedures for working and/or communicating in dead-zones?
- Yes
  - No
92. Does your agency have contingency plans for dealing with radio failures?
- Yes (please explain): \_\_\_\_\_
  - No
93. Are these contingency plans communicated to ROW workers through: (Check all that apply.)
- Training
  - Rule book
  - Briefings
  - Other:
94. Are work crews required by rules to exit the ROW in the event of radio failure?
- Yes
  - No

#### Section II-B: Personal Protective Equipment

95. Do worksite rules clearly define what, when, and where PPE is required to be worn and/or used?
- Yes
  - No
96. What personnel protective equipment (PPE) is provided to ROW workers? (Check all that apply.)
- Hard hats
  - Eye protection
  - Safety vests
  - Safety gloves
  - Safety shoes
  - Audible warning devices
  - Hand lights
  - Rain and/or cold-weather gear
  - Other: \_\_\_\_\_



97. Is this equipment permanently issued to ROW workers or available at the worksite?
- Permanently issued
  - Issued at a worksite
  - Other: \_\_\_\_\_
98. Are ROW workers trained and directed to properly store, inspect, and test their PPE?
- Yes
  - No
99. Are ROW workers permitted to work if any of their PPE is missing, compromised, or not functioning properly?
- Yes
  - No
100. Are ROW workers disciplined if any of the PPE is damaged or missing?
- Yes
  - No
101. Who is disciplined if there is a worksite PPE rule violation?
- Employee
  - Crew supervisor
  - Both
  - Neither
102. What are the disciplinary procedures for PPE rule violations:
103. Is there a clear process for ROW workers to follow to replace or repair damaged PPE?
- Yes
  - No

#### Section II-C: Signaling and Train Control

104. Does your agency's signal system allow the control center to manually prohibit and/or restrict train movement speed through a worksite?
- Yes
  - No
105. Does your system use Positive Train Control (PTC) or similar technology to prevent or restrict train movement through a worksite?
- Yes
  - No
106. Is traction power managed through the control center?
- Yes
  - No
107. Can traction power be de-energized and isolated remotely and/or at the worksite
- Remotely
  - Locally
  - Both (Who, if either, has priority?): \_\_\_\_\_
108. If a separate console or department manages traction power, can work crews request traction power isolation directly and/or through the control center?
- Directly
  - Through the control center
  - Both
109. Does your agency use portable warning devices to monitor train movement?
- Yes
  - No

110. Does your agency use portable warning devices to monitor traction power status?
- Yes
  - No
111. If “Yes,” what type/brand is used, how many are in use around the system, how long have they been in use and have there been any issues with the reliability of the units?
112. Are employees informed/directed to use these devices through? (Check all that apply.)
- Training
  - Rule book
  - Bulletins
  - Briefings
  - Other: \_\_\_\_\_
113. Are employees trained and directed through procedures to properly store and test these warning devices between uses?
- Yes
  - No
114. Are there clear plans and procedures for dealing with warning device failure?
- Yes
  - No
115. Are ROW workers trained on these plans and procedures?
- Yes
  - No
116. If “Yes,” is this training provided by the manufacturer or internal-system source and if so, by whom?
117. Are workers directed to leave the ROW in the event of a device failure?
- Yes
  - No
118. What are track workers permitted to do when there is a worksite rules violation? (Check all that apply.)
- Continue working
  - Report the violation and continue working
  - Stop working and leave the immediate area of the ROW worksite
  - Stop working but remain at the worksite
  - Stop working, report the violation, and remain on the worksite
  - Report the violation and leave the worksite
  - Other: \_\_\_\_\_

#### Section II-D: Flagging

119. Is flagging protection provided to a worksite?
- Yes, on one side of the worksite
  - Yes, on both sides of the worksite
  - No
120. Is flagging protection provided by a designated employee with no other duties or responsibilities at the worksite?
- Yes
  - No
121. Are employees assigned to flagging protection duty specifically trained on the tasks, responsibilities, and procedures of flagging?
- Yes
  - No

122. What actions can flaggers take? (Check all that apply.)
- Warn operators of a worksite ahead
  - Warn worksite employees of an oncoming train
  - Stop and/or slow train movement
  - Other: \_\_\_\_\_
123. Are operators trained to acknowledge a flagger's "warning" or "slow" signal?
- Yes (how do they acknowledge?)
  - No
124. Are employees assigned to flagging protection visually distinguishable from other worksite employees by using different colored vests or hats?
- Yes (how are they distinguished from other workers?)
  - No
125. Are specific stand-off distances for flagging protection, between flaggers and the work area, established and communicated to all worksite employees?
- Yes (what are the distances?)
  - No
126. What equipment is provided to an employee assigned to flagging protection? (Check all that apply.)
- Flag (what colors?)
  - Colored lights/lanterns (what colors?)
  - Horn, whistle, or other audible warning device
  - Radio
  - Other: \_\_\_\_\_
127. Are flaggers directed to sound an audible warning in advance of all train movement through a worksite?
- Yes
  - No
128. If "Yes," what kind of device do they use, how often do they use it, and do worksite employees need to acknowledge the warning?
129. Are multiple flaggers used in limited sight-distance situations such as curves?
- Yes
  - No
130. Are employees assigned to flagging protection trained and directed in contingency plans for dealing with failures of their radio and/or audible warning device?
- Yes
  - No

#### Section II-E: Lone Employees on ROW

131. According to rules, are lone ROW workers and/or track inspectors permitted on to the ROW?
- Yes
  - No
132. Are lone ROW workers required to carry a radio while on the ROW?
- Yes
  - No, they are assigned a radio but not required to carry it on the ROW
  - No, they are not assigned a radio
133. Are lone ROW workers required to inform the control center each time they enter or exit the ROW?
- Yes
  - No
134. Are lone ROW workers required to give continuous updates regarding their location and status while on the ROW to the control center?
- Yes
  - No

Section II-F: Hazard Reporting/Mitigation

135. Does your agency have clear and specific rules and/or practices for mitigating, reporting, and/or managing hazards adjacent to a ROW worksite?

- Yes  
 No

136. If “Yes,” please explain:

137. What hazards do these procedures or practices address? (Check all that apply.)

- Vehicular traffic  
 Adjacent tracks  
 Adjacent ROWs of other transit systems or railroads  
 Adjacent system traction power  
 Adjacent public utilities (electrical, pipeline, water, sewer)  
 Other: \_\_\_\_\_

138. Does your agency have clear and specific rules and/or practices for mitigating, reporting, and/or managing ROW environmental worksite hazards?

- Yes  
 No

139. What specific hazards do these procedures or practices address? (Check all that apply.)

- Severe weather  
 Restricted clearances  
 Elevated work surfaces  
 Working above waterways  
 Working above vehicular or rail traffic  
 Confined spaces  
 High crime areas  
 Other: \_\_\_\_\_

140. Are these specific procedures covered and/or addressed in: (Check all that apply.)

- Training  
 Rule book  
 Briefings  
 Worksite checklists  
 Bulletins  
 Direct supervision  
 Control center communications  
 Other: \_\_\_\_\_

141. What equipment is provided to ROW workers when working in or around these hazards? (Check all that apply.)

- Fall protection  
 Hearing protections  
 Respiratory protection  
 Personal flotation devices  
 Electrical or gas powered warmers  
 Rain/snow tents  
 Other: \_\_\_\_\_

Section III: Incident Reporting, Investigation, Analysis, and After-Actions

142. Which of the following incidents are work crews required to report? (Check all that apply.)

- Accidents  
 Near-misses  
 Rules violations  
 Other: \_\_\_\_\_

143. Which of the following situations have specific reporting procedures? (Check all that apply.)

- Accidents (please describe)  
 Near-misses (please describe)  
 Rules violations (please describe)  
 Other: \_\_\_\_\_

144. Do the agency's policies encourage reporting by limiting or exempting employees reporting near misses and rules violations from disciplinary action?

- Yes
- No (if no, has it been considered?)

145. How are these procedures communicated to employees? (Check all that apply.)

- Training
- Rule book
- Briefings
- Bulletins
- Supervisory direction
- Control center communication
- Posted in an employee area
- Other: \_\_\_\_\_

146. Are there specific forms for employees to use when reporting: (Check all that apply.)

- Accidents
- Near-misses
- Rules violations
- Other: \_\_\_\_\_

147. Are these forms readily available to employees?

- Yes
- No

148. If "Yes," how/where are they available?

149. What is the lead department in investigating accidents?

- Safety
- Police
- Legal
- Human Resources
- Operations
- Other: \_\_\_\_\_

150. In the event of a train vs. employee accident or other incident that fouls the ROW, is train movement stopped:

- In the affected area
- On the affected line
- System wide
- Other: \_\_\_\_\_

151. What/who triggers train stoppages or restricted speed operations? (Check all that apply.)

- Report of an accident, injury, or fatality on the ROW
- The control center based on information or lack thereof
- The worksite supervisor
- Worksite employees
- Other: \_\_\_\_\_

152. What is the lead department in investigating near-miss incidents?

- Safety
- Police
- Legal
- Human Resources
- Operations
- Other: \_\_\_\_\_

153. What is the lead department for investigating rules violations?

- Safety
- Police
- Legal
- Human Resources
- Operations
- Other: \_\_\_\_\_

154. Are worksite rules or practices evaluated and/or modified following an incident?

- Yes  
 No

155. What department leads the effort to evaluate and/or modify worksite rules and practices?

- Safety  
 Maintenance  
 Operations  
 Other: \_\_\_\_\_

156. Are briefings/stand-downs conducted after: (Check all that apply.)

- Accidents  
 Near-miss incidents  
 Rules violations  
 Other: \_\_\_\_\_

157. What department leads the briefings/stand-downs?

- Safety  
 Maintenance  
 Operations  
 Other: \_\_\_\_\_

158. Who attends these briefings/stand-downs?

159. Are disciplinary actions taken after most near-miss incidents?

- Yes  
 No

160. If “Yes,” what are the procedures?

161. Is data relative to rules violations, near-miss incidents, and accidents compiled and analyzed?

- Yes  
 No

162. What department is responsible for managing incident data?

- Safety  
 Police  
 Legal  
 Operations  
 Maintenance  
 Other: \_\_\_\_\_

163. Does incident data analysis typically lead to revisions or modifications to: (Check all that apply and cite an example.)

- Rules  
 Practices  
 Training programs  
 Work site staffing  
 Communication procedures  
 The use, storage, and testing of equipment  
 Emergency response procedures  
 Other: \_\_\_\_\_

164. Did we miss anything concerning your system’s processes for identifying, assessing, prioritizing, and mitigating hazards for ROW workers? Please explain.

## **APPENDIX C**

### **List of Persons Interviewed**

#### **AMERICAN PUBLIC TRANSPORTATION ASSOCIATION**

Director—Safety

#### **MARYLAND TRANSIT ADMINISTRATION**

Executive Director  
Office of Safety, Quality Assurance and Risk Management

Manager, Light Rail Control Center  
Service Quality Division

Deputy Director  
Light Rail Operations

Training Supervisor, Signal Department  
Light Rail Operations

#### **MARYLAND DEPARTMENT OF TRANSPORTATION**

Program Director  
Office of Risk Management and Rail Safety

#### **MASSACHUSETTS BAY TRANSPORTATION AUTHORITY**

Operator  
Green Line

System Safety Engineer  
Safety Department

Supervisor of Transportation  
Construction

Safety Inspector  
Safety Department

Director of Safety & Light Rail Operations  
Rail and Transit Division

Deputy Director  
Operations Control Center and Training

Inspector  
Green Line

Construction Coordinator  
Green Line

Supervisor of Transportation  
Construction

Superintendent  
Green Line Transportation

Division Chief—Training  
Operations Control Centers and Training

**NEW YORK CITY TRANSIT**

Vice President  
Office of System Safety

Acting Vice President  
Maintenance of Way

Director, Hazard Assessment  
Office of System Safety

**SOUTHERN NEW JERSEY LIGHT RAIL TRANSIT SYSTEM (RIVER LINE)**

Acting System Safety Manager

**TORONTO TRANSIT COMMISSION**

Chief Safety Officer

Safety Liaison Inspector

Safety Liaison Officer

Superintendent—Communications, Bus & Rail

Superintendent—Training Rail Transportation

Superintendent—Training Rail Maintenance

Superintendent—Analysis & Procedures

Electrical Superintendent

Superintendent—Subways/SRT Track

Superintendent—Transit Control Center

Acting Superintendent—Streetcar Way

Chief Signal Engineer

Supervisor—Signals

Signal Maintenance—Safety Designate, Canadian Union of Public Employees

Equipment Operator—Track Level Safety Team

Railcars & Shops—Employee CARE Representative

Signals/Electrical/Communications—Employee CARE Representative

**BOMBARDIER**

Product Manager, Technology Solutions

Account Manager, Material Solutions, North America Transportation



## Abbreviations used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation